Archaeology and STEM in Primary School Education: Integration and Development

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by

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Abstract

This thesis is borne out of concerns about the uptake of science, technology, engineering and mathematics (STEM) education (and by extension, careers) amongst the UK population. Arguments for increasing the number of people participating in STEM, inspired the author to examine how archaeology might contribute. Archaeology occupies a unique position at the nexus of humanities, arts and STEM, making it a potential tool in engaging learners who have not connected with STEM via traditional means. Self-concepts and identity are critical contributors to STEM participation, fed by individuals' understanding of the skills and aptitudes they possess. This thesis explores the impact that engaging with archaeology can have on learners' perceptions of their abilities and suitability for STEM. Early STEM experiences are key indicators for future engagement, therefore this project focuses on primary level children.

233 pupils from 5 primary schools participated in three archaeological interventions, delivered throughout one academic year. Multi-modal data collection methods tracked potential changes in participants' STEM self-concepts. Data collection comprised questionnaires and child-friendly interview techniques to assess participants' perceptions of skills, aptitudes and identity. Participants demonstrated the capacity to develop nuance in their STEM perceptions throughout multiple peer discussions. Results highlighted shortcomings of the STEM acronym when considering skill usage, and revealed the importance of interdisciplinary education in supporting learners' engagement with concepts of ability and identity across the curriculum. Many participants did not fully appreciate the relationship between their interests and STEM practice, indicating that more can be done by educators to capitalise upon this. Curriculum reform, currently underway in Wales, represents a crucial opportunity to adopt a new approach to STEM education. Embedding interdisciplinary subjects like archaeology into primary education empowers learners to engage with skills/aptitudes throughout the curriculum, and supports individuals to understand the value of their contributions within STEM contexts.

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Chapter 1: Introduction

Science, technology, engineering and mathematics (STEM) education has acquired a position of national prominence due to widespread assumptions that STEM industries are key to future economic success (UKCES 2015; Social Market Foundation 2016, 5; Emsi 2018), and that STEM education is key to supporting those industries (Straw and McLeod 2013; BEIS 2017; NAO 2018). Much STEM engagement literature emphasises the importance of early experiences (Early Childhood STEM Working Group 2017; Simoncini and Lasen 2018; Dou *et al.* 2019), as children's natural curiosity and experimental play are an excellent basis for STEM exploration (Lucas *et al.* 2014, 11; Finegold and Jones 2016, 51). Research has shown young people's enthusiasm for STEM declines as they progress through compulsory education (Pell and Jarvis 2001, 857; Murphy and Beggs 2003, 111; AT Kearny 2016, 7), leading to arguments that their interest must be capitalised on in primary school (Turner and Ireson 2010, 129; Archer 2013a, 27). Formation of a STEM-aligned identity (Kyriacou and Goulding 2006, 17; Dou *et al.* 2019) is reliant on individuals' knowledge of how their skills and aptitudes are relevant and valuable in STEM (Macdonald 2015; Godec *et al.* 2017, 33). Therefore efforts to increase STEM participation should focus on providing access to STEM in ways that are personally meaningful and engaging. Despite extensive recognition of STEM's educational value, numerous barriers prevent young people from accessing STEM education and careers (Archer *et al.* 2013a; Macdonald 2014; APPG on Diversity and Inclusion in STEM 2020, 16).

Although archaeology is traditionally located in the humanities, it is increasingly STEM based. Archaeologists use a wide range of STEM skills, from basic concepts like problem solving, data collection and interpretation to highly technical analytical methods. This application of STEM-related skills in an unusual context is key to the aims of this project, though the intention is not to instil all participants with aspirations for an archaeological career. Instead it aims to examine the potential of archaeology in STEM engagement and STEM-identity development by providing a novel access point to STEM for lower KS2 pupils (aged 7-9). Taking STEM-based curriculum requirements and using them in a novel way allows individuals to recognise how their skillsets are applicable across a range of fields. To achieve this, participants were recruited from five schools across Cardiff and Hampshire. Three archaeological interventions were devised and delivered, and multi-modal data collection methods were used to assess their impact. This introduction outlines some major issues of STEM engagement: the 'crisis' facing the UK STEM workforce, and the key barriers to STEM participation faced by young people. It also argues for a social justice perspective of STEM engagement, and explores how archaeology is placed to enact this. The aim and objectives which guide this project are established, and a brief description of the thesis structure is provided.

1.1 STEM definition

The precise definition of STEM differs between publications and datasets, with organisations and authors using it to encompass varying combinations of sectors, subjects and industries (NAO 2018, 18). For example, the Higher Education Statistics Agency (HESA) separates subject areas into 'science' and 'non-science'; though HESA have a reasonably broad definition of 'science' subjects they do not include social sciences (HESA 2012), where others might argue that these should be considered alongside STEM (Lenihan *et al.* 2020). Though there is no universally agreed definition of STEM, the one used throughout this thesis is guided by the APPG on Diversity and Inclusion in STEM.

In education, it means the study of [STEM] *subjects. In secondary schools, other subjects sit under these terms including biology, chemistry, physics, statistics, computer science and design and technology. Outside of education, STEM refers to sectors of employment and industry which use the specialised skills associated with science, technology, engineering, and maths, rather than just subject knowledge.*

(APPG on Diversity and Inclusion in STEM 2020, 11)

This definition's emphasis on skills allow for more broad applications of the term 'STEM'. This is essential when attempting to engage people with STEM in a novel and personalised way. Providing new access points to STEM requires facilitators to consider STEM more broadly, to capture the interest of those who have not connected with it via traditional routes or definitions. Focusing on STEM-based skills allows individuals to identify how they already engage with STEM concepts in areas of personal interest. Recognising their current STEM aptitudes empowers young people to consider how they might be happy and successful in STEM, while making valuable contributions to STEM industries and research (Macdonald 2015; Godec *et al.* 2017, 33).

1.2 The STEM 'crisis'

A common theme in STEM engagement discourse is the supposed 'shortage' of people qualified to fill an increasing number of highly skilled STEM roles (Roberts 2002, 28; UKCES 2015, 52; Social Market Foundation 2016, 4; Finegold and Jones 2016, 5; BEIS 2017, 94). STEM industries are touted as essential for the UK's economic future (BIS 2013; Walker and Zhu 2013; Royal Academy of Engineering 2017, 4; STEM Learning 2018), and therefore requiring a high level of funding and investment (HM Government 2017, 25; NAO 2018, 30), often at the expense of arts and humanities sectors (Office for Students 2021, 14). Countless arguments have been made in favour of improving STEM engagement to meet this need (e.g. Finegold 2011; Archer *et al.* 2013a; Lucas *et al.* 2014; The Royal Society 2014a), whilst also questioning what that need is. A common critique of the 'shortage' discourse is the lack of data on supply and demand of STEM workers (Select Committee on Science and Technology 2012, 29) meaning that there is currently no '*robust, independent evidence base that defines the STEM skills problem'* (NAO 2018, 16). The notion of STEM shortage is also criticised for relying on unsuitable or inconsistent economic projections and datasets (Harris 2014, 57; Smith 2017, 186; NAO 2018, 18; Smith and White 2020, 4).

The STEM employment situation is much more complex than an issue of supply not meeting demand. An alternative perspective emphasises the issue of skills 'mismatch', where skills needed in the economy do not match those available in the workforce (NAO 2018, 21). Enrolments onto STEM degrees courses have remained static since the 80s (Smith and White 2019, 29). Annual Population Survey data indicates that over time, a majority of STEM graduates never progress to highly skilled STEM jobs, and those that do tend to be graduates of Russell Group universities (Smith and White 2019, 35-36). The most recent HESA data (2018/19) on STEM graduate outcomes shows that 81% entered high skilled roles, but only 12% progressed to 'professional, scientific and technical activities' (35% enter 'human health and social work', and a further 10% enter 'education': HESA 2021a)[1]. Disaggregating graduate outcomes by subject area reveals substantial differences in progression to 'professional, scientific and technical activities'; only 9% of biological science graduates achieved this, compared to 21% of physical science, engineering and technology graduates (HESA 2021a).

A similar picture arises in data on supply and demand of archaeologists in the UK, albeit on a much smaller scale and less frequently featured in national discourse. Recent surges in major infrastructure projects have seen increased demand for archaeologists, raising concerns over whether there are enough appropriately trained individuals to meet this (Hook *et al.* 2016). Concerns are reflected in the inclusion of archaeologists on the UK Government's skilled worker visa shortage occupation list (UK Visas and Immigration 2021). Since 2014, approximately 1000 students have enrolled onto archaeology undergraduate degree courses every year (HESA 2020a; HESA n.d.), but there are currently only around 6300 archaeologists working professionally in the UK (Aitchison *et al.* 2021a).

[1]In contrast to this, 13% of 'non-science' graduates progressed to professional, scientific and technical activities, though this largely comprises law graduates, 52% of which go on to occupy this Industrial Classification (HESA 2021a).

1.3 Key barriers to STEM engagement

Discussions around barriers to STEM engagement frequently focus on gender, ethnicity and socio-economic status (SES). Due to the wealth of literature on these issues (e.g. Engineering UK 2018a; Finegold and Jones 2018; WISE 2019; Morgan and Scarlett 2021), they are most broadly considered throughout this thesis. STEM education and employment has been dominated by white, middle class men (Francis *et al.* 2017; NAO 2018, Advance HE 2019), making it difficult for people outside of this demographic to see how they might 'fit' into STEM (Macdonald 2014). STEM is also frequently perceived as being inaccessible to 'non-clever' people resulting in low uptake amongst people with low STEM confidence, who are often female (Brown *et al.* 2008, 8; Archer *et al.* 2013b, 183; Bian *et al.* 2017, 390). STEM confidence is linked with prior attainment; those who have previously achieved high grades in STEM subjects are more likely to continue studying those subjects (The Royal Society 2008, 18; AT Kearney 2016, 9). Prior attainment is associated with SES (Gorard and See 2009, 118; Banerjee 2016, 2), meaning individuals from low income families are less likely to continue STEM education. Poor careers advice is another factor in STEM participation: many young people are unaware of the range of options available in STEM industries, or are unable to access them due to limited information on pathways into them (Archer *et al.* 2013a, 28; AT Kearney 2016; Committee of Public Accounts 2018, 6).

STEM engagement is increasingly discussed in terms of identity; those who recognise how they 'fit' into STEM are more likely to pursue it (Kyriacou and Goulding 2006, 17; Stevens *et al.* 2008, 358; Macdonald 2014, 12; Dou *et al.* 2019). Identifying with STEM (or otherwise) is subject to multiple factors: family influence in terms of advice, experiences and opportunities (Archer *et al.* 2012; Smith and Tyler-Wood 2020); representations of who 'does' STEM in popular culture and media (Moreau *et al.* 2009. 146; Chimba and Kitzinger 2010, 612; Steinke 2013, 4); being 'recognised' as suited to STEM, particularly in school (Carlone 2004, 405; Brown and Leaper 2010, 868; Boston and Cimpian 2018, 198; Hazari and Cass 2018); inclusion in STEM environments (Ong *et al.* 2011; Lindemann *et al.* 2016, 223; Jones 2016); whether STEM is perceived as compatible with other key identity markers (Cheryan *et al.* 2011, 657; Archer *et al.* 2013b, 178-9; Archer *et al.* 2014, 19-20). Identity is a key component of this project, though the focus is not on asking participants to change their identity, but to reflect on how STEM is compatible with current identities.

1.4 STEM and archaeology

Archaeology lies at the nexus between STEM, humanities, social sciences and the arts, incorporating a multitude of data collection, analysis, interpretation and dissemination methods across these fields. Current popular discourse situates STEM as being highly valued, at the expense of humanities and arts (e.g. Nussbaum 2017; Strauss 2017; Joby 2020; Sears and Clark 2020), and though it might be tempting to argue archaeology's value by preferentially highlighting its proximity to STEM (Cooney 2014; Colaninno 2019; Ardill 2021), this misses the point. Historically, the supremacy of science and technology was not so readily assumed: in 1933, the president of the British Association for the Advancement of Science argued that '*science is one of the humanities'* (Gowland Hopkins quoted in Collins 1978, 249) in response to contemporary perceptions that such utilitarian and labour-based work was beneath the highly valued study of human thought and existence. More recently, increased governmental focus on remaining internationally competitive in a global market has resulted in the rise of STEM to the top of educational and funding agendas (BEIS 2017, 94; Nussbaum 2017, 2; Office for Students 2021, 14).

These points illustrate how the perceived value of each field is subject to government policy and social perceptions of the day. Instead of arguing the importance of archaeology based on its alignment with shifting public opinion and policy, this thesis celebrates all aspects of archaeology. In the context of a project which seeks to provide access to STEM, based upon personal interests, skills and aptitudes, archaeology's interdisciplinarity is its greatest strength. The potential scope for study across archaeology provides multiple access points through which to engage with STEM, humanities and the arts, making it an excellent medium for STEM participation for those who align outside of STEM as well as those with an interest in it. This multidisciplinary style of learning benefits learners by allowing them to develop skills across a range of contexts (Donaldson 2015, 40), helping them to become critical, adaptive, active and ethical citizens (Epstein *et al.* 2010, 2; Lucas *et al.* 2014, 2; Nussbaum 2017, 86-7; RAE 2019, 24; Nuttall 2021).

Though archaeology's alignment with STEM does not elevate it above other humanities or arts disciplines, in a thesis with a specific focus on STEM, the case must still be made for archaeology as an appropriate vehicle for STEM education. Even before the rise of modern archaeological scientific analysis, early archaeologists and antiquarians used STEM-related knowledge and skills, such as observation, collection, quantification, categorisation and interpretation (Schnapp 2002, 137; Murray 2007, 18). Numerous scientific and technological methods for identifying, recovering, analysing and presenting archaeological artefacts and data now exist, from those made famous by popular culture and media (e.g. radiocarbon dating, geophysics, aDNA analysis) to those at the cutting edge of the profession (e.g. Cank *et al.* 2021; Miše *et al.* 2021; Ramsey and Nadel 2021; Scorrer *et al.* 2021). Outside the specific remit of archaeological science, archaeology utilises STEM-based skills such as data collection, analysis and interpretation, critical and logical thinking, and problem solving. These skills are highlighted in Welsh and English school STEM curricula (see Chapter 5) making archaeology an excellent discipline through which to explore school-based STEM.

1.5 STEM engagement as social justice

Myriad arguments have been made for the economic value of increasing STEM participation: for national and global economies (Atkinson and Mayo 2010; Hoyles *et al.* 2011; MBIE 2015; Innovation and Science Australia 2017; Noonan 2017), as well as for individuals, who are likely to have higher earnings (Emsi 2018, 16). This thesis recognises those arguments but seeks to examine STEM engagement from a perspective of social justice. Engaging with STEM creates active citizens, equipped with logical and critical thinking skills for creative problem solving, and social decision making (Epstein *et al.* 2010, 2; Finkel 2018, 45; Nicol *et al.* 2019, 1006; RAE 2019, 24). Widening STEM access is not simply about encouraging more people to 'become STEM', instead it should demonstrate the relevance of STEM in those people's lives. Linking personal experiences and aptitudes to STEM enables people to perceive it in a new light, where their expertise and contributions are valued (Godec *et al.* 2017, 33). Providing novel access points to STEM is key to enacting social justice; it empowers people who do not consider themselves aligned with STEM to explore STEM practice (and its associated cognitive and social benefits) in a personally meaningful way.

Social justice in STEM can also address issues of representation; historically a multitude of factors have prevented people from participating in STEM, and continue to have an impact today (see Chapter 2). Taking a perspective of social justice allows educators, employers and policy makers to recognise those barriers, and to take action to ensure that the STEM workforce represents the population that their work and research serves. This is particularly pertinent to archaeology, where 97% of the workforce are white (Aitchison *et al.* 2021c) and the majority have a middle class background (Aitchison *et al.* 2021d). Archaeology and heritage play a vital role in national identity and have the potential to be deployed in exclusionary ways (Diaz-Andreu 2008, 290-3; Gonzalez-Ruibal 2016; Frieman and Hoffman 2019); it is essential that this identity be constructed by, and genuinely reflect the people it represents.

1.6 Thesis aim and objectives

This research explores the impact of engaging with archaeology on young people's STEM identity development and aspirations. Participants were encouraged to reflect on their use of STEM skills and aptitudes in archaeological interventions, to gain a deeper understanding of how their current skills and aptitudes are relevant in a range of contexts, and to identify how their skillsets might be valuable in future pursuit of STEM. The project was situated in Cardiff and Hampshire reflecting the dual nature of this doctoral studentship, and broadening the research scope for comparison of the Welsh and English national curricula and the impact of differing educational policy. This research was guided by the following aim and objectives:

1.6.1 Aim:

To examine the potential of archaeology in STEM engagement and STEM-identity development by providing a novel access point to STEM for lower KS2 pupils (aged 7-9).

1.6.2 Objectives:

- Foster relationships with primary schools in target areas (Cardiff and Southampton) through local contacts and the *See Science* STEM Ambassador network

- Review Welsh and English KS2 curricula knowledge and skill requirements to identify opportunities for STEM and archaeology crossover

- Exploit STEM and archaeology-related curriculum requirements to devise a series of practical, interactive and problem-based learning interventions, to be delivered throughout one academic year

- Observe potential changes in participants' STEM self-concepts by assessing perceptions of skills, aptitudes and identity via quantitative and qualitative data collection methods

- Combine findings from each intervention and data collection method to ascertain participants' understanding and engagement with archaeology and STEM, and potential development over time

- Interrogate how common barriers to STEM manifest amongst participants and the potential of archaeology to address them

- Develop recommendations based upon findings for future directions for archaeology in primary education and STEM engagement

1.7 Thesis structure

The following outlines the structure of this thesis, from an examination of the major themes in STEM education and participation, to the development of the project, a summary and discussion of findings and recommendations for future directions of primary level STEM education policy. Chapter 2 explores the development of STEM subjects in formal education, common barriers faced in the pursuit of STEM education, and considers the impact of identity on STEM participation. Chapter 3 outlines the general principles underlying this research, and describes the participant sample and the data collection methods used throughout the project. Chapter 4 summarises a series of interviews conducted with teachers at participating schools, which provided the baseline of challenges and expectations for the project. Chapter 5 outlines three archaeological interventions delivered throughout the main research period, and examines the impact of interventions on participants based on their engagement with content. Chapter 6 examines the results of quantitative data collection, a questionnaire administered to all pupils participating in archaeological interventions, and situates findings in the wider context of STEM engagement.

Chapter 7 describes the results of a word sort exercise, undertaken with a sample of pupils from each school; results are examined for evidence of participant change in response to interventions. Chapter 8 examines interview participants' reflections on personal skills and aptitudes. The results of this are described and scrutinised for evidence of participant alignment with STEM, and potential shifts in self-concepts relating to STEM compatibility or aspiration. Chapter 9 presents the results of a survey, undertaken by interview participants at the end of the research period, which provides a 'final snapshot' of STEM perceptions and self-concepts. Chapter 10 considers the results to each data collection method in relation to each other, and identifies major themes and outcomes of the entire research project. Chapter 11 presents a series of recommendations, based upon the findings of this thesis; it advises educators and policy makers on how to action these findings and outlines steps for archaeology's contributions to the future of STEM engagement.

1.8 Chapter 1 summary

This chapter has introduced the concept of the 'STEM crisis', and briefly examined barriers to STEM participation. A working definition of 'STEM' for this thesis has been established, and social justice arguments for broader participation have been explored. This chapter highlighted the potential of archaeology as a vehicle for STEM engagement, and outlined aims and objectives to explore this proposal. The following chapter explores barriers to STEM participation in greater detail, and also examines the role of STEM subjects in current primary education.

2 Chapter 2: STEM education in the UK

This chapter examines the inequities in STEM participation in Wales and England. It explores the historical status of STEM in those education systems and describes their current form. Limitations on students' potential trajectories from school education to higher education (HE) are discussed; from institution specific educational policy and university entry requirements, to social factors, such as gender, class and ethnicity which contribute to the ways students perceive and interact with STEM. This chapter also examines the current role of archaeology in education, and how far the above issues of access manifest in this discipline. This chapter seeks to establish the scale and origins of pertinent issues from which it is possible to explore potential solutions.

2.1 STEM in the education system of Wales and England

Schools were first required to teach to a national standard in 1988, when the national curriculum was introduced (House of Commons: Children, Schools and Families Committee 2009, 9-13). The establishment of STEM subjects in the national curriculum has not been a straightforward process, requiring significant shifts in societal values and educational policy. In the case of engineering, advocates are still arguing for its inclusion on the pre-Key Stage 4 curriculum as a subject in its own right (Lucas *et al.* 2014; Finegold and Jones 2016). Inclusion of STEM subjects in education before the 20th century was inconsistent, and mostly reliant on campaigning of private individuals (Stow 1850, 303; Turner 1980, 591). Though the national curriculum is a relatively recent development in British education, it has undergone numerous alterations since its conception (House of Commons Children, Schools and Families Committee 2009; The Royal Society 2010, 7) and continues to be under review today (Donaldson 2015; Ofsted 2021). The Welsh curriculum is currently under reform, which will see school subjects desegregated into 'Areas of Learning'. This has major implications for lesson content and structure, providing greater scope to incorporate disciplines like archaeology into formal education. The following will consider the historical development of each STEM branch in school education by identifying their entry into English and Welsh primary school education, and tracking their subsequent development to the position they occupy today.

2.2 Science

The appearance of science in Welsh and English education was not straightforward; the passage from a fringe interest to the core of the national curriculum is described by some as a '*long struggle'* (Jenkins 2007, 265). This was largely thanks to sustained campaigning throughout the late 19th to mid 20th century by 'public scientists', who criticised the lack of politicians and civil servants with scientific training (Turner 1980, 605-607; Smith 2010, 190). They argued that this represented a barrier to science education's inclusion on the political agenda. In 1867, the Taunton Committee sought to oversee a curriculum for science on the basis that learning science was both useful and enjoyable (Schools Inquiry Commission 1868). The advancement of World War One, saw the conversation around scientific education shift to focus on the importance of a scientifically literate workforce in issues of national security (Turner 1980, 593; Smith 2010, 190). Growing demand for technically trained industrial workers post-World War Two, led to the realisation that science could no longer be ignored and that provision of science teachers was inadequate. Science education was subject to review in the Plowden Report in England (Central Advisory Council for Education 1967, 240-247), and the Gittins Report in Wales (Central Advisory Council for Education (Wales) 1967, 325-336). Following this, scientific attainment remained limited, and many schools' science teaching was deemed ineffective (DfES 1978, 58), however Key Stage 1 and 2 science attainment in England and Wales has since improved (The Royal Society 2010, 15, 21).

Science education was standardised and presented as a 'core' subject in the first National Curriculum, and has been subject to multiple revisions since then (The Royal Society 2010, 6; Harlen 2018, 21). The current KS1 and 2 science curriculum taught in England was introduced in 2013 (DfE 2013). The Foundation Phase 'Knowledge and Understanding of the World' curriculum, and KS2 science curriculum were introduced in Wales in 2008 (DfCELLS 2008a; DfCELLS 2008b). Despite remaining a core subject, science is not tested at national level in KS2 in England[2], or in Wales. Science is a compulsory subject until the end of Key Stage 4, though the way pupils may engage with it at this level differs. GCSE (KS4) science is commonly pursued as a 'double' or 'triple' award: triple science awards pupils individual GCSEs in physics, biology and chemistry. Triple science is touted as an excellent route into A level science, but criticised for excluding lower achievers (Archer *et al.* 2016, 299). While science remains compulsory until the end of KS4, it is clear that the routes pupils take impacts future participation (see section 2.6).

2.3 Technology

Technology in the Primary curriculum is taught in two subject areas: design technology (DT), and Computing or Information and Communication Technology (ICT).

[2] Aside from sample testing conducted every two years (STA 2013)

2.3.1 Design Technology (DT)

In the 1880s, a series of reports into technical education highlighted Britain's shortcomings, and suggested that the country's global industrial leadership could be challenged by other nations (Samuelson 1884, Montague 1887, 11-4). Provisions were made to facilitate better technical instruction, including better funding and new institutions (1889 Technical Instruction Act, 1891 Schools for Science and Art Act). In the 20th century, DT education remained dependent upon individual schools, with a mix of craft, design and technology being taught across the country (Smithers and Robinson 1992, 8-10). With the first national curriculum, formal requirements for technology were introduced for the first time (DfES and the Welsh Office 1990). However, producing a technology curriculum which conveyed the complexity of the subject, whilst also being actionable for teachers proved challenging (Smithers and Robinson 1992, 6). A review of the impact of DT education in 2003 found that DT had developed into a multidisciplinary subject, although it suggested that the links between DT, ICT, maths, art and science could be exploited more effectively (Harris and Wilson 2003, 169). It was also thought that the generalised nature of primary education (where teachers are not required to hold specialist knowledge) led to an overly simplistic way of teaching design (Mawson 2003, 118-20). The review also raised concerns that an increased emphasis on literacy and numeracy in primary education were impacting the time available for DT (Harris and Wilson 2003, 166). The current DT curriculum in Wales for KS2 was introduced in 2008 (DfCELLS 2008d); in England it was introduced for KS1 and 2 in 2013 (DfE 2013). DT is compulsory until the end of KS3, when pupils may choose to continue their studies to GCSE level.

2.3.2 Computing and Information Communication Technology (ICT)

ICT has taken many forms since the 1980s when it first appeared in schools as 'Computer Studies'. The Stevenson report (The Independent ICT in Schools Commission 1997) argued that ICT should be embedded in every aspect of education. Following this, Computer Studies was replaced by Information and Communication Technology (ICT). As the importance of computer and digital technology in modern life became apparent, the Government recognised a need for it in education. Digital technology was lauded as a way to revolutionise education (Robertson 2002, 405; Plowman and Stephen 2003, 150; Livingstone 2012, 10), both in terms of teaching digital skills, and to support and facilitate learning across the rest of the curriculum. By 1998, ICT was one of only five subjects tested by Ofsted, highlighting its perceived importance within the curriculum (Selwyn and Bullon 2000, 321).

The ratio of pupils to computers in schools improved during the 1990s (Robertson 2002, 404), and technology became embedded in classrooms e.g. interactive whiteboards, projectors

(Livingstone 2012, 10). However, ICT was widely regarded as dull by pupils, as the majority of teaching focused on the use of programs and applications, such as word processing (The Royal Society 2012, 5). Additionally, schools experienced difficulties in hiring teachers with relevant qualifications, and inadequate teacher training resulted in limited exploitation of ICT's potential (Beastall 2006, 108). This also resulted in a lack of confidence within pupils of their teachers' ICT ability (Selwyn and Bullon 2000, 328; Goodison 2002, 287).

In 2012, the Royal Society recommended that ICT be replaced by a system where Computer Science and Information Technology (IT) are taught together, underpinned by general digital literacy (The Royal Society 2012). This and other arguments about the range of potential transferrable skills in Computer Science (logical reasoning, problem solving), led to an overhaul in the English ICT curriculum (Brown *et al*. 2013, 4-8; DfE 2013). The current English KS1 and 2 Computing curriculum requires children to use computational thinking and programming skills in addition to developing and communicating ideas with technology (DfE 2013). The Welsh curriculum remains focused on ICT (DfCELLS 2008e), and is taught alongside the Digital Competence Framework, which covers wellbeing online, digital rights and licensing, and problem solving (Welsh Government 2018, 5). The new Welsh curriculum will reform ICT education to bring it more in line with the English computing curriculum (Welsh Government 2019a, 72). It will also include guidance on building physical devices (Welsh Government 2020, 208), which is especially relevant in the context of an increasing market for internet-connected and wearable technology devices (Government Office for Science 2021). ICT (Wales) and computing (England) are currently compulsory until the end of KS4.

2.4 Engineering

There is currently no specific provision for engineering in the primary or secondary curriculum. In the 19th century, state-mandated engineering education was often perceived as a risk to 'trade secrets', reflecting the nature of knowledge at this time which was specific to individual companies and machinery (Smith and Whalley 1996, 34). The prevalence of apprentice style training (Downey 2005, 585) and assumptions about manual labour components of engineering (Smith and Whalley 1996, 32) resulted in engineering being largely ignored by formal education. It was not until the 1980s that the links between the UK's engineer shortage and absence from formal education were highlighted (Finniston 1980). Despite recommendations for improvement, those concerns persist to this day (Finegold and Jones 2016, 9; Bianchi and Chippindall 2018, 4), as pupils' engagement with it remains sporadic (Clark and Andrews 2010, 586; Lucas *et al.* 2014, 3). Engineering is not a school subject in its own right, but does feature on maths, physics, computing and DT curricula; however, these subjects currently face serious challenges in specialist teacher recruitment and retainment (RAE 2019, 6), meaning pupil engagement with key engineering concepts remains inconsistent.

Under the new Welsh curriculum, physics, computing and DT will all be taught together under 'Science and Technology', providing greater scope to explore engineering in formal education. In contrast to this, the most recent English curriculum has been criticised for having an increased emphasis on knowledge, reducing opportunities to exploit the space between science, maths computing and DT where *'engineering comes alive'* (RAE 2019, 25). This deviation in STEM education pedagogy between Wales and England may result in inconsistent education and training for young people. Welsh teachers will require support to embed engineering in their pedagogy, but opportunities for continued professional development (CPD) remain limited. As of April 2020, only 81 out of 1129 CPD courses listed on the STEM Learning website were for engineering (Figure 2.1), 42 of which were aimed at primary educators (Figure 2.2).

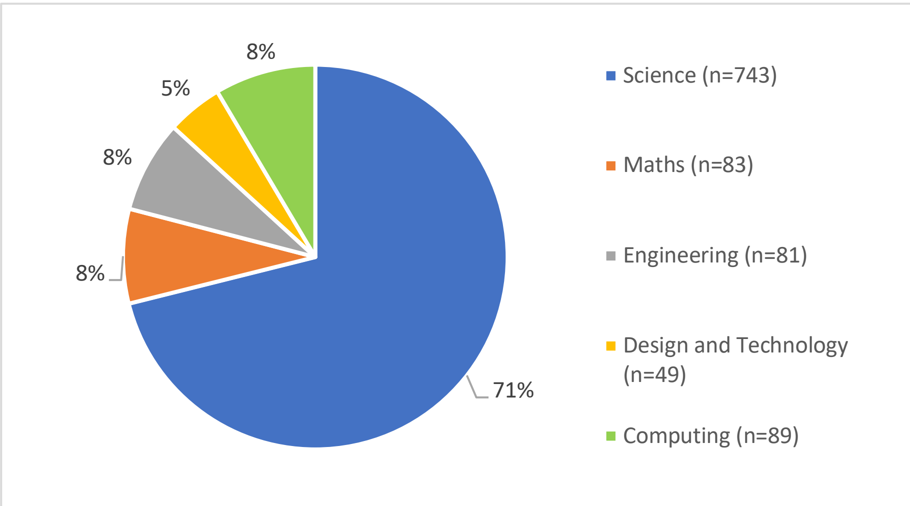

Figure 2.1: Breakdown of available CPD courses on STEM Learning website by subject.

Recommendations for engineering reform emphasise the potential of primary schools (e.g. Lucas *et al.* 2014, 3), due to children's '*natural curiosity and keenness to play and experiment'* which may be extinguished by secondary education (Finegold and Jones 2016, 51). The value of engineering education lies deeper than surface level knowledge; it facilitates critical thinking, problem solving and ethical judgement (Andrews and Clark 2013; RAE 2019, 24). These are essential skills for young people that will serve them beyond an engineering education and prepare them to be engaged citizens with a range of career options. Based on these factors, and the benefit to the national economy (Finegold and Jones 2017, 4) campaigners have re-asserted that engineering be better integrated into formal education (Lucas *et al.* 2014, 7-8; Finegold and Jones 2016, 48).

2.5 Maths

An 1858 education commission found that only 69.3% of children in schools (and only 33.8% in private schools) were taught arithmetic (Howson and Rogers 2014, 259). Following this, a system of assessment for schools and pupils was devised, and access to funding was dependent on attaining these goals. This system was abandoned in 1897, when it became clear that it was not having the desired effect on pupil attainment (Howson and Rogers 2014, 260). In 1938, the Mathematical Association set out to examine '*the teaching of mathematics to children up to the age of 11*' (Daltry 1938, 148). However, no major changes were made before the outbreak of the Second World War, and the next significant development in maths education was in 1955, with the publication of 'The Teaching of Mathematics in Primary Schools' (Mathematics Association 1955). This paved the way for a 'child-centred' approach to mathematical teaching in the 60s (Cornelius 1985, 33), and the introduction of a new range of mathematical concepts

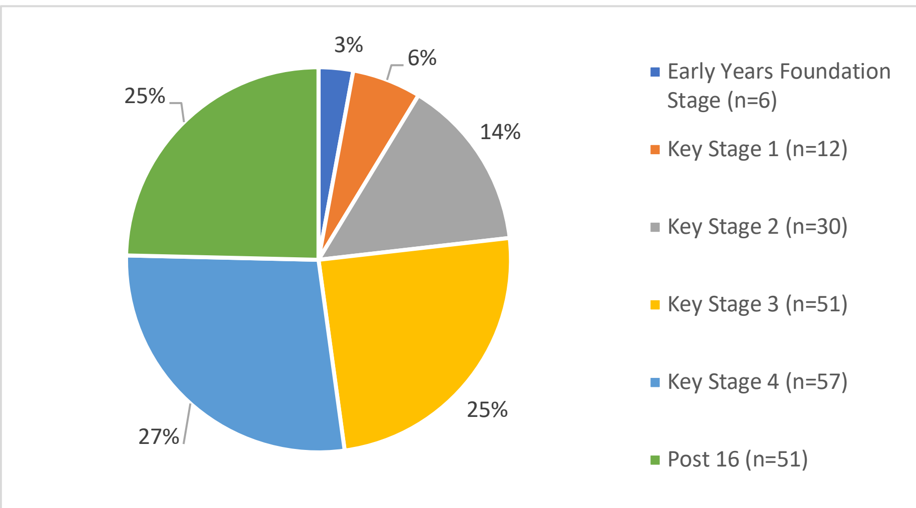

Figure 2.2: Breakdown of engineering courses by Key stage. In both graphs, courses may be listed as more than one subject or Key Stage, resulting in multiple entries for the same CPD course.

like logic and probability (Jones *et al.* 2005). In 1982, *Mathematics Counts* was published (Cockcroft 1982), which commended an investigative and practical approach to maths education in primary schools (Jones *et al.* 2005). From 1999, responsibility for education in Wales was devolved to the Welsh Assembly Government[3], and from that point national mathematics strategies became split (The Royal Society 2010, 8). That year also saw the implementation of the National Numeracy Strategy in England, which has been credited with significantly raising numeracy standards by 2010 (DfE 2011, 12). The Welsh Government also implemented a numeracy strategy (Welsh Office 1999), though this did not see the same improvements to maths skills (Jerrim and Shure 2016, 70).

The current primary maths curriculum in England was published in 2013 (DfE 2013), and a new Numeracy Framework was established in Wales in 2016 (DfES 2016). Maths is assessed at the end of both Key Stage 1 and 2 in England, and at the end of each academic year (from Year 2 – Year 9) in Wales in the National Reading and Numeracy Tests (Welsh Government 2012, 11). Maths is a compulsory subject in both Wales and England until Key Stage 5, when pupils make their A level choices.

2.6 Patterns of STEM participation in compulsory and higher education

The metaphoric 'leaky pipeline' of STEM refers to the attrition of individuals from STEM fields at each stage of educational or career development (Metcalf 2010; House of Commons Science and Technology Committee 2014, 11; Silim and Crosse 2014; Resmini 2016, 3533). Some researchers have questioned the accuracy of this metaphor: describing it as an active 'filter' rather than a passive loss of talent (Blickenstaff 2005); or as a reductive metaphor which requires simplistic (and therefore ineffective) fixes and does not reflect the lived experience of those pursuing STEM (Cannady *et al.* 2014). However, the pipeline metaphor holds some value as a chronological device for examining factors that impact STEM participation in individual's progression from school to university, and into a professional career. Individuals' interactions with STEM are often specific to academic and professional stages; the following will outline general patterns of STEM engagement throughout primary, secondary and higher education, and examine academic and institutional barriers to STEM participation. This will demonstrate the complexity of factors that influence individuals' STEM engagement post-primary school, and underlines the need to build strong foundations of STEM confidence, interest and identity in primary school.

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[3] Now known as the Welsh Government.

2.6.1 Primary School: Foundation Stage and Key Stage 1-2

In Wales and England STEM subjects are compulsory throughout primary education. However, frequency of engagement differs between subjects; maths is taught every day (Welsh Office 1997, 16; DfES 2006, 8), while science is covered at least once a week (Ofsted 2016, 5; Estyn 2017, 14). Computers are used across the curriculum (DfCELLS 2008e, 6-8; Ofsted 2011, 32-33) and most schools also designate specific time to each class to spend using IT each week. Though pupils do not make choices about which STEM subjects to study at this stage, there are other factors which affect their engagement with these subjects. Anxiety, particularly in maths, is associated with low enjoyment and attainment (Geist 2010; Rozek *et al.* 2019, 60), and while it is uncommon amongst primary aged pupils, it can still have an impact from an early age (Maloney and Beilock 2012, 404; Dowker *et al.* 2019). Though most children leave primary school with a reasonable level of enthusiasm for science (AT Kearney 2016, 7), some areas of science content are perceived as less enjoyable than others (Murphy and Beggs 2003, 114). Children's interest and enjoyment of ICT and computing can decline if the novelty of particular learning tools (e.g. Scratch programming) wears off (Wohl *et al.* 2015). Teachers' attitudes towards subjects also play a role in how pupils engage with them. Primary teaching is general rather than specialised, and many teachers do not hold STEM specific qualifications (The Royal Society 2010, 36; Brown *et al.* 2013, 14). As a result, numerous teachers have low confidence in teaching some STEM subjects (Murphy and Beggs 2005, 35; Murphy *et al.* 2007, 424), which influences pupil experiences (Geist 2015, 330).

2.6.2 Secondary School: Key Stages 3-5

Though many pupils initially express an interest in science when entering secondary school, this largely does not translate into STEM participation at A level (Gorard and See 2009, 112; AT Kearney 2016, 7). GCSE and A level choices can impact individuals' options to pursue STEM in the future (Schoon *et al.* 2007, 136; Smith 2010, 192, 194), so it is worth examining the contexts in which they are made. The perception of STEM subjects as more difficult than others is a major factor in pupils avoidance of them (Brown *et al.* 2008, 4; Coe *et al.* 2008, 135; Gorard and See 2009, 118). Individuals may avoid subjects that they believe they will fail (Gorard and See 2009, 107), and 'play it safe' with their GCSE and A level selections (Nardi and Steward 2003, 347; AT Kearney 2016, 9). Physics, maths and computing are frequently associated with people who possess 'innate genius', which can impact whether pupils feel these subjects are appropriate for them (Nardi and Steward 2003, 357; Mendick 2006, 63; Macdonald 2014, 12: Cheryan *et al.* 2016, 10). This is common amongst female pupils, who more often attribute personal success to hard work rather than 'raw talent', resulting in avoidance of subjects where 'genius' is perceived as necessary to succeed (Brown *et al.* 2008, 11; Bian *et al.* 2017, 390).

Consequently, prior attainment in STEM is a strong indicator of whether individuals choose to continue subjects at GCSE and A level (The Royal Society 2008, 18; Noyes 2009, 180; Smith 2010, 196). High grades allow individuals to integrate ‘STEM ability’ into their self-concept and identity, which is crucial to motivation and success (Schulz 2005; Kyriacou and Goulding 2006, 17-18; Mendick 2006, 63; Wong 2012, 44). School attainment is closely linked with socio-economic status (Gorard and See 2009, 118; Banerjee 2016, 2), which creates a socio-economic divide in who persists with STEM education. Institutional structures also have an impact, as students who do not take particular subjects or achieve certain grades may not be allowed to progress in their studies (Schoon *et al.* 2007, 138; Gorard and See 2009, 107; AT Kearney 2016, 12; APPG on Diversity and Inclusion in STEM 2020, 21). Additionally, the placement of students into learning groups (‘sets’) based on ability can impact pupils’ engagement (Kyriacou and Goulding 2006, 14). Placement in a lower ability set may compound individuals’ self-perception as a person who is not suited to that subject (Nardi and Steward 2003, 358; Brown *et al.* 2008, 11). This has implications for particular ethnic groups, such as boys with Black African or Caribbean heritage, as they are more likely to be placed in lower sets (Codiroli 2015, 25).

The way STEM subjects are taught and assessed impact pupil enthusiasm and preparedness for post-school education. Enthusiasm for subjects like science, where pupils value practical learning very highly (Gorard and See 2009, 112), may decline in response to the increased emphasis on exams and theoretical knowledge throughout secondary education (AT Kearney 2016, 17). Staff knowledge is key to preparing pupils for future study of non-curriculum subjects like engineering. Much of pupils’ engagement with engineering occurs via DT and maths, leading to concerns that pupils leave school with a limited understanding of what engineering careers entail (Finegold and Jones 2016, 19; Penlington *et al.* 2018, 29).

Inadequate career advice also impacts other STEM subjects, as many pupils have limited access to information on how qualifications translate into careers (Brown *et al.* 2008, 10; Archer *et al.* 2013a, 15; AT Kearney 2016, 10). However, in 2010 UK career advice services were completely defunded (Moote and Archer 2018, 188), and current access is associated with gender, ethnicity and social class; white boys with high cultural capital are most likely to receive it (Archer and Moote 2016). Many young people get career advice from parents, peers and subject teachers, rather than career specialists (Finegold 2011, 6), which can entrench existing inequalities if adults and peers have an equally limited knowledge of STEM careers. Young people also report receiving career advice ‘too late’ in their education, after they had already made A level subject choices (Moote and Archer 2018, 198). The result of all these factors, is that pupils are unaware of the full range of STEM-related career options, and therefore cannot access them.

2.6.3 *Higher education (HE)*

While progress has been made in recruiting undergraduates to STEM degree courses, it is largely undermined by high drop-out rates (Pinxten *et al.* 2015). Literature examining this phenomenon has focused on two interlinked areas: the transition between A level and university education, and the ways students adapt and cope with their first year in HE. Amongst some university lecturers there is a prevailing assumption that students are not equipped with the skills or knowledge needed to succeed in HE (Hoyles *et al.* 2001, 831; Jones 2018, 25; Deeken *et al.* 2019, 26). This is often attributed to an inadequate A level education; maths A level is frequently cited as failing to prepare students for degree level physics, engineering and mathematics (Hoyles *et al.* 2001, 831; Smith 2010, 196). Despite some evidence that entry grades are linked to student attrition (Soilemetzidis and Dale 2013, 2331; Bullough and Taktak 2018, 34), there is a growing appreciation that students' prior attainment must be viewed within their socio-economic context to fully understand their potential performance at university (Boliver 2013, 346).

It can also be argued that university STEM courses fail to match students' expectations. Course structure and content play a role in student disaffection, as does the learning environment of individual institutions or departments. Fast-paced lectures with large classes can feel impersonal and make it hard for students to connect with each other or the material (Baillie and Fitzgerald 2000, 152; Lindemann *et al.* 2016, 230; Hernandez-Martinez 2016). Self-perceived ability is a key predictor of HE academic achievement (Pinxten *et al.* 2015), and so these alienating factors contribute to feelings of inadequacy and 'imposter syndrome' amongst students (Lindemann *et al.* 2016, 222). Imposter syndrome and a sense of 'not belonging' can be felt even more keenly by Black, Asian and Minority Ethnic (BAME), or female students, who may not see others like themselves represented amongst their peers or faculty staff (Cheryan *et al.* 2016, 13; Lindemann *et al.* 2016, 233-4). Intersecting identities can result in women of colour experiencing feelings of isolation to an even greater extent (Ong *et al.* 2011, 183).

2.7 Impact of identity on STEM participation

The previous section demonstrates that the STEM pathway through school and university is complex. A person's identity and their perception of how that identity 'fits' into STEM is crucial to their participation in STEM (Kyriacou and Goulding 2006, 17; Mendick 2006, 63; Stevens *et al.* 2008, 358; Archer *et al.* 2010; Macdonald 2014, 12). Development of a 'STEM identity' is dependent on whether an individual perceives themselves as aligned with STEM, and how that is also 'recognised' and facilitated by the people around them (Dou *et al.* 2019). Barriers to developing STEM identity arise from intersecting personal and social factors, such as gender, ethnicity or socio-economic status (SES, Schoon *et al.* 2007, 149; Noyes 2009, 180; Wong 2012, 44; Codiroli 2015). These elements interact in different ways at different life stages, for example girls may become more aware of stereotypes regarding their ability in STEM as they age (Lindemann *et al.* 2016, 222; Bian *et al.* 2017, 389), whereas the impact of food insecurity and malnourishment on cognitive function (and therefore academic attainment) may affect a child from birth (Banerjee 2016, 8).

Families are highly influential in young peoples' opinions and decisions in pursuing STEM (Ong *et al.* 2011, 186; Archer *et al.* 2012, 883; Macdonald 2014, 19; Silim and Crosse 2014, 12). Many of the messages that individuals and their families absorb about 'who STEM is for' come from popular culture and media representations, which overwhelmingly represent those working in STEM as white, middle class and male (Moreau *et al.* 2009. 146; Chimba and Kitzinger 2010, 612; Steinke 2013, 4). These representations are reflected in reality: in 2019/20 the majority of physical and mathematical sciences, engineering and technology, and computing undergraduates were male, while 73% of STEM undergraduates were white (HESA n.d.). Low SES students are less likely to enter and complete engineering and technology degrees (Engineering UK 2020, 122), and to progress to a science-based career (The Royal Society 2014b, 27). Only 24.2% of people in the STEM workforce in 2019/20 were female (WISE 2021), and representation of minority ethnicity employees in STEM industries remains low (The Royal Society 2014b, 23; CaSE 2018; Engineering UK 2018b, 181).

While much STEM engagement literature has focused on gender, ethnicity and SES, other groups of people also experience STEM inequity; e.g. those with special educational needs and disabilities, of looked after status (children in care), and young carers (APPG on Diversity and Inclusion in STEM 2020, 16). Research into these areas is limited, so the focus of this section will be upon gender, ethnicity and SES with the caveat that other factors exist. A further limitation in the current body of literature is the acronym 'BAME'. Used to mean 'Black, Asian and Minority Ethnic', this acronym refers an broad range of ethnicities that may experience very little overlap in perceived identity despite being collected under a single term. While limitations of the BAME acronym are becoming more widely recognised (Centre for Social Justice 2020, 5; London Local Government 2020, 4; Milner and Jumbe 2020), much of the previous research into STEM engagement has been reported using these terms, and so they are used here when referring to the results of specific publications.

The following will consider the three characteristics separately for the sake of coherence, though they are not three separate agents that act individually. Instead many facets of an identity may intersect and amplify feelings of belonging or otherwise (Noyes 2009, 180; Johnson 2011, 79). The role of identity and social/ institutional structures in an individual's pursuit of STEM is complex, and the following summary is by no means exhaustive. Examples have been chosen to demonstrate this complexity and to emphasise the challenges in achieving the social and structural change needed to address the underrepresentation of non-traditional students in STEM.

2.7.1 Gender

It is widely understood that women and girls are underrepresented in STEM, despite there being no evidence for differences in ability (Silim and Crosse 2014, 5; NAO 2018, 26; Schleicher 2019, 31). Researchers have explored a range of ways in which STEM is assumed to be incompatible with female personalities and priorities: the impression that STEM is too competitive (Shapiro and Sax 2011, 8); women do not possess the 'raw talent' needed to succeed in STEM (Bian *et al.* 2017, 390); a STEM career is unsuited to family life (Ceci *et al.* 2009, 231); STEM personalities must reject feminine traits such as nurturing or social skills (Cheryan *et al.* 2011, 657; Archer, DeWitt *et al.* 2013, 178-9). Gendered assumptions about STEM can also impact individuals who do not align with traditional concepts of masculinity (Cheryan *et al.* 2016, 6), or choose to reject other perceived elements of STEM personalities, such as 'nerds' or 'brainy' (Archer *et al.* 2014, 19-20) regardless of their gender identity.

When women and girls *do* choose to pursue STEM, there appears to be further division amongst which branch of STEM they engage with (George-Jackson 2011, 165), leading researchers to reframe their enquiry from 'women's trajectories' to 'cultures of [STEM] fields' (Cheryan *et al.* 2016, 2). Women are substantially underrepresented in engineering and technology industries (Engineering UK 2018b, 170; WISE 2021), which can be traced back to low numbers of female enrolments onto STEM A levels (WISE 2020) and certain degree courses (HESA n.d.). In contrast to this, women are overrepresented in some STEM degree courses, such as medical and biological sciences (HESA n.d.). Though medical science graduates are extremely likely to enter highly skilled occupations, biological science graduates have relatively low rates of entry into highly skilled occupations (Figure 2.3).

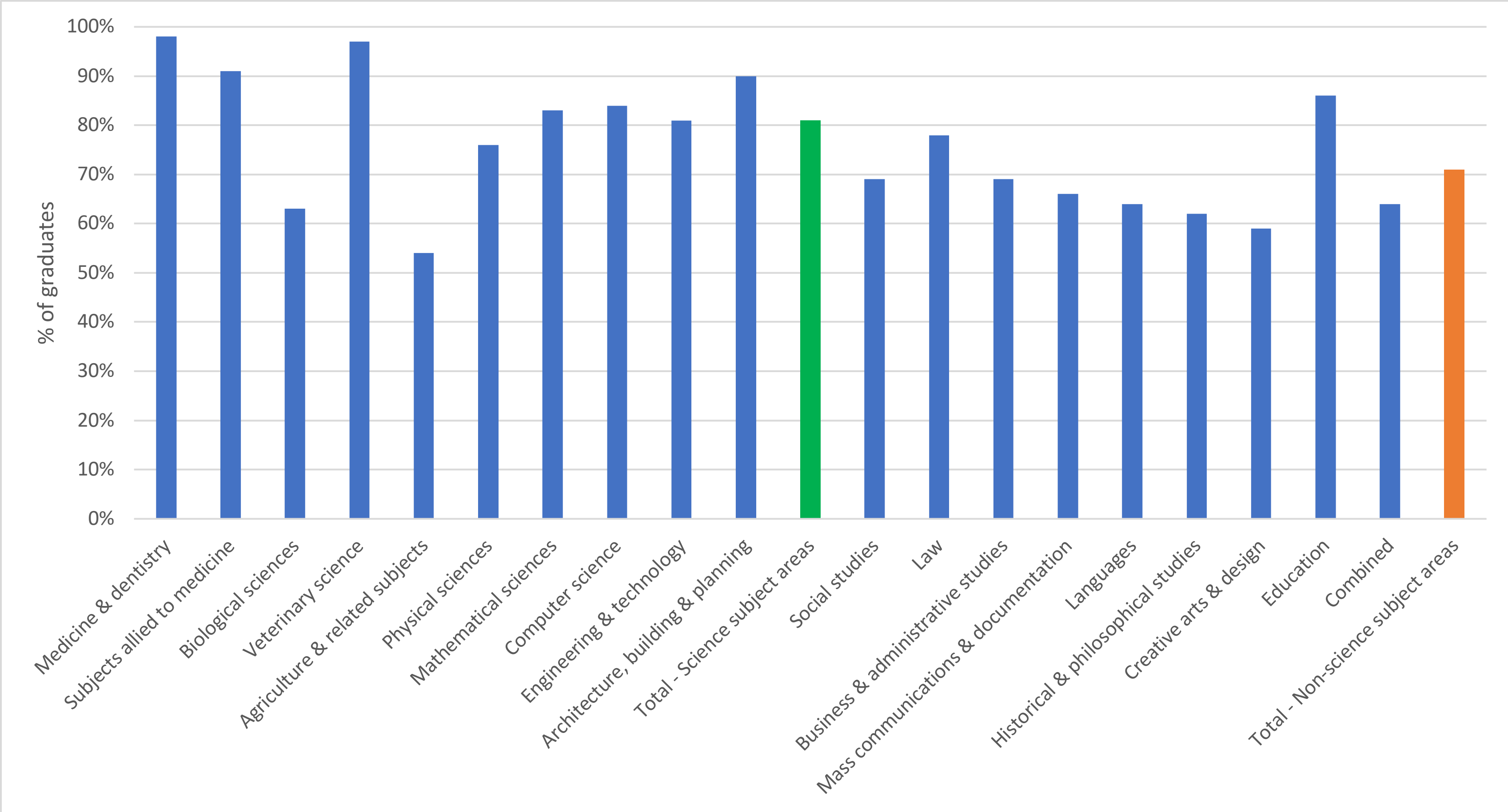

Figure 2.3: Percentage of graduates in high skilled occupations in 2018/19. Data from HESA (2021b).

2.7.2 Ethnicity

The impact of ethnicity on STEM participation is complex. Although STEM fields are largely regarded as being dominated by white men, in 2019 a higher proportion of BAME students studied science, engineering and technology (SET[4]) subjects than white students (50.3% compared with 47.3%: Advance HE 2019, 109). However, there are clear discrepancies between the proportion of students from Black or Asian backgrounds: only 5.5% of BAME SET undergraduate degree qualifiers in 2019 were Bangladeshi, and only 4.9% had Black Caribbean heritage (Advance HE 2019, 138). Ethnicity also impacts students' choice of STEM subject, with the majority of BAME students studying medicine or dentistry (37.6%) and fewer studying subjects such as computer science (28%) or veterinary studies (5.4%, Advance HE 2019, 109). Ethnicity intersects with gender, with women of colour less likely to be represented in key STEM industries and less likely to occupy positions of responsibility (STEM Women 2021).

Differences in representation are not due to a lack of interest or aspiration, both Asian and Black children are more likely to express science-related aspirations than white students (Archer *et al.* 2013a, 21). Differences cannot be explained by attainment either: while GCSE attainment of some BAME students[5] is lower than that of white students, when SES is taken into account their attainment is equal to or above that of white pupils (Strand 2014, 145). Instead it is likely that STEM aspirations do not translate into participation in post-16 education due to social or structural factors. BAME students may experience feelings of isolation on courses where they are underrepresented amongst peers (Walton and Cohen 2007; Johnson 2011, 80; Lindemann *et al.* 2016, 233-4) and academic staff (Cheryan *et al.* 2016, 13). In addition to this, BAME students must frequently navigate assumptions about their legitimacy as STEM practitioners, which can impede progression through academia (Ong *et al.* 2011, 183).

2.7.3 Socio-economic status

For the purposes of this summary, SES is regarded as an individual's access to variable economic, educational and cultural resources (The Royal Society 2008, 160). SES influences academic attainment, which is a strong predictor of STEM participation (Gorard and See 2008, 222; The Royal Society 2008, 18). SES is also linked to STEM aspirations (Archer *et al.* 2012, 894) and uptake of STEM at A level and in HE (Gorard and See 2008, 218; Gorard and See 2009, 103; Codiroli Mcmaster 2017, 13-4). Those with higher SES are more likely to attain a career in STEM,

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[4] HESA data uses SET rather than STEM, the website states that this is in order to include subjects such as nursing and agriculture, which may not be included in other definitions of STEM. HESA includes 'mathematical sciences' within the SET acronym.

[5] Bangladeshi, Pakistani, Black African and Caribbean

and access that career more quickly than those with a low SES background (TBR 2013, 18). Post-graduate qualifications are common amongst the scientific workforce (The Royal Society 2014b, 20), and access to those qualifications is also associated with higher SES (HESA 2021c).

The concept of 'STEM capital' is particularly important here. Developed by Archer *et al.* (2013a, 13) when researching science aspirations, this concept is used more widely here to cover all areas of STEM. Individuals with access to STEM resources, such as knowing someone in a STEM-based occupation, are able to gain insight into STEM education and industries that may not be available to those without (Archer *et al.* 2012, 898). STEM careers are generally high earning (Greenwood *et al.* 2011, 19-20; The Royal Society 2014b, 19; Emsi 2018, 16) and high status, meaning that those who occupy these roles are able to provide both insight into STEM and a relatively high SES to their children. Consequently, those children may be better placed to understand how a STEM education and career might be compatible with their identity and to pursue them.

2.8 Archaeology in the curriculum

Archaeology is recognised as an excellent opportunity for primary pupils to engage with historical enquiry, as the use of artefacts is highly accessible for younger children (Johansson 2019, 250). Archaeology is not currently a subject on the primary curriculum in its own right, though there is some scope to explore it via history curriculum requirements. These requirements differ between England and Wales, likely leading to varying levels of engagement with archaeology. Since 2013, British prehistory has been included in the English Key Stage 2 history curriculum (DfE 2013, 190); the nature of prehistoric source material necessitates the inclusion of archaeology to cover this requirement. The 2008 Welsh Key Stage 2 curriculum also has some provision for prehistory in the requirement that '*pupils should be given opportunities to study the daily life of people living in… the time of the Iron Age Celts*' (DfCELLS 2008f, 12). The Welsh KS2 and 3 history curriculum also specifies that artefacts ought to be used as part of '*a range of sources*' (DfCELLS 2008f, 13), opening opportunities to engage with archaeology further. Though teachers may choose to incorporate archaeology into other history lessons, it is this prehistoric content which is likely to comprise the most substantial exploration of archaeology.

Including prehistory in the curriculum presents challenges for teachers; these requirements were cited by English primary teachers as an area they felt they needed more support or training in (The Historical Association 2019, 19). Additional anecdotal data suggests that this arises due to a lack of prior experience in teaching prehistory or archaeology (Historic England

2018; University of Manchester 2019). School-based archaeology should not just be confined to prehistory: Henson (2016, 53-6) outlines many of the ways archaeology is suited to teach across the pre-Key Stage 4 curriculum, including archaeological knowledge and skills. Despite this potential, teacher access to archaeological resources is largely dependent on local provisions (e.g. SHARE with Schools n.d.; University of Manchester n.d.; Canterbury Archaeological Trust n.d.) and individuals' ability to identify and capitalise on them.

There are some STEM-based archaeological learning resources currently available to teachers from national heritage institutions and other educational organisations. Amgueddfa Cymru|Museum Wales provides a wide range of free digital learning resources including e-books covering topics like Roman medicine, Minecraft challenges, and construction activities (Amgeuddfa Cymru n.d.a). STEM-themed activity ideas are available from Cadw, however these activities are largely designed to be undertaken on a physical trip to the site, such as challenges based around mapping physical spaces (Cadw n.d.a, 5), and observing and categorising materials (Cadw n.d.b, 8). The STEM Learning website hosts a few archaeology-based activities such as 'Stone Age cheese making' (STEM Learning n.d.a) and Maritime archaeological problem solving (STEM Learning n.d.b). English Heritage also presents a few STEM-related activity ideas, including building a scale model of Stonehenge from biscuits (English Heritage 2019a, 46), Minecraft challenges (English Heritage 2019b, 60), and decomposition experiments (English Heritage 2022, 25).

In the past, archaeology was a GCSE and A level subject, promoted for its interdisciplinarity and potential to provide learners with a wide range of transferrable skills. The AQA exam board described archaeology on its website as:

> *'The ultimate subject for an 'all-round' student, in that it combines elements of many other academic disciplines, such as Science, Art, Technology, Geography, History, Sociology and Religious Studies. The study of Archaeology challenges students to understand and use a range of evidence to draw substantiated conclusions and raises their awareness of the uncertainty of knowledge'*
> Quoted by Tim Loughton (HC Deb 14th December 2016a)

Despite this, both options were removed due to low uptake. In 2003, there were only 92 archaeology GCSE candidates (HC Deb 15th September 2004) compared to 5,733,487 GCSEs taken in England (The Guardian 2003). In 2016, only 340 candidates sat archaeology A level (HC Deb 14th December 2016b) out of 769,340 A levels awarded in England in 2016 (Ofqual n.d.). A level archaeology was thought to be a key contributor to degree enrolments (Aird 2014, 27), and its discontinuation raised concerns that archaeology student numbers would decrease (CBA 2016; HC Deb 14th December 2016c). Assuming that all 340 2016 A level archaeology candidates continued study at degree level in 2017[6], they would have represented 32.5% of all archaeology first year undergraduates (HESA 2020d). Proportions of archaeology degree enrolment have decreased steadily since 2017/18 (Figure 2.4), with the most recent data[7] reflecting the lowest number of first year archaeology undergraduates in the past five years (Table 2.1). This decrease is not as substantial as a hypothetical 340 archaeology A level holders, but still demonstrates the influence of pre-university education on archaeology degree uptake.

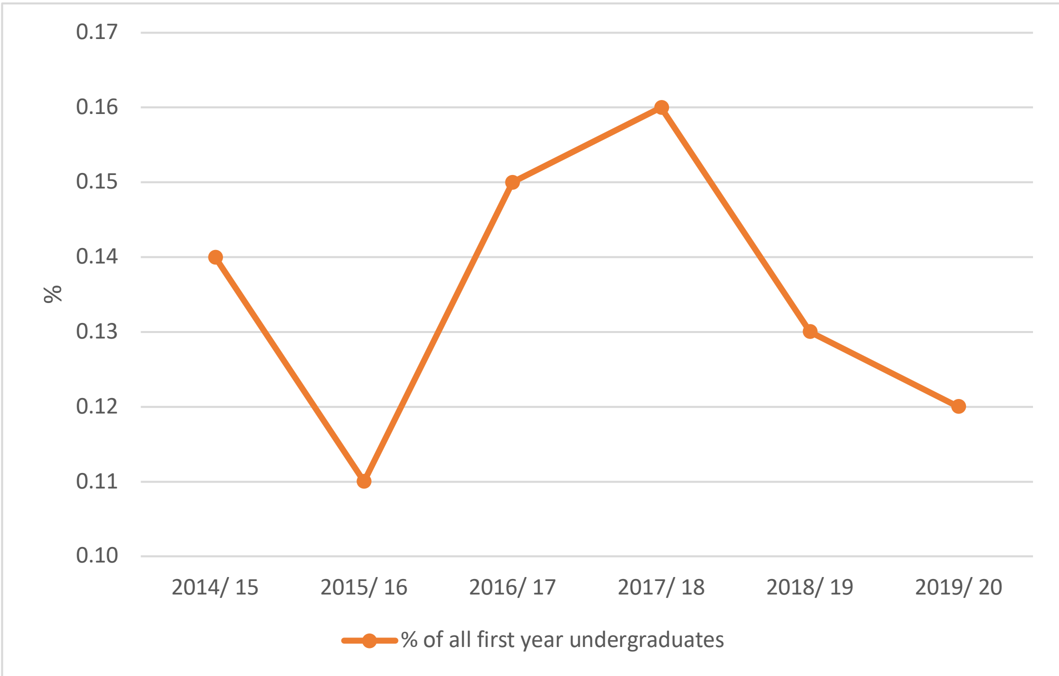


Figure 2.4: Percentage representation of archaeology first year undergraduates in the entire first year undergraduate cohort from 2014-2020. 2019/ 20 data: HESA 2022; 2014-2019 data: HESA 2020d.

[6] The final year that A level archaeology was an option.

[7] At the time of writing, 2020/21 HESA data does not disaggregate by specific subject (i.e. archaeology).

Year	First year undergraduate archaeology students	% of all first year undergraduates
2014/ 15	945	0.14
2015/ 16	1090	0.11
2016/ 17	1020	0.15
2017/ 18	1045	0.16
2018/ 19	910	0.13
2019/ 20	895	0.12

Table 2.1: Number of first year undergraduate enrolments onto archaeology degree courses in the UK from 2014-2020. 2019/ 20 data: HESA 2022; 2014-2019 data: HESA 2020d.

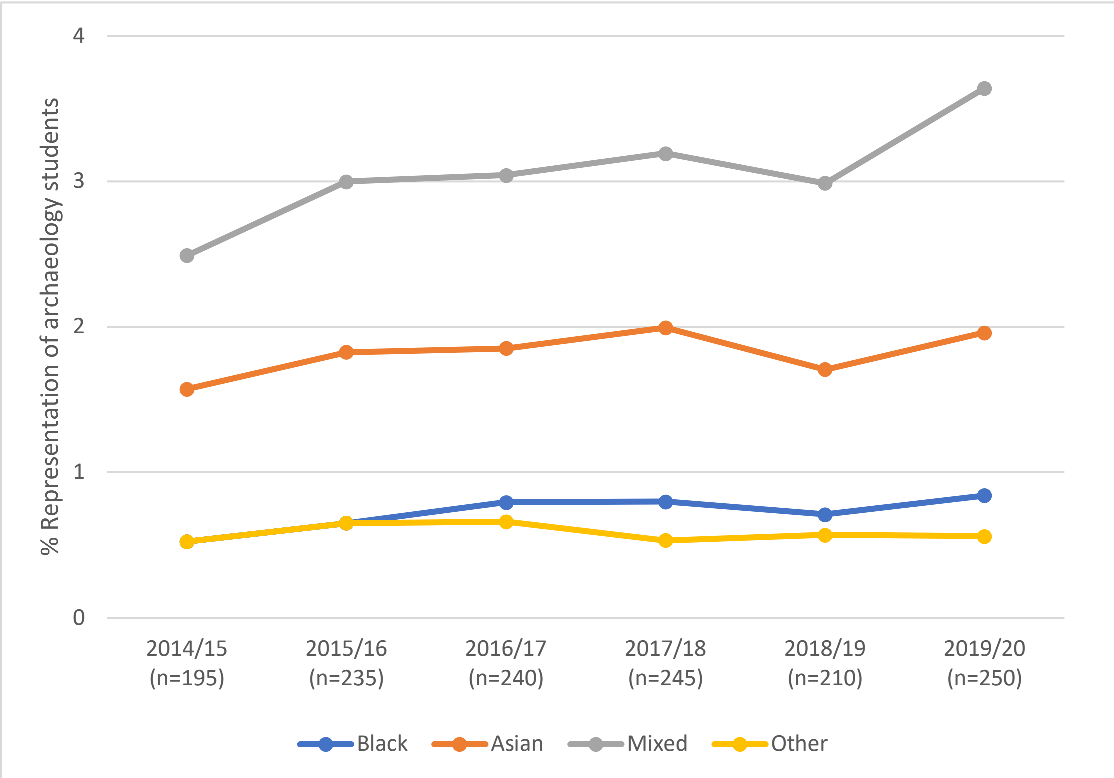


Figure 2.5: Percentage of Black, Asian and other minority ethnicity students enrolled on archaeology degree courses between 2014 and 2020. 2014-2019 data from HESA 2020b, 2019/20 data from HESA 2021c.

Higher education data indicates that many of the factors which influence STEM participation also impact archaeology degree uptake. In 2019/20, between 91-93% of undergraduate archaeology students were white (data differs between Aitchison *et al.* 2021c and HESA 2021d). HESA data indicates that a higher proportion of Asian (n=70) and mixed heritage (n=130), than Black (n=30) students were enrolled on archaeology courses (total archaeology students n=3565, HESA 2021d). Longitudinal HESA (2020b) data shows very little change in archaeology student demographics over time: white students have remained around 91-92% since 2014/15, while representation of other ethnicities amongst archaeology students has remained below

3.6% (Figure 2.5). Ethnic minority archaeology students may face similar issues in seeing how they 'fit' into archaeology if the majority of peers, academic staff, and course content is white.

HESA does not collect data on SES, but the Profiling the Profession 2021 report demonstrates that SES is also a factor in archaeology participation, with 30% of professional archaeologists having a 'higher professional and managerial' family background, compared to the current average of households with that economic distinction (19%, Aitchison *et al.* 2021d). At the other end of the economic scale, only 1% of archaeologists grew up in households with unemployed adults, in contrast with 9% of current households in the UK. Before A level archaeology was discontinued, access was also dependent on SES; in 2016 only 26 of the 340 students who sat A level archaeology attended state funded schools (HC Deb 14th December 2016b). One factor influencing STEM participation which does not appear to influence archaeology degree uptake is gender. Female archaeology undergraduates have consistently outweighed male students by around 20% since 2014 (Figure 2.6). This is consistent with other research which suggests that while men are better represented amongst older professional archaeologists, women make up a larger proportion of young professional archaeologists (Lazar *et al.* 2014; Aitchison *et al.* 2021e).

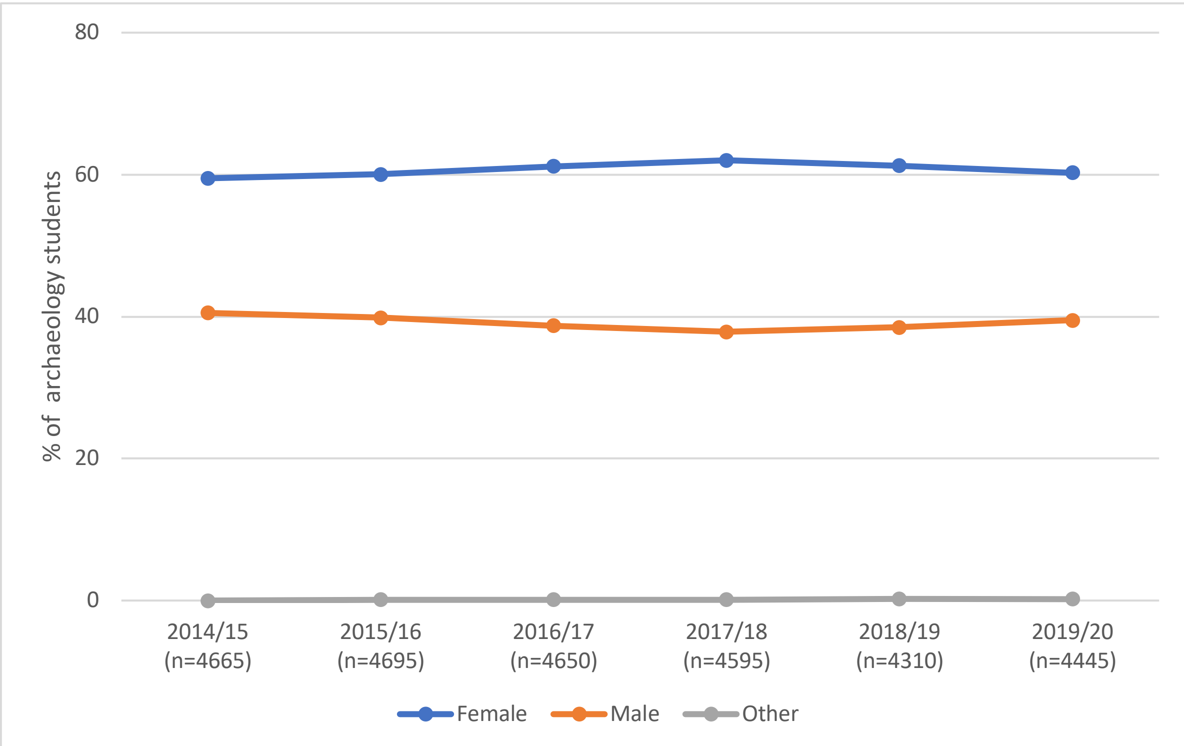


Figure 2.6: Percentage of female, male and other undergraduate students enrolled on archaeology degree courses between 2014 and 2020. 2014-2019 data from HESA 2020c, 2019/20 data from HESA 2021d.

Similarities in how identity-related factors influence participation in STEM and archaeology are of particular interest for the premise of this thesis, which posits that archaeology represents an opportunity to address low STEM engagement. Archaeology, while a highly engaging way to deliver STEM content, has deep colonial roots and a strong association with the middle class. In the past, archaeology was used to assert 'civilised superiority' (Diaz-Andreu 2008, 290-3; Gonzalez-Ruibal 2016), and continues to be (mis)used in nationalist and political agendas across the modern world (Hamilakis 2005; Diaz-Andreu 2010; Gür 2010; Popa 2015; Frieman and Hoffman 2019, 536; Hakenbeck 2019; Madgwick *et al.* 2021). In addition to this, Euro-American scholars remain gatekeepers to archaeology (Gonzalez-Ruibal 2016; Heath-Stout 2019, 85-6), as people of colour publish fewer archaeological papers and their papers are less likely to be published in prestigious journals (Heath-Stout 2020). Archaeology is also seen as a pursuit of the middle classes, via its production and consumption (Merriman 1989; McGuire and Walker 1999; Ellison and Powell 2018). Middle class families are better able to capitalise on museum visits for their children's learning (Archer *et al.* 2016; Whitaker 2016, 8), meaning that many of these children are better connected with heritage and archaeology. The intersection of ethnicity and SES is important here, white people are more likely to occupy middle class status (UK Government 2020) and therefore have greater access to archaeology than people of other ethnicities.

The relative absence of archaeology in Welsh and English compulsory education further compounds this inequity and resulting low uptake of archaeology amongst ethnic minority and low SES students. To ensure all young people access the myriad benefits of archaeological education, including its potential as a vehicle for STEM engagement, it must take a more central role in formal education. Currently archaeology is limited to the history curriculum, and largely up to individual teachers to pursue within that. Taking a broader approach across the curriculum would enable learners to engage with archaeology in a range of settings, giving them a greater appreciation of how their skills, aptitudes and interests hold relevance in multiple contexts. Consequently the inclusion of archaeology on the primary curriculum has potential to address barriers to STEM and archaeology participation. This thesis explores that potential through the delivery of STEM-themed archaeological interventions in a primary school setting, and by examining their impact on participants' STEM self-concepts and identities. Incorporating archaeology into the primary curriculum is of particular relevance in light of Welsh curriculum reform, which is discussed further throughout this thesis.

2.9 Chapter 2 summary

This chapter has explored how each branch of STEM became embedded within primary education in Wales and England, or as in the case of engineering, has yet to be recognised as a subject in its own right. It has demonstrated how these journeys were influenced by social, political and practical factors. Devolution of power to the Welsh Government led to differences in how STEM subjects are taught across England and Wales, the most notable of which is anticipated to come into effect in Wales with a reformed curriculum[8]. It is clear that in both Wales and England some STEM subjects are valued above others, as indicated by the proportion of time that is devoted to each in the primary school timetable. The ‘leaky pipeline’ metaphor was used to examine the barriers individuals may encounter throughout compulsory and higher education. A number of factors were considered; structural barriers, such as institution specific qualification requirements, prevent pupils from pursuing STEM; social and economic barriers relating to gender and ethnicity may deter individuals from integrating STEM into their identity. This sheds light on the complex array of factors that people must navigate to achieve success in STEM education, which underlines the clear need for social and institutional structural change to address current barriers to STEM participation. This chapter also examined the state of archaeology in current Welsh and English education systems, and began to explore how better inclusion of archaeology in formal education may address some of the issues identified. While it is not within the scope (or the capability) of this thesis to address all of these challenges, this chapter reveals the need to instil new perceptions of STEM early on in a child’s development, to better prepare them for the journey ahead. The following chapter will consider the interventions and data collection methods used throughout this project, which will be discussed in relation to issues raised in this chapter to locate them within relevant contexts.

[8] The new Welsh curriculum was intended to come into effect by 2021, but was delayed to late 2022 by the COVID-19 pandemic.

3 Chapter 3: Methods and sample

This chapter lays out the research and data collection methods used throughout this thesis, and introduces the participant sample with which these methods were used. The objectives of this thesis represent different stages of the research project, and therefore require a staged approach within its methods. These stages are outlined throughout the chapter, which begins by establishing general methodological principles behind the research; from use of Design Based Research principles and mixed data collection methods, to the underlying educational theory of the project's interventions and ethical considerations of researching children. The chapter then introduces the methods used to foster relationships with primary schools across Cardiff and Southampton, and the resulting participant sample. The chapter proceeds to outline data collection methods used in the pilot and main research period, with both adult (teachers) and child (pupils) participants, and finishes with a timeline of events for the entire project.

3.1 General methodological principles

This section lays out principles behind the approaches taken in this project. It introduces the use of archaeological interventions as a STEM engagement tool and examines the value of Design Based Research in developing those interventions. This section also argues the case for using mixed methods of data collection, whilst considering the ethical and logistical issues of working with child participants.

3.1.1 Design based research

Design based research (DBR) is an approach to educational research which facilitates interventions in real life contexts (Barab and Squire 2004, 2). DBR arose from criticisms of the disconnect between theory and practice and the limited impact educational theory has on its practice (Getenet 2019, 483). DBR generates educational tools or interventions that can produce change at a local level, but that also advance current theoretical understanding for future practice (Barab and Squire 2004, 6). Cobb *et al.* (2003, 9) argue that while these theoretical advancements may be 'relatively humble' and domain specific, they form an essential part of educational improvement. The Design Based Research Collective (2003, 8) highlight the value of DBR in exploring novel learning and teaching environments and increasing innovation in education. Interventions are designed in collaboration with education practitioners (Herrington *et al.* 2007; Getenet 2019), and form an iterative cycle of delivery and refinement (Bakker and van Eerde 2015, 438). This thesis draws on elements of DBR: the delivery of an intervention in a real educational context in an iterative process, that is assessed via mixed methods, with the intent to contribute to current theoretical understandings of STEM engagement (Anderson and Shattuck 2012). Collaboration with teachers was sought where possible (Getenet 2019), initially in a consultation period to ascertain individual concerns with STEM education, and then in developing appropriate interventions for pupils' needs and ability. However, this project differs from DBR in that it does not seek to 'improve learning' in a traditional educational sense (Walker 2006, 10), instead it aims to introduce a new perspective on STEM to participants.

DBR shares similarities with action research, but with some crucial differences. Action research also focuses on collaborative interventions, located in real contexts, which are frequently subject to cycles of development and refinement (Altrichter 1999). However, the key difference between the two, is that action research interventions are based in change rather than design (Bakker and van Eerde 2015, 435). While DBR designs specific interventions or 'artefacts' that are presented in naturalistic settings (Barab *et al.* 2000; Barab and Hay 2001; Tiberghien *et al.* 2009; Ketelhut *et al.* 2010), action research introduces a change to those contexts instead (Cole *et al.* 2005). As this project focusses on providing archaeological engagements rather than making a change to pupils' learning, it is more closely aligned with the DBR approach.

3.1.2 Using mixed data collection methods

Establishing perceptions of participants is complex, and methods must capture layers of nuance that are subject to change depending on context (Mayall 1994; Scott 2008, 92). A mixed method data collection strategy is characteristic of DBR (Anderson and Shattuck 2012), and is used in this study to collect both qualitative and quantitative data (Bryman 2006, 97). This approach allows the capture of information that may otherwise be lost, if only one data type were collected. Quantitative data is that which can be represented numerically, subjected to statistical analysis (Goertzen 2017,12), and ought to be replicable with an identical sample and methods (Cohen *et al.* 2013, 148). However, quantitative data only reveals behaviours or trends, it cannot explain social motivations behind them (Goertzen 2017, 12). Quantitative data reveals trends over time, and is suitable for large scale data collection (Goertzen 2017), and so a quantitative data collection method is used to assess potential change across all participants in this sample.

Qualitative data is less focused on causal relationships, and instead attempts to understand how people construct meaning within their lived experience (Denzin and Lincoln 2000, 8). It holds potential to explore *why* behaviours or trends occur. Qualitative data can be collected from interviews, direct observations during fieldwork, and written materials (Patton 2015, 14). While such data collection can capture a rich range of information, its findings can often be time consuming to interpret. Interpretations are also subject to criticism; that they are unscientific, unreliable, or subjective (Blaikie 2003, 20; Denzin and Lincoln 2000, 7). In acknowledgement of this, it is crucial for researchers to be aware of how their own lived experience impacts actions and interpretations when conducting qualitative research (Cohen *et al.* 2013, 149).

Collecting both qualitative and quantitative data addresses the shortcomings of each data style by balancing them against one another. The following data collection methods were used: teachers at each participating school were consulted via interview on their perceptions and experience of STEM education; pupils were also interviewed in small groups using child friendly task-based methods; a questionnaire was completed by all pupil participants prior to and following each intervention to assess their impact.

3.1.3 Archaeological interventions

This thesis is based on the assumption that engaging with STEM via the medium of archaeology provides young people with a novel access point to STEM. Exploring the full extent of human existence necessitates broad avenues of enquiry, making archaeology uniquely positioned to deliver learning across the entire curriculum. Archaeology presents opportunities for young people to connect with STEM in personally meaningful ways, such as through historical investigation or creative practice. Therefore delivering STEM-themed archaeological engagements holds the potential to positively impact learners' relationships with STEM learning. In order to examine the impact of archaeological engagement on primary pupils' STEM perceptions and self-concepts, three engagements – referred to throughout as 'interventions' – were designed according to the educational theory outlined below (section 3.1.3.1) and pertinent curriculum requirements (see Chapter 5). One intervention was delivered at each participating school in each term of the 2018/19 academic year

3.1.3.1 STEM education: theoretical approaches

Since the mid-19th century, educators and policy makers have called for STEM education to emphasise its relevance in real life contexts (Stow 1850, 306; Layton 1973, 42). The desire to create meaningful learning experiences using real life examples of STEM is also present in contemporary education literature (Furner and Kumar 2007, 187; Glancy and Moore 2013, 8; Craft *et al.* 2014, 26). Acronyms (e.g. STEM, SET) have encouraged education to shift from 'silo' style teaching to integrated disciplines, to better reflect the reality of STEM industries (Glancy and Moore 2013, 3) and to improve learning outcomes (Redmond *et al.* 2011). Farzana *et al.* (2018, 59-61) highlights the value of external STEM experts in providing 'real world' experiences, and describes the potential for developing 'collaborative learning communities' between them and teachers. While those relationships were built and maintained over many years, this project aims to mirror the core principles of this approach by presenting opportunities for pupils to engage with STEM in realistic archaeological contexts, and by communicating with participating teachers to ensure that interventions met their needs and expectations.

Recent approaches to education are also 'learner-centred'; emphasising the importance of pupil voices, facilitating dialogue, and pursuing inquiry-based exploration and experimentation. This approach is based in social learning theories, as developed by psychologists such as Vygotsky (1978) and Bruner (1996), where the 'social' nature of human beings is the basis for effective learning (Moore 2000, 15; Wenger 2009, 210). Addressing social factors can range from simple recognition of the role that language and communication play in learning (Slater and Bremner 2017, 330), to complex integration of social and cultural issues into teaching practice (Wenger 2009, 211). Amplifying pupils' voices is crucial when utilising co-operative group work, where learners use discussion and inquiry to complete a task (Alexander 2005; Furner and Kumar 2007, 187; Dole *et al.* 2016).

Presenting pupils with a problem to solve represents an excellent way to combine all of the above factors (Glancy and Moore 2013; Dole *et al.* 2016). STEM educators may facilitate 'real world' problems that highlight the relevance of STEM while providing students with a challenging learning experience, where they are required to engage in hands-on, collaborative work that is largely completed via communication and experimentation, or exploration of resources (Rosicka 2016, 8). Archaeological enquiry is well suited to this as interaction with physical objects is a powerful and accessible way to engage young people (Stone 2004, 2; Johansson 2019, 250). Another feature of 'learner-centred' education is the recognition that individuals construct their own meanings in relation to their current understanding or context (Bransford *et al.* 2000, 136), and that providing a personal connection to the learning experience is vital to engagement (Glancy and Moore 2013, 7; Godec *et al.* 2017, 27). Interventions (see Chapter 5 for full details of each session) were devised with these principles in mind; to create hands on, interactive sessions which challenge pupils to solve 'real life' problems. Problems are based on authentic archaeological questions, which are explored via archaeological material (e.g. artefacts and data). Scenarios were personalised through the use of local archaeological sites and research units, discussions of personal identity, and comparisons of life in the past to the experiences of participants.

3.1.4 Ethical and logistical considerations of using child participants

The use of child participants in research raises numerous ethical considerations, and must therefore be justified. The importance of early childhood STEM experiences in enhancing young people's STEM self-concepts (Patrick *et al.* 2009, 182) and development of an identity that is aligned with STEM (Dou *et al.* 2019) is widely reported. Research has also shown that children form lasting opinions about STEM in primary school (Silver and Rushton 2008, 52), and that STEM enthusiasm frequently declines as young people progress through compulsory education (Pell and Jarvis 2001, 857; Murphy and Beggs 2003, 111; AT Kearny 2016, 7).

Research has also shown that while ethnicity has little impact on science aspirations, with Asian and Black students more likely to express science aspirations than white students (Archer, Osborne *et al.* 2013, 21), these aspirations do not translate into participation in STEM education and careers (CaSE 2014, 43; Engineering UK 2018b, 181; HESA 2022a; HESA 2022b). Similarly, there is evidence that stereotypes about intelligence, gender, and science become more influential as children get older (Miller *et al.* 2018, 1949-51). Children are aware of the gendered and classed roles they are required to perform to maintain acceptance from peers (Reay 2001; Hughes and Seta 2003; Ringrose and Renold 2010), and it is common for individuals to reject STEM-aligned identities as they prioritise other performances of femininity and masculinity, which are inevitably connected to social class (Hughes 2001, 281; Wong 2012; Archer, DeWitt *et al.* 2013).

It is clear that early interventions are needed to combat ideas about who can successfully participate in STEM. Numerous researchers argue the value of focusing STEM engagement efforts in primary schools (Turner and Ireson 2010, 129; Archer 2013a, 27; Finegold and Jones 2016, 51; Rosicka 2016, 5). The focus of this thesis on primary education is a result of these recommendations. Consequently, it was necessary to get ethical approval to work with child participants. This was granted via the appropriate Cardiff University procedures. Permission was sought from pupils' parents for them to contribute data to the project. Permission letters were formatted to ensure that only parents who did *not* want their child to participate needed to return them. This was done at the advice of teachers, who felt that many parents who did not object to their child's participation might not return the permission slip, reducing the sample size unnecessarily. Only one child's parents declined to give permission for their participation.

Not all qualitative data collection methods (e.g. semi-structured interviews) are suitable for use with children, and task-based participatory methods are frequently recommended (Fargas-Malet *et al.* 2010, 180; Johnson *et al.* 2014). These methods differ from traditional interview methods in that they are structured around a series of activities, rather than a set question schedule (James *et al.* 1998, 160). Tasks are particularly useful when interviewing children, as they provide a stimulus from which discussions develop (Harden *et al.* 2000; Punch 2002a, 53; O'Kane 2008, 131). Using participatory techniques empowers children to direct interviews and does not limit them to one interview agenda, or pressure them to provide 'correct' answers (O'Kane 2008). Pupils were interviewed three times in small groups: two boys and two girls from each school. Tasks differed between each interview, to avoid boredom on the part of participants, and to appeal to different interests and preference for self-expression (James *et al.* 1998, 189). Group interviews have the potential to reveal information that may not be disclosed in individual interviews; interactions between participants can develop discussion in a way that is unlikely in a one-to-one setting (Hoppe *et al.* 1995, 102; Hill *et al.* 1996, 134). Group interviews are subject to additional concerns (e.g. demographic), which are explored further in sections 3.1.4.1 and 3.1.4.2.

Pupils' data relating to protected characteristics (e.g. ethnicity, sex), or other pertinent factors (e.g. socio-economic status, parent occupation) was not collected by questionnaires for two reasons: data protection, and reservations about the accuracy of that data when self-reported by children of this age. Though parents are able to provide this information, the research was conducted in a school-based context; accessing 233 parents was beyond the scope of this study, and would have placed an unfair burden on teachers and schools to solicit responses. Information about the gender of small-group interview participants *was* noted, as this was relevant to teachers' choices to recommend them for interviews, and to the activities used to generate discussions in them (e.g. differences in how girls and boys articulate their personality, see section 3.4.4.1). Anonymity is provided to child participants through the use of pseudonyms; individuals were encouraged to choose their own pseudonym to increase their agency and ownership within interviews.

3.1.4.1 Balance of power and social context

Adults interviewing children must consider the power imbalance between researcher and participant (Hill *et al.* 1996, 133; Cree *et al.* 2002, 52; Punch 2002a, 323), and how interviewing in a school context reinforces this by positioning children as 'passive' actors (Edwards and Alldred 1999, 264; Devine 2002, 307). Existing and developing relationships between child participants might also impact interview outcomes; for example, children may contribute less to a discussion with peers they are uncomfortable with (Punch 2002b, 48). The author sought to address the power imbalance between herself and the participants in various ways. Encouraging use of first names distinguishes the researcher from teachers and creates a less formal interview environment (Morgan *et al.* 2002, 9). Consideration of seating and room arrangements can also foster an informal interview setting (Hoppe *et al.* 1995, 108); where possible, the researcher and participants chose to sit on low tables or the floor (e.g. on cushions in the school library), and in circular configurations. The location of the interview is also key, and the author aimed to conduct interviews in 'resource rooms' rather than classrooms (Fargas-Malet *et al.* 2010, 178).

Participants were further empowered by having control of the recording device, and were provided with a non-verbal way to indicate that they were uncomfortable answering a question (Cree *et al.* 2002, 51). Each child was given a post-it note and asked to write their name on it (the researcher also made their own name label). Participants were then able to move their name between two designated spots (indicated by a tick and a cross) to express whether they wished to opt in or out of a discussion (Johnson *et al.* 2014, 55). Task-based and participatory interviews attempt to redress power imbalance by allowing children to direct discussion topics and communicate in a diverse range of ways (Christensen and James 2008, 158), rather than being limited by answering a series of questions set by the researcher (O'Kane 2008, 131).

3.1.4.2 Group demographic

Some existing literature on interviewing children in groups recommends dividing children by gender (Hoppe *et al.* 1995, 106; Punch 2002b, 46), though this decision appears to have been made based on specific research content (e.g. discussing sensitive topics). Other researchers have conducted successful interviews with mixed gender groups (Hill *et al.* 1996, 134; Mishna *et al.* 2009), with some citing the younger age of participants (ages 7-10, the same as those in this study) as their rationale for doing so (Morgan *et al.* 2002, 8). The age when children begin to identify and internalise gender differences is complex (Martin and Ruble 2010), but there is evidence that primary level children are used to working within mixed gender groups (Thorne 1993, 37; Swain 2005, 78). The presence of an adult can also reduce concerns children may have about working in this way (Thorne 1993, 56), by ensuring that all voices are heard and acknowledged (Reay 1991, 173). Due to the non-sensitive nature of this research, the age of participants, and limitations on the time allotted for interviews within schools, interviews were carried out with mixed gender groups.

Previous research highlights how the number of children present in an interview can impact the efficacy of data collection (Hoppe *et al.* 1995, 106; Kennedy *et al.* 2001, 185; Morgan *et al.* 2002, 8), so groups were limited to four participants with an even split of male and female participants. Additionally, age differences between participants in group interviews can influence results (Gibson 2007, 475); conducting the research within a school setting has largely negated this as participants are already categorised by age. The presence of existing friendship groups in interviews can also influence results, with some researchers reporting high levels of 'giggling' amongst friends (Morgan *et al.* 2002, 14), and others highlighting how groups of friends appeared more relaxed and more willing to contribute to discussion (Hoppe *et al.* 1995, 106). The effect of existing friendships was noted in this research also (see Chapter 8).

3.2 Participating schools

Five schools participated in this project, the following details recruitment strategies used to secure their engagement and broad demographics of pupils and locality of each institution.

3.2.1 School recruitment strategy

To foster relationships with schools based in Cardiff and Southampton, institutions were approached via personal contacts of the author's supervisory team, and through See Science; a Cardiff based education consultancy that coordinates the STEM Ambassador programme in Wales. See Science facilitated 'cold' emailing of potential participants, and provided access to newsletters where teachers detailed requests for STEM ambassador engagement, which the author responded to. Personal contacts yielded three schools, and two schools responded to See Science's requests for participants. This recruitment strategy produced a non-random sample, however, it is outside the scope (and capability) of a single PhD project to randomly sample all primary children in Wales and England. Additionally, access to schools is dependent upon 'gatekeepers', meaning that the project depended on institutions willing to provide that access (Clark 2010, 487). The nature of this project required schools to devote a considerable amount of time to it. Institutions facing funding or attainment challenges may be less likely to respond to participation requests, or to have enrolled onto See Science's mailing list at all. In this context, achieving a truly random sample is impossible; therefore this thesis does not seek to directly generalise its findings across all primary pupils in Wales and England.

3.2.2 School pupil and local demographics

Three participating schools were based in Cardiff and a further two were located in the Hampshire Test Valley. Statistics for each school were gathered using two sources: the My Local School database for Welsh schools and the school comparison service on gov.uk for English schools (Figure 3.1). Data for Cardiff local areas is taken from the 2011 national census, with the caveat that local conditions may have changed in the years following that data collection[9]. Data for Hampshire local areas is dated to 2018 as part of the local council annual survey. Each school is discussed briefly here, though as schools were not randomly sampled, social and economic factors were not controlled. The following will outline publicly available data on participating schools (Figure 3.1), which are coded for the purposes of this study. This data relates to each school's circumstances as of the 2018/19 academic year, when the main body of research for this thesis took place. School size differed dramatically, ranging from 102 pupils at BF to 539 at SP (Table 3.1). All schools and classes are mixed gender. Of the Welsh schools, YP is Welsh medium, though interventions and data collection were conducted in English. The schools in this sample reflect a range of environments: BF is rural and NB is located in a large semi-suburban village; while YP and BG are on the outskirts of Cardiff, SP is located near the city centre. Four of the five schools were a level two ('Good') in their most recent school inspection (Figure 3.1). This is consistent with the assumption that schools not undergoing serious attainment pressures, are more likely to participate in studies such as this. SP was inspected in 2018, after data collection began, and was reclassified from a level two, to a level four ('Unsatisfactory and needs urgent improvement'). Despite this, the school continued engaging with the study, and the author is grateful to these teachers for their continued participation despite external performance pressures.

[9] A new national census was conducted in 2021, though results were not published in time to include here.

School	Curriculum	No. of Pupils	Estyn/ Ofsted Grade	English as Additional Language (%)	Pupils from Ethnic Minority backgrounds (%)	Budget Per Pupil	Local Authority Median Budget	Free School Meals (%)	Pupil Deprivation Grant/ Pupil Premium
SP	Welsh	539	4	36.3	51.9	£3,229	£3,820	12	£66,096*
YP	Welsh	207	2	N/A	6.3	£4,420	£3,820	2.1	£3,150*
BG	Welsh	414	2	11.6	26.6	£3,227	£3,820	7.7	£38,700
BF	English	102	2	1		£5,295	£4,682	10.8	£12,820
NB	English	276	2	5.4		£4,284	£4,682	15.2	£59,320
Welsh av.				6.2	12.2			18.4	
English av.				20.8		£4,916	£4,685	24.9	

*Table 3.1: Publicly available data for participating schools in 2018/2019 academic year. SP, YP and BG data (www.mylocalschool.gov.wales); BF and NB data (www.gov.uk/school-performance-tables) . Red and green budget data indicates where budget per pupil is above or below local authority median. Pupil deprivation grant/ pupil premium data as self-published on each institution website for 2018/2019 academic year; not all schools do this annually, and data with an * is from previous years.*

Local area of school	Qualifications (%)		Housing Tenure (%)								Economic Activity (%)		Minority ethnicities (%)	
	People with Level 4 Qual.	Local Average L4 Qual.	Owned outright	Local average owned outright	Owned with mortgage	Local average owned with mortgage	Social rented	Local average social rented	Private rented	Local average private rented	Active people	Local average active people	Minority ethnicity	Local average minority ethnicity
SP	39.1	32.3	14.9	26.5	17.7	32.6	10.5	17.1	55.1	21.9	64.1	67.1	22.3	15.3
YP	45.5	32.3	40.9	26.5	39.5	32.6	3.7	17.1	14.3	21.9	72.1	67.1	8.4	15.3
BG	42.8	32.3	40.6	26.5	40.7	32.6	3.7	17.1	13.6	21.9	73.5	67.1	10.8	15.3
BF	43	30.5	48.3	34.5	33.8	35.9	14.4	14.4	11.4	12.8	66.8	73.3	3.1	9.8
NB	27	30.5	41.3	34.5	36.5	35.9	13.1	14.4	7.7	12.8	82.4	73.3	3.6	9.8
Welsh Av. (%)	24		35		32		10		13		66			
English Av. (%)	27		31		33		9		15		70			

Table 3.2: Indicators of socio-economic advantage and proportion of people from an ethnic minority background in each schools' local area. Data is taken from 2011 census (Cardiff) and 2018 ward profiles (Hampshire). Red and green text reflects data which is above or below local averages.

Ethnic diversity in schools is recorded differently in Wales and England; although it is outlined explicitly on the My Local School database, gov.uk only lists the percentage of pupils who speak English as an additional language (EAL). For the purposes of this discussion, percentage of EAL[10] pupils is taken as a rough proxy for ethnic diversity at English schools. This approach does not capture pupils who are from ethnic minority backgrounds, but speak English as their first or only language. This is demonstrated by SP, which has 51.9% pupils with an ethnic minority background but only 36.3% EAL pupils. This approach also fails to account for pupils who do not have an ethnic minority background, but do speak English as a second language. However, this is the only information available currently on ethnicity of pupils in English schools. The majority of participating schools have low ethnic diversity (Figure 3.1). SP and BG are exceptions to this; over half of SP and a quarter of BG pupils are from an ethnic minority background compared to the Welsh national average of 12.2%. The limited representation of pupils from ethnic minorities attending YP, BF and NB is likely a reflection of populations in their catchment area[11] (Figure 3.2). The 2011 census for Cardiff identified that 84.7% of inhabitants described themselves as 'white-British', and as of June 2019, only 15.7% of Cardiff inhabitants describe themselves as being from an ethnic minority background (Welsh Government 2019b). In the 2018 Hampshire council survey 94.1 and 94.4% of people living in the locality of NB and BF described themselves as 'white-British'.

Free school meal eligibility (eFSM) is a common proxy for socio-economic status; though it does not account for *all* socio-economically disadvantaged children, it is an effective indicator of disadvantage in terms of educational outcomes (Cook *at al.* 2014; Ilie *et al.* 2017; Taylor, 2018). Data on eFSM for each school is presented as an average for the past three (Wales) or six (England) years; all schools were below respective national eFSM averages (Figure 3.1). Schools can apply for additional funding based on the number of eFSM and looked after pupils in attendance, known as the Pupil Deprivation Grant (PDG, Wales) and Pupil Premium (PP, England). These grants provide low SES children with resources to address developmental and educational challenges associated with low SES (DfE 2021), such as speech and language therapy, breakfast clubs, and counselling. Both schools that received substantial PDG and PP funding in 2018/19 (BG and NB, see Figure 3.2) still had lower per-pupil budgets than other

[10] YP is a Welsh medium school, therefore EAL status of pupils is not listed.

[11] Low proportions of BG locals with an ethnic minority background in 2011 census does not reflect the relatively high number of ethnic minority pupils enrolled in the school in 2018. This is likely due to population changes between 2011 and 2018/19.

schools in their local authority, raising questions about how effective grants are in providing equity for these children.

Local indicators of socio-economic advantage (higher education qualification, home ownership, economic activity) are another way to gauge potential socio-economic status of pupils (Table 3.2). Though these factors are not concrete indications of privilege (e.g. economic activity denotes employment rather than income) they can identify areas of relative prosperity using census information. This data presents a mixed picture; YP, BG and BF all have high levels of higher education and home ownership, while NB has lower than average higher education and SP has lower than average home ownership. Some of these factors may be explained by local demographics: lower than average employment around BF reflects the retired population, while the substantial student population around SP may account for many of the privately rented homes.

The intersection of ethnicity and SES is demonstrated amongst the pupil populations of participating schools (Table 3.1). Both SP and BG had higher than average proportions of ethnic minority pupils *and* lower per pupil budgets than other schools in their local authority. In contrast, two schools (YP and BF) with lower than average proportions of ethnic minority pupils had higher budgets per pupil. Consequently, in this example, pupils with minority ethnicity backgrounds theoretically had access to fewer school-based resources, such as highly experienced teachers (reflected in higher salaries), small class sizes, and additional support staff (Welsh Government 2019c). However, the impact of pupil enrolments at each institution on relative budget must also be considered: BF had a high per pupil budget compared to other local schools, but only 102 pupils in attendance, meaning their total budget was not as substantial as it first appears. It is likely that the ethnic and socio-economic demographics of pupils at each school are varied and complex.

3.3 Pilot research

Piloting research methods prior to the main research period is necessary to test their suitability and to highlight any changes that might improve their efficacy, such as unanticipated interpretations of words or phrases (Arksey and Knight 1999, 95; Berg and Lune 2016, 77). For this thesis, pilots were carried out in the 2017/18 academic year, and in four main areas: a teacher interview, pupil questionnaires, pupil task-based interviews, and one intervention session. Pilot testing was carried out with individuals outside of the final sample to preserve the number of potential respondents in participating schools (Arksey and Knight 1999, 95; Van

Teijlingen and Hundley, 2001) and the novelty of the intervention session. The following comprises further details of each area that was piloted.

3.3.1 Pilot: teacher interview

Before developing interventions, teachers from participating schools were invited to be interviewed so that the researcher might better understand the STEM specific challenges and needs of each institution. The question schedule for those interviews was piloted amongst three teachers based at a school outside the final sample. All pilot participants were lead coordinators for a STEM subject: maths, science and ICT. Pilot teachers were taken through the question schedule (Figure 3.3) in realistic interview conditions (including attaining informed consent) and asked to respond accordingly. The findings of these interviews can be found in Appendix 1, along with details of changes made to the question schedule prior to commencing the main research period. Transcripts of these interviews are in Appendix 2, Appendix 3, and Appendix 4.

	Question
Intro	I'm interested in the reasons why the UK has such low levels of engagement in Science, Technology, Engineering & Mathematics (STEM) careers. Research has shown that people's attitudes towards STEM careers are formed from a very young age, and so I want to find out what can be done at a primary school level to enhance pupils' enthusiasm in later life for STEM subjects and careers. I would like to ask you about your experiences as a primary school teacher delivering STEM content.
1	First, may I ask how many years you have been a teacher?
2	And what is your position in your current school?
3	In your opinion, what is the level of pupil engagement with STEM subjects in your class?
4	Do you find that your pupils enjoy STEM?
5	Do you think this level is reflected in the rest of the school?
5a	*If answer differs*: What factors do you think may contribute to this imbalance?
6	Do you think your pupils engage with STEM at all outside of school?
6a	*If answer is negative*: What reasons do you think there are for this?
6b	*If answer is positive:* Can you give an example of this?
7	Do YOU ever engage with STEM outside of school?
7a	*If answer is positive:* Can you give an example of this?
8	Which aspect of STEM teaching do you feel pupils respond to best?
8a	*If appropriate:* Can you give an example of this?
9	Which aspect of STEM teaching do you yourself most enjoy?
9a	*If appropriate:* Why is this?
10	When preparing for STEM lessons, where do you look for ideas and resources?
11	Do you find that resources for STEM lessons are easy to come by?
11a	*If negative:* Has this ever affected how you plan and carry out lessons?
11b	*If appropriate:* Can you give an example of this?
12	Are you satisfied or dissatisfied with the amount of STEM content you are able to cover in your lessons?
12a	*If answer is 'dissatisfied':* What is the reason for this?
13	Have you ever tried to make your STEM lessons interdisciplinary?
13a	*If negative:* Do you think it could be of potential benefit?
13b	*If positive:* Can you give an example?
14	This next question is in three parts, and we can address each part separately: I would like to know when it comes to STEM engagement, which barriers (if any) you feel are in place for pupils, teachers (as a group) and yourself personally.
14a	What do you feel is the biggest influence on pupil's long term engagement with STEM subjects and careers?
14b	What do you feel is the key challenge faced by teachers (as a group) when teaching STEM content?
14c	What do you feel is key challenge faced by yourself personally when teaching STEM content? This answer may be the same as the previous question.
16	Which of these three factors do you think is the most important?
17	Is there anything you think practitioners can do to address this?

Table 3.3: Question schedule used in pilot teacher interviews.

3.3.2 Pilot: pupil questionnaires

Pre and post-intervention questionnaires were deemed the most efficient way to gather widescale quantitative data from participants throughout the main research period. Questionnaires (Figure 3.1 and Figure 3.2) with accompanying glossary (Table 3.4) were piloted with pupils external to the main research sample to assess the suitability of language and clarity of instructions. Six pupils (three from Year 3, three from Year 4, a mix of boys and girls) were invited to complete questionnaires with the glossary for reference. Piloting the questionnaire revealed an issue with the wording of a pre-intervention question ('which skills do you think are important for someone working in STEM?'), which resulted in participants selecting every single option. To produce data with greater nuance, this wording was changed to 'which skills do you think **are the most important** for someone working in STEM?'.

Glossary:
Observation: you carefully watched or listened to something to learn something new.
Logical thinking: you were able to think clearly about facts and information.
Perseverance: you kept working on something, even if you found it difficult.
Problem solving: you were able to work out the answer to a problem.
Curiosity: you were keen to learn something new.
Imagination: you made up new and exciting ideas.
Independent working: you were able to work well by yourself.
Organisation: you planned your work carefully.
Working as a team: you worked well with the other people in your class.
Communication: you listened to other people's ideas and gave ideas of your own.
Investigation: you had a question and worked to find out the answer.
Creativity: you had ideas about how to present things, or make something new.

Table 3.4: Glossary provided with the pre and post-intervention pilot questionnaires.

Name of your school: ________________________________

Thank you for inviting me to speak to your class, I hope you enjoyed it! Please could you help me with my research by filling out this form with your teacher?

1) Do you know what 'STEM' stands for? Fill in the gaps:

S______________ T_________________ E_________________ M________________

2) What do you think about STEM? Tick the box that matches your opinion:

	Yes	Maybe	No
I want to be a scientist when I grow up	☐	☐	☐
I enjoy science lessons	☐	☐	☐
I enjoy maths lessons	☐	☐	☐
STEM is an important part of my life	☐	☐	☐
I would like to learn more about STEM in the future	☐	☐	☐
I would like to use STEM in my job when I'm older	☐	☐	☐

3) Which skills do you think are important for someone working in STEM? Circle all the skills you think they will need. There is a glossary on the back of this sheet.

Observation	Logical thinking	Perseverance	Problem solving
Curiosity	Imagination	Independent working	Organisation
Working as a team	Communication	Investigation	Creativity

Figure 3.1: Pre-intervention questionnaire that was piloted with pupils external to the final sample schools.

Name of your school: ______________________________

Thank you for taking part in the archaeology workshop, I hope you enjoyed it! Please could you help me with my research by filling out this form with your teacher?

1) Can you remember what 'STEM' stands for? Fill in the gaps:

S_____________ T________________ E________________ M_______________

2) What do you think about STEM? Tick the box that matches your opinion:

	Yes	Maybe	No
I want to be a scientist when I grow up	☐	☐	☐
I enjoy science lessons	☐	☐	☐
I enjoy maths lessons	☐	☐	☐
STEM is an important part of my life	☐	☐	☐
I would like to learn more about STEM in the future	☐	☐	☐
I would like to use STEM in my job when I'm older	☐	☐	☐

3) Which STEM skills did **you use** in the archaeology workshop? Circle all the skills you used. There is a glossary on the back of this sheet.

Observation	Logical thinking	Perseverance	Problem solving
Curiosity	Imagination	Independent working	Organisation
Working as a team	Communication	Investigation	Creativity

Figure 3.2: Post-intervention questionnaire that was piloted with pupils external to the final sample schools

3.3.3 *Pilot: pupil task-based interview methods*

Two pilots were conducted for task-based interview methods that were to be carried out with pupils. One potential interview activity was piloted with four Year 4 (two girls, two boys) pupils from BF[12]. In this activity, pupils were asked the question "what does STEM mean to you?" and asked to create a collage in response. Though pupils engaged well with the exercise, the time taken to complete the task proved too long to be used in the main research period. Details of this pilot activity and its findings are in Appendix 5, the transcript is Appendix 6. The second task-based interview pilot was conducted with the same pupils who piloted the questionnaires (section 3.3.2). This pilot tested a method to explore STEM self-concepts and identity through a word sort exercise. Pupils were presented with a series of words and phrases (Table 3.5, with accompanying glossary: Table 3.6), and asked to discuss each one to demonstrate understanding and to highlight any words they were unsure of. Words like 'reflective' and 'methodical' were queried, though pupils were able to use the glossary and extended explanations provided by the interviewer to answer their questions effectively. Following this pilot session, the activity was considered suitable to be used in the main research period, details of which are in section 3.4.4.

Artistic	Enjoys drawing	Likes learning languages
Can take risks	Enjoys history	Likes to learn new things
Can use computers	Enjoys maths	Likes to try new things
Can work in a team	Enjoys reading	Likes visiting other countries
Can work independently	Enjoys science	Listens to other people's opinion
Careful	Enjoys sport	Logical
Clever	Gets all of the answers right	Methodical
Comes up with lots of new ideas	Hard working	Organised
Competitive	Honest	Practical
Creative	Imaginative	Reflective
Curious	Inventive	Reliable
Determined	Learns from their mistakes	Resourceful
Discusses ideas with others	Likes being outdoors	Sensible
Encourages others	Likes computer games	Shares information with others
Enjoys building things	Likes helping others	Wants to understand how things work
Enjoys dancing		

Table 3.5: Words and phrases that were piloted with external pupils for task-based interview methods.

[12] As this was conducted in the academic year prior to beginning the main research period, these children fell outside of the final sample group.

Glossary:
Curious: is keen to learn something new.
Logical: is able to think clearly about facts and information.
Creative: has ideas about how to present things, or make something new.
Artistic: good at making beautiful items – drawings, paintings, sculptures.
Honest: likes everything to be truthful and open, not secretive.
Sensible: makes good judgements based on reason and experience.
Resourceful: finds quick, clever ways to get things done or to make things easier.
Careful: avoids danger and follows instructions.
Imaginative: thinks of new and exciting ideas
Inventive: comes up with new ideas to solve puzzles, or design new things.
Reliable: always does what they have promised, and can be trusted.
Determined: doesn't give up, even if things become difficult.
Methodical: follows a set of instructions carefully.
Hard working: always works well and tries their best.
Competitive: always tries their best to win.
Practical: good with their hands, good at doing practical tasks like experiments.
Organised: good at making plans and sticking to them.
Clever: quick to understand new information.
Reflective: can look back on work and think about what went well and what can be improved.

Table 3.6: Glossary that accompanied words/ phrases in Table 3.4.

3.3.4 Pilot: intervention

One archaeological intervention was piloted at four[13] of the participating schools in the 2017/18 summer term. The intervention focused on faunal analysis; piloting it was an opportunity to test the suitability of format and content, and also to build relationships with participating schools by providing engagements prior to the start of the main research period. This session gave schools a sample of what they could expect from participating in the research and allowed teachers to reflect on whether they would like to continue. The session was trialled across year groups according to requests of individual schools; where schools had no preference, a year group was selected that was not already represented (Table 3.7). These pilot sessions highlighted which elements of the workshop were effective and which would need improvement. These decisions were further aided by insightful feedback provided by individual class teachers. Piloting this workshop generated a better understanding of how to effectively deliver a session to a large group of children at the same time. Knowing what kind of content to use and the most appropriate ways to disseminate it to each class were crucial to the success of

[13] BG joined the project in September 2018.

the project. Having the input of teaching experts was invaluable in this, and their continued support in the development of subsequent interventions was extremely welcome.

School	Year Group
BF	3 & 4
NB	5
SP	6
YP	4

Table 3.7: List of year groups (by school) where the faunal analysis intervention was piloted in Summer 2018.

The pilot intervention challenged participants to conduct a faunal analysis on a fictional Roman faunal assemblage. Part of this analysis involved specimen identification and recording. To most accurately mirror the practice of zooarchaeologists it initially was anticipated that each pilot class would record specimens in a single excel database, which could then be analysed and interpreted. However, the complexity of this proved too time consuming in the pilot sessions, and in future iterations pupils recorded specimens independently and then analysed a predetermined dataset instead. Additional elements of faunal analysis (cattle dental ageing and chicken sex identification) were also incorporated into pilot sessions, but issues of timing prevented these exercises from featuring in future iterations.

Feedback was sought from the class teachers who participated in pilot sessions, which proved valuable for the future direction of this intervention. The recommendation from a BF teacher to ask pupils to discuss questions in pairs before feeding back to their table, rather than asking individuals to respond to the entire class, created greater opportunities for pupil voices to be heard than was previously possible. This teacher also suggested turning a whole-class discussion about skeletal elements into a paper-based activity, where pupils could label a human skeleton diagram. This suggestion transformed the exercise into an active learning experience, where pupils could apply prior or new knowledge. At the recommendation of a BG teacher, a slide was added into the PowerPoint which covered the essential elements of a bar chart; the inclusion of this allowed pupils to graphically represent their faunal datasets more effectively. Other logistical suggestions, such as providing a greater number of specimen identification and recording sheets, ensured that all pupils could participate equally.

3.4 Main research

The main research for this project was conducted in the 2018/19 academic year. Research was conducted with teachers and pupils of participating schools and comprised four major components: interviews with teachers prior to the development of interventions; delivery of three STEM-themed archaeological interventions to pupils at each school; questionnaires completed by all pupil participants; task-based small group interviews with pupils at each school. The following will outline the specifics of each component of research.

3.4.1 Teacher interview

Consulting teachers on the specific challenges and concerns they experience with STEM education was crucial to inform the design and development of interventions that would best meet the needs of all participants. A semi-structured interview was devised to explore the STEM challenges, needs and expectations of each participating institution. 13 teachers from the five participating schools were interviewed prior to the delivery of archaeological interventions. BG joined the project after the initial intervention was developed, resulting in reduced input, however, their opinions and experience remained invaluable for the following two interventions. Individual teachers were invited to participate in interviews by the person who first made contact with the project. The project’s overt focus on STEM may have influenced which teachers opted to be interviewed, though the final sample included participants with varying experience and expertise (Table 3.8). Participants work across a range of subjects and year groups, and varying levels of managerial responsibility. One Infant teacher (Key Stage 1) was interviewed, along with 12 Junior teachers (Key Stage 2). The scope of experience was also vast, ranging from a single year of teaching to 33 years. Six participants had taught for less than 10 years, seven were between 14 to 33 years. All participants are referred to by the initials of their school and an individual teacher number (e.g. YPT1).

Participants were given a brief outline of the project aims, and taken through the consent form before being interviewed. Interviews were audio recorded and range from 13-45 minutes. Interviews took place in school, both during and at the end of the school day (Table 3.8). Location and timing of interviews can impact responses, as respondents may speak less freely if interviewed somewhere indiscreet, or after a long day (Brinkman and Kvale 2015, 121). Additionally, some teachers were interviewed in groups while others were interviewed individually. Group interviews can result in participants having less time to speak, or withholding information from peers (Berg and Lune 2017, 104; Fontana and Frey 1994, 365; Patton 2015, 478). While the contributions of each participant are invaluable, it is important to consider these potential limiting factors.

School	Curriculum	Interview Type	Interview Location	Interview Time	Participant	Years Teaching	Co-ordinator Role	Key Stage
YP	Welsh	Group	Staff Room	After School	YPT1	26	STEM	KS1 & KS2
					YPT2	5	Non-STEM	Lower KS2
SP			Classroom		SPT1	33	STEM	Lower KS2
					SPT2	1	n/a	Upper KS2
					SPT3	14	STEM	Upper KS2
					SPT4	1	n/a	Lower KS2
BG					BGT1	21	n/a	Lower KS2
					BGT2	20	n/a	Lower KS2
BF	English	Individual	Private Office	Morning	BFT1	9	Non-STEM	Upper KS2
					BFT2	20	Non-STEM	KS1
					BFT3	15	Non-STEM	Lower KS2
NB			Classroom	Lunch Time	NBT1	3	STEM	Upper KS2
				After School	NBT2	5	Non-STEM	Upper KS2

Table 3.8: Breakdown of teacher interview participants with details regarding their demographic and interview circumstances.

Interviews were semi-structured to reflect the exploratory and flexible nature of this stage of the project (Berg and Lune 2017, 69; Bryman 2016, 466; Cohen *et al.* 2013, 349; Kvale 1996, 84). The experience of teaching is vast and varied, and may be effectively captured by an open-ended approach. Consequently, the question schedule comprised entirely open-ended questions (Table 3.9) to capture as much depth as each participant felt necessary. Participants were positioned as experts by providing the interviewer with insight otherwise unavailable to them: that of a teacher engaging with STEM within a primary school context. Initial questions eased participants into the interview context by asking simple fact-based questions (Berg and Lune 2017, 72; Qu and Dumay 2011, 250). Questioning progressed by establishing participants' understanding of how their pupils engage with STEM, as well as their own personal engagement with it (see Table 3.10 for engagement examples presented to participants). It was hoped that this would shed light on the methods that respondents find effective in STEM teaching, which would inform the pedagogical approach taken in the archaeological interventions. Recognising that 'STEM engagement' does not equal 'STEM enjoyment', a follow-up question asked whether participants considered themselves interested in STEM in their *'personal time'*. Establishing respondents' personal connection with STEM will reveal how individual perceptions of STEM interact with pedagogical methods. This may provide useful insight into what people of differing STEM interest or knowledge find engaging, which is particularly relevant to a project which seeks to enthuse people who may not have connected with STEM before.

Intro	I'm interested in the reasons why the UK has such low levels of participation in STEM careers. For this interview, I am using the word 'STEM' to refer to Science, Technology, Engineering & Mathematics. To help me understand these reasons, I would like to ask you some questions about your experiences as a primary school teacher delivering STEM content.
1	First, may I ask how many years you have been a teacher?
2	And what is your position in your current school?
3	In your opinion, what is the level of pupil enthusiasm for STEM subjects in your class?
4	Do you think that your pupils engage with STEM at home?
4a	*If answer is negative*: What reasons do you think there are for this?
4b	*If answer is positive:* Can you give an example of this?
5 (intro)	I am also interested in whether *you* interact with STEM at home. I've created a list of examples of ways you might engage with STEM, but there are many more, so please feel free to add your own activities.
5	Which of the activities from this list would you say that you have engaged with at least once in the past year?
6	Would you describe yourself as someone who is interested in STEM in your personal time?
6a	*If answer is positive:* Do you think this is reflected in your teaching?
6b	*If answer is positive:* Can you give an example of this?
7	What do you think pupils enjoy most about STEM learning?
8	What do you enjoy most about teaching STEM?
9	When preparing for STEM lessons, where do you look for ideas and resources?
9a	*Internet:* Can you give an example of which sites you use?
9b	*If unusual website:* What is it that you like about this site?
9c	*Internet:* Do you find that these sites are pitched appropriately for your class?
9d	*Negative:* How does this affect the way you use the information?
10	Do you find that physical resources for STEM lessons are easy to come by?
10a	*If negative:* Has this ever affected how you plan and carry out lessons?
10b	*If appropriate:* Can you give an example of this?
10c	*If appropriate:* Would you do anything differently if you had access to more resources?
11	Are you satisfied or dissatisfied with the amount of STEM content you are able to cover in your lessons?
11a	*If answer is 'dissatisfied':* What is the reason for this?
12	Have you ever tried to make your STEM lessons cross-curricular?
12a	*If negative:* Do you think it could be of potential benefit?
12b	*If positive:* Can you give an example?
13	This next question is in three parts, and we can address each part separately: I would like to know when it comes to STEM engagement, which barriers (if any) you feel are in place for pupils, teachers (as a group) and yourself personally.
13a	What do you feel is the biggest influence on pupil's long term engagement with STEM subjects and careers?
13b	What do you feel is the key challenge faced by teachers (as a group) when teaching STEM content?
13c	What do you feel is key challenge faced by yourself personally when teaching STEM content? This answer may be the same as the previous question.
14	Which of the things that we've discussed do you think is the most important factor in STEM engagement?
14a	*If appropriate:* Why?
15	Is there anything you think practitioners can do to address this issue?

Table 3.9: Question schedule used in teacher interviews during main research period.

Read about a STEM subject in mainstream media (newspapers/ magazines)	Watched something related to STEM on TV (news, documentary e.g. David Attenborough)	Interacted with STEM on social media (follow STEM pages on Facebook, Instagram, Twitter)
STEM hobbies (e.g. model building, coding, web design)	With children in your family (e.g. staging a STEM activity for them)	Puzzles or games (e.g. Sudoku)
Mending or trouble-shooting your own devices	Museum visits	Other?

Table 3.10: List of potential STEM engagements presented to teacher interview participants for question 5 of the schedule presented in Table 3.9.

Following this was a discussion of teachers' access to resources for STEM lessons, their satisfaction with STEM provision, and their opinions on interdisciplinarity. Understanding participants' current access to lesson resources determines the extent to which the researcher must provide materials (e.g. graph paper, construction materials, pre-printed questionnaires) for interventions and data collection. Archaeology holds great potential for cross-curricular teaching; understanding participants' perspectives on this was crucial for workshop content and development. Respondents were then prompted to consider the challenges faced by pupils and teachers in STEM teaching and learning, and discuss how educators can tackle them. These discussions aimed to reveal how interventions could be most effective for participating teachers and schools. Establishing the expectations of participants was key to developing interventions that were relevant and enjoyable for their pupils. The findings of these interviews informed progression of the project: from content, pedagogy and delivery of interventions, to logistical questions such as the extent of materials that were provided by the researcher.

The resulting dataset detailed a wide range of teaching experience and expertise that is not easily quantified, and instead was assessed thematically (see Chapter 4). Interviews were audio recorded and transcribed by the interviewer (Appendix 8 to Appendix 15). Recordings were transcribed to present responses in a consumable format without compromising original meaning. Informal verbal buffers and discourse markers (e.g. 'um' or 'like') were removed, and long unconstructed sentences (both of which hold little interpretive value) were paraphrased for clarity (Arksey and Knight 1999, 146; Brinkman and Kvale 2015, 206). Responses to each question were coded and collated to ensure comparability between participants: frequency of key words and themes within each response was noted for each question. The results of each interview are presented and discussed in Chapter 4.

3.4.2 Interventions

Interventions were developed following the consultation with teachers (see section 3.4.1 and Chapter 4). Interventions were classroom based, and comprised three STEM-themed archaeological workshops. Following the pilot of the first intervention, participating teachers and the researcher agreed that the main body of research would be conducted with lower Key Stage 2 pupils to avoid impacting upper Key Stage 2 pupils' exam preparation. Teachers also noted that lower Key Stage 2 children are frequently overlooked for external engagement activities, which tend to favour children transitioning to secondary school. The Year 4 curriculum has numerous learning requirements that dovetail appropriately with archaeology, see Chapter 5 for further details of curriculum-archaeology-STEM crossover. BF was an exception as all lower Key Stage 2 pupils at this institution are in a single class, meaning that Year 3 and 4 are combined. All Year 3 and 4 pupils at BF undertook archaeological interventions, but data was collected from Year 3 pupils only, as Year 4 had participated in the pilot intervention[14]. Three interventions were delivered to Year 4 (and Year 3 at BF) pupils throughout the 2018/19 academic year; one in each term, apart from at NB, where the first two were presented at the start and end of the second term due to timetable constraints.

Session content was developed in collaboration with participating teachers, and with reference to appropriate curriculum requirements. Methods of delivering content were based in learner-centred and problem-based educational approaches. Archaeological content was selected based upon the expertise of the researcher, access to suitable resources, and adaptability to the curriculum and topics of participating schools. Intervention content covered: faunal analysis, climate change and environmental reconstruction, aqueduct design and construction. Each intervention was designed to cover curriculum requirements and to link with class projects where appropriate. For example, SP and BG teachers identified how themes of water and waste removal in the aqueduct session linked to their 'burps, bottoms and bile' topic. Sessions aimed to present pupils with practical activities, which required STEM skills they were likely to recognise from lessons (e.g. graph drawing, temperature reading) to demonstrate how STEM can be explored in an engaging way. Chapter 5 outlines the full details of activities and resources used in each intervention.

[14] Year 4 pupils did not join the first intervention, as they had already undertaken it in the summer prior, however, they did undertake the following two interventions, but no data was collected from them.

3.4.3 Questionnaires

A questionnaire was devised to observe potential change in pupils' STEM self-concepts and perceptions in response to interventions, which was completed by all participants (n=233, see Table 3.11). Two (slightly different) versions of the questionnaire were completed; one before each intervention and one afterwards. Each pupil filled out a total of six questionnaires apart from cases where individuals were absent from school when questionnaires were completed. Thus, the number of questionnaire respondents varied in accordance with pupil attendance. By only surveying pupils who were present on the day of the researcher's visits, there is a risk that the perceptions of children with long-term patterns of absence from school[15] are not represented in the final dataset. However, data on pupil absence for each school demonstrates that attendance was high throughout 2018/19 (Table 3.12). Pupils were asked to complete pre-intervention questionnaires before each session and post-intervention questionnaires at the end. Post-intervention questionnaires were completed immediately following archaeology sessions to capture children's impressions while they were fresh. At NB, due to scheduling conflicts, questionnaires were completed in the weeks following the first and second interventions, which may have impacted data collection. It is likely that those children were less able to recall their experience, influencing questionnaire responses. Data from NB's first two post-intervention questionnaires is not considered a reliable reflection of pupils' STEM perceptions following these sessions, and is discounted from further analysis (where this is not the case, it has been made clear and the rationale explained, see Chapter 6).

School	Curriculum	Year	Classes	Participants
SP	Welsh	4	3	72
YP	Welsh	4	1	30
BG	Welsh	4	2	57
BF	English	3	1	11
NB	English	4	2	63

Table 3.11: Number of classes and participants at each school who completed questionnaires during the main research period.

[15] Either due to illness or other unauthorised absence.

	School	2018	2019	2018/2019
Wales	BG	3.40%	3%	
	SP	4.40%	4.40%	
	YP	3.20%	3.60%	
England	BF			3%
	NB			3%

Table 3.12: Percentage of pupil absence across the school year. Differences in data presentation is due to how it is collected in England (www.gov.uk/school-performance-tables) and Wales (www.mylocalschool.gov.wales).

3.4.3.1 Question style and schedule

Questionnaires comprised three questions, the third of which was phrased slightly differently on pre and post-intervention versions (Figure 3.3. and Figure 3.4). The first question asked participants to state what the STEM acronym stands for to establish whether participants had a basic understanding of STEM. This ensured validity of answers to later questions, as children frequently answer questions regardless of whether they understand it (Fargas-Malet *et al.* 2010, 187). It is impossible for participants to give their true opinion on pursuing a career in STEM if they do not know what it is, therefore this question provides a filter for baseline knowledge of the STEM branches. For the second question respondents stated whether they agreed ('yes', 'maybe' or 'no') with a series of statements. The statements were intended to gauge each child's current level of engagement or enthusiasm for STEM, as well as their anticipated relationships with STEM in the future (see Appendix 7 for detailed rationales behind each statement).

The third question was phrased differently on the pre and post-intervention questionnaires (Figure 3.3. and Figure 3.4). This question was multiple choice: on the pre-questionnaire participants were presented with 12 skills, and asked to select those that they considered to be the most important for someone working in STEM. Some skills (e.g. observation, curiosity) were inspired by the Science Capital Approach teaching pack (Godec *et al.* 2017, 58). A glossary, adapted from Macdonald (2015), was provided on the back of each questionnaire with definitions of each of the 12 skills (Table 3.13). Post-pilot attempts to dissuade pupils from circling every option on the pre-intervention questionnaires by rephrasing the question (as well as teachers specifically telling their classes not to circle everything), were unsuccessful (see Chapter 6). Consequently the question was rephrased again following the first intervention: 'Which **three** skills do you think **are the most important** for someone working in STEM?'. The potential to extract nuance from this question outweighed the risks of changing the research protocol. This new phrasing was effective and followed by the majority of children. By tracking skills pupils considered to be of most importance to a person working in STEM, it was possible to explore whether their perceptions changed across the research period. Changes to perceptions may have occurred in response to both archaeological interventions, and other STEM-based influences in their school and personal lives.

Glossary:
Observation: you carefully watched or listened to something to learn something new.
Logical thinking: you were able to think clearly about facts and information.
Perseverance: you kept working on something, even if you found it difficult.
Problem solving: you were able to work out the answer to a problem.
Curiosity: you wanted to learn something new.
Imagination: you made up new and exciting ideas.
Independent working: you were able to work well by yourself.
Organisation: you planned your work carefully.
Working as a team: you worked well with the other people in your class.
Communication: you listened to other people's ideas and gave ideas of your own.
Investigation: you had a question and worked to find out the answer.
Creativity: you had ideas about how to present things, or make something new.

Table 3.13: Glossary definitions given to participants alongside pre and post-intervention questionnaires throughout the main research period.

Question three on the post-intervention questionnaire asked respondents to reflect on their experience of skill usage during the archaeological intervention, using the same list of skills as on the pre-intervention questionnaire. The reflective aspect of this question was suggested by a teacher at YP in response to the new curriculum being piloted in Wales. This curriculum places an emphasis on using meta-cognition and reflective practice to empower children to take greater responsibility for their own learning (Donaldson 2015, 69). In addition to this, the importance of considering STEM careers in terms of skills and attributes is highlighted by the WISE Campaign in order for young people to perceive them as being '*for people like me*' (Macdonald 2014, 27). It was anticipated that by considering skills/aptitudes that are useful in a STEM career, and identifying them in their own conduct, pupils would better recognise their potential aptitude for STEM. It may also serve to remove feelings that STEM practitioners have skills beyond participants' own capacity, and highlight how a STEM career might be a realistic aspiration. Additionally, by choosing skills they think are important for a person working in STEM, and then recognising their own engagement with those skills, participants may be able to better visualise themselves in a similar role. Repeating the process across an academic year served to reinforce aspirational messages and demonstrated how a future in STEM is achievable and appropriate for ‘*people like me’* (Archer *et al.* 2013, 18; Macdonald 2014, 27).

Name of your school: ________________________________

Thank you for inviting me to speak to your class, I hope you enjoyed it! Please could you help me with my research by filling out this form with your teacher?

1) Do you know what ‘STEM’ stands for? Fill in the gaps:

S______________ T_________________ E_________________ M________________

2) What do you think about STEM? Tick the box that matches your opinion:

	Yes	Maybe	No
I want to be a scientist when I grow up	☐	☐	☐
I enjoy science lessons	☐	☐	☐
I enjoy maths lessons	☐	☐	☐
STEM is an important part of my life	☐	☐	☐
I would like to learn more about STEM in the future	☐	☐	☐
I would like to use STEM in my job when I’m older	☐	☐	☐

3) Which skills do you think **are most important** for someone working in STEM? Circle all the skills you think they will need. There is a glossary on the back of this sheet.

Observation	Logical thinking	Perseverance	Problem solving
Curiosity	Imagination	Independent working	Organisation
Working as a team	Communication	Investigation	Creativity

Figure 3.3: Pre-intervention questionnaire completed by participants following the first intervention.

Name of your school: ______________________________

Thank you for taking part in the archaeology workshop, I hope you enjoyed it! Please could you help me with my research by filling out this form with your teacher?

1) Can you remember what 'STEM' stands for? Fill in the gaps:

S_____________ T________________ E________________ M_______________

2) What do you think about STEM? Tick the box that matches your opinion:

	Yes	Maybe	No
I want to be a scientist when I grow up	☐	☐	☐
I enjoy science lessons	☐	☐	☐
I enjoy maths lessons	☐	☐	☐
STEM is an important part of my life	☐	☐	☐
I would like to learn more about STEM in the future	☐	☐	☐
I would like to use STEM in my job when I'm older	☐	☐	☐

3) Which STEM skills did <u>you use</u> in the archaeology workshop? Circle all the skills you used. There is a glossary on the back of this sheet.

Observation	Logical thinking	Perseverance	Problem solving
Curiosity	Imagination	Independent working	Organisation
Working as a team	Communication	Investigation	Creativity

Figure 3.4: Post-intervention questionnaire completed by participants throughout the main research period.

3.4.3.2 *Data analysis*

Questionnaires were subject to statistical analysis based upon the condition that Q1 had been answered appropriately (see section 3.4.3.1 for rationale). Answers to Q1 were accepted as correct if pupils had identified three of four STEM branches. Incorrect spellings were accepted if it was obvious what the individual's intention was (e.g. 'scients') and answers in Welsh (e.g. mathemateg) were accepted. In instances where participants identified fewer than three of the STEM branches correctly, the question was considered unanswered. Questionnaires that did not evidence participant understanding of STEM (i.e. those with Q1 unanswered) were not considered in analysis of Q2 and Q3. While some statisticians argue that statistical analysis cannot be conducted on non-random samples (Gorard 2001, 10), it was decided that statistical analysis *would* be carried out on this data, albeit with some assumptions and caveats. It is outside the scope (and capability) of a single PhD project to randomly sample the entirety of primary level children in Wales and England, and therefore impossible to capture a sample that might truly represent this population.

Statistical analysis was conducted on the responses to Q2 in IBM SPSS Statistics 27. Due to the challenge of matching student responses on pre and post-intervention questionnaires, pre and post questionnaires had to be treated as two independent groups rather than paired samples. Attempts to match pre and post-intervention questionnaires would have impacted the anonymity of the study, as young children are less able to use anonymising methods effectively (e.g. using a reference number rather than their name). The Mann Whitney U statistical test is most appropriate to investigate significance between two individual groups using ordinal variables (e.g. 'yes', 'maybe', 'no'; see Gorard 2001, 125). To establish significant differences in pupils' responses to statements following interventions and across the main research period, the Mann Whitney U statistical test was used. Exact significance was calculated using a two-tailed test, and the significance threshold was set at $p<0.05$.

Where the same datasets were subject to multiple statistical analyses, p values were corrected using the Bonferroni method of dividing the significance threshold by the number of tests run on that dataset (VanderWeele and Mathur 2019). Datasets were considered by question, pre or post-test, and participants. For example, where responses to question 4 on the pre and post-intervention 1 questionnaires were compared, 'all participant responses' and 'SP responses' were considered to be part of the same dataset and therefore subject to the Bonferroni correction. However, when testing 'NB responses' to question 4 on post-intervention 1 and pre-intervention 2 questionnaires and 'NB responses' to question 4 on pre and post-intervention 2 questionnaires, these were *not* considered to be the same dataset and were not subject to the Bonferroni correction.

As Q3 was modified following the first set of pre-intervention questionnaires, and pre/post-intervention questionnaires asked slightly different questions, the responses to this question are not directly comparable across the whole dataset. Responses to this question are dealt with in two separate groups: responses to pre-intervention questionnaires and responses to post-intervention questionnaires. These two groups reflect two different concepts: the skills that participants believed are important for '*someone working in STEM'*, and the skills that they felt they used in each intervention. The frequency at which skills were identified as '*important to someone working in STEM*' was tracked across each intervention to examine participants' perceptions over the research period. This was then examined alongside frequency of responses listing the skills utilised by participants to attempt to identify whether perceptions of 'important' skills in STEM were influenced by participants' understanding of their own STEM practice. Although Q3 on the first pre-intervention questionnaire allowed more flexibility in response than those that followed (pre-workshop 2 and 3), broadly similar trends were identified in both (although with the caveat that they represent two separate tasks). The responses to this question collected prior to interventions 2 and 3 were analysed for statistically significant changes in which skills were deemed 'important' using a Chi-square test in Microsoft Office Excel. The significance threshold was set at $p<0.05$.

3.4.4 Pupil task-based interviews

In addition to administering questionnaires to all 233 intervention participants, 20 pupils were invited to take part in small group, task-based interviews. Interviews were designed to shed further light on how participants' STEM self-concepts and perceptions may have altered in response to archaeological engagements. The researcher introduced themselves and the project to participants in each school using an approach informed by Yamada-Rice's (2017) child-friendly method (e.g. storytelling and games) recommendations. A short PowerPoint presentation was shown at each school, with details of the project and information on how the children could expect to participate. The talk began with a game: using clues on a PowerPoint slide (Figure 3.5) and objects that were handed out (animal bones, pottery, trowel), children were challenged to guess "what kind of scientist" the researcher is. Pupils were asked to consider what 'STEM' might stand for, and how it might be relevant in a range of jobs. Finally, the proposed plan for pupil participation was outlined: three archaeological interventions (one in each term), class wide questionnaires (before and after each activity), and small group tasks with volunteers. Children were not asked to volunteer immediately after the introductory talk, but to register interest with the class teacher. This was done in recognition of the adult-child power structure within a school setting (Devine 2002, 307). Children are vulnerable to persuasion in cases where adults are positioned as authorities over them, and may feel pressure to comply with requests without fully considering what they are being asked to do (Hill 2005, 63). Creating distance (both temporal and physical) between the researcher's request and the child's decision to participate, reduces the effect of this power dynamic.

Figure 3.5: Slides shown to potential participants in introductory talk

Sampling for group interviews was purposive rather than random, as teachers were asked to select participants – from those who had volunteered – who best reflected the range of ability within the class. The resulting sample of 20 children comprised two girls and two boys from each school (Table 3.14). Participants chose their own pseudonyms and are referred to accordingly throughout this thesis. One drawback to this approach is that teachers may select children they felt would ‘perform best’ in interviews, unintentionally biasing the sample groups. Despite this, it was decided to utilise expertise of teachers to generate a sample of children that represented the range of ability across a class or year group. This decision was supported by the framing of teachers’ as ‘experts’ on their pupils (Day 2004, 88; Kagan and Tippins 1991).

School	Pseudonym	Year Group
YP	Barry	4
YP	Stanley	4
YP	Pippin	4
YP	Molly	4
SP	Skull Trooper	4
SP	NJ	4
SP	Cupcake	4
SP	Blossom	4
BG	Buster	4
BG	Blackjack	4
BG	Pasta	4
BG	Videogame Guy	4
BF	Black Cat	3
BF	Olivia	3
BF	Bluebell	3
BF	Bumble	3
NB	Pepperoni	4
NB	Apple	4
NB	Jelly	4
NB	Cleo	4

Table 3.14: Participants in small group interviews by pseudonym (as chosen by each child).

Three interviews were held across the 2018/2019 academic year: one before the initial intervention, and then following the second and third interventions. The possibility of running four interviews (one prior to interventions and one following each workshop) was considered, but rejected on the grounds that schools would be less able to accommodate this. Additionally, some initial interviews were conducted on the same day as the first intervention; interviewing children both before and after a session may have resulted in interview fatigue and less useful results. The exception to this was the second interview conducted with NB, where time was limited and so pupils were interviewed *before* their second intervention. This group had undertaken their first intervention only seven weeks prior to this interview (unlike other schools that had undertaken it 17 weeks before on average), which was an important consideration in this compromise.

In recognition of participants' age, interviews were based around tasks rather than a specific question schedule. Interview activities acted as a device around which participants explored their opinions of skill/aptitude usage in STEM practice. Completion of tasks was not the central goal, instead it was the discussions generated by tasks that formed the basis of analysis and interpretation (Harden *et al.* 2000). Interview tasks varied throughout the main research period: a word sort, self-reflections and a final survey. These methods produced three main datasets, which are discussed in Chapters 7, 8 and 9. These methods are outlined in sections 3.4.4.1 to 3.4.4.3. Interviews were audio recorded and transcribed in the edited transcription format (see Appendix 22 to Appendix 36). Transcribing group interviews with child participants presented additional challenges to those with individual adults. Hoppe *et al.* (1995, 110) noted the difficulty in distinguishing between the voices of child participants; to avoid this, pupils were asked to say their names at the start of recordings, and the interviewer used children's names when replying to their comments.

3.4.4.1 Word sort

A word sort activity, inspired by previous good practice (Punch 2002b; Johnson *et al.* 2014, 38), was used to generate discussion around STEM skills and those who work in STEM. Participants were presented with a series of cards with words or phrases relating to a range of skills and aptitudes (Table 3.15). These cards were inspired by Macdonald's (2015) 'People Like Me' activity pack, with some key adaptations. The 'People Like Me' pack is a STEM engagement tool, which supports young people to think about STEM careers in terms of self-concepts. Macdonald (2014, 7) argues that STEM engagement must emphasise personal characteristics to support young people in recognising how they might be suited to a future in STEM. Discussing the relevance of skills/aptitudes that are not traditionally associated with STEM provides a novel access point for those who have not engaged with STEM via traditional routes. This approach is also supported by the Children's Conceptions of Career Choice and Attainment (CCCA) model, which outlines how children's understanding of careers develops as they age (Howard and Walsh 2011, 260). According to the CCCA model, as children develop more refined cognitive skills, their approach to careers progresses from abstract 'magical thinking' to complex consideration, where they are able to appraise and reflect on the skills and qualifications required by particular roles (Howard and Walsh 2010, 151). Participants of this study fall into the CCCA stage of development where they can recognise the importance of interest and ability in career attainment (Howard and Walsh 2010, 146).

Skills/aptitudes listed in the 'People Like Me' pack were adapted for the word sort exercise. Macdonald (2014, 26) highlights how boys and girls construct and articulate their self-identity differently, with boys more likely to use verbs, and girls more likely to use adjectives. The 'People Like Me' pack was designed to be used with girls, and therefore lacks 'verb' descriptors. The skill/aptitude cards presented in this study were broadened to include verbs *and* adjectives, meaning that some cards had similar meanings (e.g. 'inventive and 'comes up with lots of new ideas'). Additional cards were also included to cover specific interests that participants might hold, such as enjoying sport, dance, languages and reading. 46 skill/aptitude cards were used in the first interview (Table 3.15). Previous research into how children describe their personalities has highlighted issues of comprehension: where participants are unable to understand vocabulary, they may be less able to complete the task effectively (Markey *et al.* 2002, 178; Soto *et al.* 2008, 732). Therefore a glossary was adapted from Macdonald (2015) and provided for skills/aptitudes expressed as an adjective (Table 3.16).

Artistic	Enjoys drawing	Likes learning languages
Can take risks	Enjoys history	Likes to learn new things
Can use computers	Enjoys maths	Likes to try new things
Can work in a team	Enjoys reading	Likes visiting other countries
Can work independently	Enjoys science	Listens to other people's opinion
Careful	Enjoys sport	Logical
Clever	Gets all of the answers right	Methodical
Comes up with lots of new ideas	Hard working	Organised
Competitive	Honest	Practical
Creative	Imaginative	Reflective
Curious	Inventive	Reliable
Determined	Learns from their mistakes	Resourceful
Discusses ideas with others	Likes being outdoors	Sensible
Encourages others	Likes computer games	Shares information with others
Enjoys building things	Likes helping others	Wants to understand how things work
Enjoys dancing		

Table 3.15: Skills and aptitudes presented to participants in their first interview word sort exercise.

Glossary:
Curious: is keen to learn something new.
Logical: is able to think clearly about facts and information.
Creative: has ideas about how to present things, or make something new.
Artistic: good at making beautiful items – drawings, paintings, sculptures.
Honest: likes everything to be truthful and open, not secretive.
Sensible: makes good judgements based on reason and experience.
Resourceful: finds quick, clever ways to get things done or to make things easier.
Careful: avoids danger and follows instructions.
Imaginative: thinks of new and exciting ideas
Inventive: comes up with new ideas to solve puzzles, or design new things.
Reliable: always does what they have promised, and can be trusted.
Determined: doesn't give up, even if things become difficult.
Methodical: follows a set of instructions carefully.
Hard working: always works well and tries their best.
Competitive: always tries their best to win.
Practical: good with their hands, good at doing practical tasks like experiments.
Organised: good at making plans and sticking to them.
Clever: quick to understand new information.
Reflective: can look back on work and think about what went well and what can be improved.

Table 3.16: Glossary presented to participants in first interview word sort. Adapted from Macdonald (2015).

Participants were challenged to interact with these cards in varying ways throughout the main research period, but it was anticipated that the conversations generated in each interaction would shed light on how their perceptions of STEM skills/aptitudes changed during this time. Outcomes of each interview informed those that followed, resulting in an iterative data collection method. In the pre-intervention interview, participants were asked to identify which of the skills/aptitudes they thought were most important for a person who worked in STEM. The first group interviewed (YP) decided to rank cards they had chosen in order of importance. Researchers stress the importance of empowering children to plan and direct research (Cree *et al.* 2002, 49; Fargas-Malet *et al.* 2010, 176; Roberts 2017), so the researcher followed this lead. The group decided to rank cards 1-5 in order of importance, with 1 being most and 5 being least important to a person working in STEM. To ensure comparability, this system was used by subsequent groups in their first interview. Other modifications were made by groups to suit their requirements, such as establishing overlapping categories with the SP group. The aim of this activity was to stimulate discussion, therefore the distinctions between ranked words were noted, but not extensively interrogated.

During these interview sessions, it became clear that the number of cards was a hinderance to the sessions, vastly increasing the time estimated they would take. To ensure parity, the selection of words was not altered between groups in the first round of interviews, with one exception. NB group's interview time was limited, and so skill/aptitude options were reduced to reflect this. Multiple rationales were used to eliminate cards from the selection. MacDonald's (2014) assertions regarding children's use of adjectives and verbs as self-descriptors did not emerge amongst these participants; instead all pupils used a mix of verbs and adjectives to describe themselves (see Chapter 8) and those working in STEM careers. Based on this, it was decided that cards with attributes that were expressed as both an adjective and a verb could be removed, for example 'artistic' was kept while 'enjoys drawing' was removed. NB were the last group interviewed, so cards were also reduced based on how other groups had previously interacted with them. Those noted as being similar by participants (e.g. 'likes to learn new things' and 'likes to try new things') were removed. However, cards chosen by pupils in their self-reflections (Chapter 7) which had otherwise limited interaction and no alternate meanings remained. Both 'reliable' and 'organised' stimulated little word sort discussion, but were chosen by participants as traits they identified in themselves and so were retained. NB participants were presented with 38 cards in their first interview (Table 3.17). These changes were applied to all subsequent interviews. Following participant confusion, changes were also made to the glossary: definitions of 'methodical' and 'practical' were modified (Table 3.18).

Artistic	Enjoys maths	Likes to learn new things
Can take risks	Enjoys reading	Likes visiting other countries
Can use computers	Enjoys science	Listens to other people's opinion
Can work in a team	Enjoys sport	Logical
Can work independently	Gets all of the answers right	Methodical
Clever	Hard working	Organised
Competitive	Honest	Practical
Creative	Imaginative	Reflective
Curious	Inventive	Reliable
Determined	Likes being outdoors	Resourceful
Enjoys building things	Likes computer games	Sensible
Enjoys dancing	Likes helping others	Wants to understand how things work
Enjoys history	Likes learning languages	

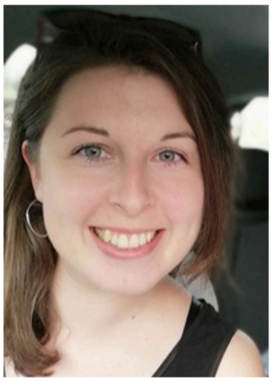
Table 3.17: Skills and aptitudes presented to NB participants in their first interview word sort exercise and all participants in the second and third interview word sort exercises.

Glossary:
Curious: is keen to learn something new.
Logical: is able to think clearly about facts and information.
Creative: has ideas about how to present things, or make something new.
Artistic: good at making beautiful items – drawings, paintings, sculptures.
Honest: likes everything to be truthful and open, not secretive.
Sensible: makes good judgements based on reason and experience.
Resourceful: finds quick, clever ways to get things done or to make things easier.
Careful: avoids danger and follows instructions.
Imaginative: thinks of new and exciting ideas
Inventive: comes up with new ideas to solve puzzles, or design new things.
Reliable: always does what they have promised, and can be trusted.
Determined: doesn't give up, even if things become difficult.
Methodical: works through each stage of a task carefully.
Hard working: always works well and tries their best.
Competitive: always tries their best to win.
Practical: good with their hands, good at doing tasks like experiments or making something.
Organised: good at making plans and sticking to them.
Clever: quick to understand new information.
Reflective: can look back on work and think about what went well and what can be improved.

Table 3.18: Glossary presented to NB participants in their first interview word sort exercise and to all participants in the second and third interviews.

Other child-based research has highlighted the need to be reflective and reflexive to ensure interview methods are suitable for participants (Cree *et al.* 2002, 50; Punch 2002a, 323). Following the first interview sessions, it was noted that participants did not interact with the activity in the anticipated way. They often discussed cards in terms of a school-child's experience, rather than that of someone working in STEM. The second set of interviews used a device to broaden participants' attention to other STEM contexts. Pupils were challenged to create a mind map of the STEM-based people in their lives, and the word sort was then framed around them. This exercise also helped build a more accurate picture of each child's STEM capital. 'Who you know' is a key factor in capital[16] (Godec *et al.* 2017, 7), and so each child's STEM perceptions must be contextualised in their access to acquaintances with a STEM background. This method was limited by the knowledge of individuals, who may be unaware of potential STEM backgrounds amongst friends and family. In case groups did not have a pool of STEM acquaintances to draw upon, a set of profiles were also provided, detailing five individuals with STEM-based careers. These profiles included: a doctor, a conservator, a civil engineer, an IT technician and a technologist, see Figure 3.6.

[16] Definition expanded here to encompass all STEM branches



Ali is a doctor, which means that she needs to understand how our bodies work and how illness or diseases can affect them. She has to know which medicine or treatment is best for her patients. She works in Emergency Medicine, so she has to be able to understand patients' problems and make decisions about their treatment quickly.

Rhodri looks after the IT equipment for lots of companies. If people are having a problem with their computer or smart phone, he helps them to work out what is wrong and fix it. He also helps everyone stay safe online, by making sure their security settings are effective.

Chloe is a civil engineer, which means that she designs things in our built environment. She has worked on projects that help to provide clean water and safe places to practice good hygiene in Peru and Uganda. Civil engineering is all about problem solving, so Chloe has to make sure that she understands what people need and the steps she needs to take to make a plan work.

Scott is a technologist, who works for a Japanese electronics company. He is a 'research scientist', which means that he does experiments on electronic products to work out ways to make them perform better. He has designed and tested screens for virtual reality headsets, and found ways to improve the screens of mobile phones. He also gets to travel to Japan to visit company's main office.

Johanna is a conservator. She looks after historical objects and buildings, to make sure that they are not damaged or destroyed over time. Johanna has to know the properties of different materials, so that she can make decisions about how best to protect them. For example, some objects have to be kept at the right temperature, or can't be exposed to too much sunlight.

Figure 3.6: Profiles of people who work in a STEM field presented to all participants in the second

The third interview took place after the final intervention, and the word sort task used the same skills/aptitude cards and glossary sheet from the second interview. This time participants selected five traits they felt were the most important for a person working in STEM, and five they felt were least important. Though it was emphasised by the interviewer that a 'medium' category was not required, most groups created one anyway, as there were things that they either disagreed on or wanted to speak about but did not define as most/ least important.

Interview content was sorted by skill/aptitude so responses from all groups could be analysed together. Responses to cards that were discarded following the first interview were recorded but not subject to analysis. The resulting dataset comprised 38 sections (each relating to a specific card) with each group's responses listed. This process was repeated for each interview, resulting in a final dataset with responses organised by skill/aptitude, group, and interview session. Structuring the data in this way made it possible to observe how participant perceptions of skills/aptitudes developed throughout the research period. Participant responses were coded for content, for example: statements that were vague (e.g. '*new stuff'* or '*new things'*), or referred to a particular behaviour (e.g. avoidance of '*trouble'*). General themes were identified and their development tracked across each interview. The results of this analysis are in Chapter 7.

3.4.4.2 Self-reflection

A self-reflective exercise followed each word sort in all three interviews. This exercise encouraged participants to reflect on their skills, aptitudes and interests by selecting cards from the word sort that they believed best represented them. The aim of this was to ascertain how participants identified with STEM, and to observe how their self-concepts might change across the research period in response to the archaeological interventions. It was anticipated that as interventions presented pupils with a novel access point to STEM they might adapt their self-concepts to include alternative aptitudes for STEM, and envision new ways to participate in STEM. In each session, participants were asked to select five cards that they felt best represented themselves and to explain their rationale for choosing them. One deviation from this occurred in YP group's first interview, where pupils selected more than five cards to describe themselves. The interviewer allowed this as they were still developing rapport with the children, and it did not prevent them from developing a broad understanding of how those participants perceived themselves. Pupils were informed that they were able to share words, and that several copies of the pack of cards were available, to prevent them from being 'unable' to select cards that were meaningful to multiple participants. Participant responses were assessed for consistency and for potential change in self-perceptions across the research period. This was done by ranking the choices of each individual, and identifying themes within their justification for those choices. Analysis (see Chapter 8) sought to observe alignment with STEM in personal identity, and to understand how this was produced and facilitated within participants' lives.

3.4.4.3 Final survey

While participants generated much conversation around the skills/aptitudes presented in the first two interview sessions, the extent to which these discussions were influenced by participation in the project remained unclear. Despite the reflective element of both interviews, questions remained about how participants' STEM perceptions were informed by their STEM self-concepts and identities. A survey instrument was devised to capture this information, and was completed by interview participants at the end of the third session. This survey consisted of a worksheet with three questions, with space provided for both written and drawn responses (Figure 3.7). While the use of drawing tasks has been applied with great success in the past (Christensen and James 2008, 162; Fung 2002; Matthews 1996), it is understood that not all children enjoy drawing (Backett-Milburn and McKie 1999, 395; Punch 2002a, 331). To ensure all perspectives were heard, participants were also given the opportunity to discuss answers verbally. 19 out of 20 participants undertook this survey; one BG child declined to participate in the third interview. Backett-Milburn and McKie (1999) and Punch (2002a) warn against researchers interpreting children's drawings on their behalf. Consequently, where it was not possible to discuss a response with the child who drew it, care has been taken not to impose meaning that may be inaccurate. Written and verbal responses to each question were coded by theme (e.g. 'now I know what 'STEM' is), and have been grouped accordingly in the presentation of results and discussion (see Chapter 9).

3.4.4.4 Pupil task-based interview schedule

Adapting interview tasks according to participant responses and needs resulted in variation of tasks between interviews. These variations are detailed in Table 3.19 to Table 3.21 along with information about which participants were present for each session, where they were held and their duration.

STEM and Archaeology

Have your thoughts or feelings about STEM changed during this project?

____

____

Write or draw an explanation for this below:

Which skills or personality traits do you have that would help you use STEM in the future?

____

____

Write or draw an explanation for this below:

Do you think you'd like a job that uses STEM when you're older?

____

____

Write or draw an explanation for this below:

Figure 3.7: Survey given to participants at the end of their third interview session.

<table>
<tr><td rowspan="6">Interview 1</td><td>School</td><td>Participants</td><td>Year Group</td><td>Time</td><td>Location</td><td>Length</td><td>Activities</td></tr>
<tr><td>YP</td><td>Barry (M)
Molly (F)
Pippin (F)
Stanley (M)</td><td>4</td><td>Day before first intervention (morning)</td><td>Resource room</td><td>40 minutes</td><td rowspan="5">- Recap STEM meaning, discuss possible STEM careers
- Word sort: rank importance of words 1-5
- Self-reflection: 5 cards that represent you</td></tr>
<tr><td>SP</td><td>Blossom (F)
Cupcake (F)
NJ (M)
Skull Trooper (M)</td><td>4</td><td>Morning of first intervention</td><td>School library</td><td>41 minutes</td></tr>
<tr><td>BG</td><td>Blackjack (F)
Buster (F)
Pasta (M)
Videogame Guy (M)</td><td>4</td><td>Morning of first intervention</td><td>Resource room</td><td>36 minutes</td></tr>
<tr><td>BF</td><td>Black Cat (F)
Bluebell (M)
Bumble (M)
Olivia (F)</td><td>3</td><td>Morning of first intervention</td><td>School hall</td><td>44 minutes</td></tr>
<tr><td>NB</td><td>Apple (M)
Cleo (F)
Jelly (M)
Pepperoni (F)</td><td>4</td><td>Lunchtime before first intervention</td><td>Classroom (not belonging to participants)</td><td>29 minutes</td></tr>
</table>

Table 3.19: Details of each interview conducted prior to the first intervention.

	School	Participants	Year Group	Time	Location	Length	Activities
Interview 2	YP	Barry (M) Stanley (M)	4	Afternoon after second intervention	Resource room	47 minutes	- Mind map of STEM acquaintances - Word sort: skills STEM people will need (using STEM profiles) - Self-reflection: choose 5 cards that represent you
	SP	Blossom (F) Cupcake (F) NJ (M) Skull Trooper (M)	4	Afternoon after second intervention	School library	32 minutes	
	BG	Blackjack (F) Pasta (M) Videogame Guy (M)	4	Lunchtime after second intervention	Resource room	50 minutes	
	BF	Black Cat (F) Bluebell (M) Olivia (F)	3	Afternoon after second intervention	School library	62 minutes	
	NB	Apple (M) Cleo (F) Jelly (M) Pepperoni (F)	4	Lunchtime before second intervention	School library	29 minutes	

Table 3.20: Details of each interview carried out following the second intervention (with the exception of NB who were interviewed prior to the second intervention).

<table>
<tr><th rowspan="6">Interview 3</th><th>School</th><th>Participants</th><th>Year Group</th><th>Time</th><th>Location</th><th>Length</th><th>Activities</th></tr>
<tr><td>YP</td><td>Barry (M)
Molly (F)
Pippin (F)
Stanley (M)</td><td>4</td><td>Afternoon after third intervention</td><td>Resource room</td><td>60 minutes</td><td rowspan="5">- Word sort: 5 most important, 5 least important
- Self-reflection: choose 5 cards that represent you
- Final survey sheet</td></tr>
<tr><td>SP</td><td>Blossom (F)
Cupcake (F)
NJ (M)
Skull Trooper (M)</td><td>4</td><td>Afternoon after third intervention</td><td>School library</td><td>63 minutes</td></tr>
<tr><td>BG</td><td>Blackjack (F)
Buster (F)
Videogame Guy (M)</td><td>4</td><td>Day after third intervention</td><td>Classroom (not belonging to participants)</td><td>108 minutes with lunch break in middle</td></tr>
<tr><td>BF</td><td>Black Cat (F)
Bluebell (M)
Bumble (M)
Olivia (F)</td><td>3</td><td>Afternoon after third intervention</td><td>Classroom (not belonging to participants)</td><td>77 minutes</td></tr>
<tr><td>NB</td><td>Apple (M)
Cleo (F)
Jelly (M)
Pepperoni (F)</td><td>4</td><td>Afternoon after third intervention</td><td>School library</td><td>43 minutes</td></tr>
</table>

Table 3.21: Details of each interview carried out following the third intervention

3.5 Timeline of pilot events, teacher interviews, archaeological interventions, and pupil-based data collection

Jan-18	Mar-18	May-18	Jul-18	Oct-18		
Pilot teacher interview	YP & BF teacher interview	SP & NB teacher interview	Preliminary research with BF pupils	Pilot pupil questionnaire & word sort	BG introduction	YP introduction
			Faunal workshop pilot at YP, SP, NB & BF			
Nov-18				**Dec-18**		
SP introduction Pre-intervention 1 questionnaire	YP pre-intervention 1 questionnaire First intervention, Post- intervention 1 questionnaire	BG pre-intervention 1 questionnaire	SP first pupil interview First intervention Post-intervention 1 questionnaire	BG first pupil interview First intervention Post-intervention 1 questionnaire	BF introduction First pupil interview Pre-intervention 1 questionnaire First intervention Post-intervention 1 questionnaire	
YP first pupil interview				BG teacher interview		

Figure 3.8: Timeline of all pilot and main project engagements, including teacher interviews, interventions, questionnaires and pupil task-based interviews.

Jan-19		Mar-19				
NB introduction First pupil interview Pre-intervention 1 questionnaire First intervention	NB post-intervention 1 questionnaire	NB second pupil interview Pre-intervention 2 questionnaire Second intervention	BF pre-intervention 2 questionnaire Second intervention Post-intervention 2 questionnaire Second pupil interview	YP pre-intervention 2 questionnaire Second intervention Post-intervention 2 questionnaire Second pupil interview	SP pre-intervention 2 questionnaire, Second intervention Post-intervention 2 questionnaire Second pupil interview	NB post-intervention 2 questionnaire
Apr-19	**Jun-19**		**Jul-19**			
BG pre-intervention 2 questionnaire Second intervention Post-intervention 2 questionnaire Second pupil interview	BG pre-intervention 3 questionnaire Third intervention Post-intervention 3 questionnaire Third pupil interview	YP pre-intervention 3 questionnaire Third intervention Post-intervention 3 questionnaire Third pupil interview	SP pre- intervention 3 questionnaire Third intervention Post- intervention 3 questionnaire Third pupil interview	NB pre- intervention 3 questionnaire Third intervention Post- intervention 3 questionnaire Third pupil interview	BF pre- intervention 3 questionnaire Third intervention Post- intervention 3 questionnaire Third pupil interview	

Figure 3.8 continued.

3.6 Chapter 3 summary

The methods outlined above address the aim of this thesis by delivering engaging archaeological interventions, and observing their potential impact on participants' perceptions of and self-concepts in STEM. The project's need to gain access to participants via willing educational gatekeepers resulted in a blended approach to school recruitment ('cold' emailing potential partners through the STEM Ambassador network and petitioning known individuals in schools). This approach produced a non-random sample, meaning that the results of this research should not be generalised across primary pupils of Wales and England. Teachers from participating schools were consulted for their expertise on the specific STEM challenges faced at their institutions, and their expectations for intervention style and content (Chapter 4). Their input was invaluable for creating sessions that were engaging, relevant to pupils' learning, and achievable in the context of each school. Pilot research was crucial in identifying the most appropriate year group to work with, and in refinement of data collection methods. Delivering interventions at multiple schools allowed the research to take an iterative approach, where pupil reception and feedback from teachers informed subsequent sessions (see Chapter 5).

Tracking changes in participants' alignment with STEM was essential to understand the impact of archaeological interventions, and multiple methods were adopted to ensure a broad range of data was collected. Quantitative data collection methods are most appropriate to gather information on a wide-scale, and so all 233 participants were invited to complete a questionnaire before and after each intervention. This method provided longitudinal and wide-scale data (Chapter 6), but was limited in its ability to reveal the nuance of participant rationales. To address this, qualitative data was also collected via three interview sessions with four participants from each school; sample size was based on previous good practice for effective group interviewing, and what was achievable for a single researcher. Interview content was designed and structured to empower participants; presenting open-ended activities removed the pressure of providing 'correct' answers and gave individuals agency over the direction of each interview. A range of qualitative data collection methods (see Chapters 7-9) were used in acknowledgement of differences in individuals' preferred working styles, and to address potential for boredom over the three sessions.

Questionnaires and interview resources were piloted and refined prior to research commencement to ensure suitability for the age group of intended users. The iterative process of this project allowed further adjustments to be made once research had commenced (see Chapters 6 and 7 for examples of this). These decisions carefully weighed the risk of incomparable data with the benefits of creating deeper nuance within that data, and the objectives of the data collection. For example, one interview exercise aimed to understand participants' broad STEM perspectives through generation of discussion with a range of stimuli (Chapter 7). For this exercise, the discussion themes were of greater importance than the specific stimuli, meaning they could be adapted to meet new concerns, such as issues of interview time allocation.

The mixed methods outlined in this chapter resulted in a broad but also nuanced dataset, which attempted to observe widescale temporal change, whilst also providing insight into individual rationales behind those changes. Taking a mixed approach ensured that the shortcomings of each data collection method were accommodated and addressed by another. The results of these methods are presented in the following chapters, along with the archaeological interventions that were designed according to the educational theory laid out in this chapter. Chapter 4 proceeds by outlining the results of the teacher consultation interviews, and their implications for the project.

4 Chapter 4: Teacher interviews

To create relevant and effective interventions for this thesis, teachers at participating schools were consulted via interview. Interviews aimed to identify teachers' approaches to STEM teaching, their personal perceptions of STEM, and to gauge their beliefs about pupil-STEM engagement. It was also important to understand the challenges faced by teachers and pupils in STEM education and how these relate to the wider literature on STEM engagement. Interview results were essential in project development as they established teachers' expectations and learners' needs, and informed the direction of archaeological interventions. These interviews opened channels of communication between the researcher and class teachers and formed working relationships. Subsequent collaboration with these teachers and their classes was more productive and effective, as a result. Interview methods, including the question schedule, are outlined in Chapter 3 and interview transcripts are in Appendix 8 to Appendix 15.

4.1 Results

4.1.1 Pupil Engagement with STEM

Respondents were asked their opinions on the enthusiasm of their pupils for STEM subjects, and the extent to which they thought pupils engage with STEM at home. All participants agreed that pupils are enthusiastic about STEM at school, with many citing its practical and 'hands on' nature as the main reason for this. Some identified a range of pupil enthusiasm across the spectrum of STEM, by highlighting differing pupil attitudes towards maths (Excerpt 4.1). The majority of participants (n=9) believed that *some* of their pupils engage with STEM at home, and gave a broad range of reasons for this. However, this question can only reveal what the participants believe to be true, it cannot capture genuine information on pupils' STEM engagement at home. One teacher was unsure whether efforts to encourage engagement with STEM outside school have been successful. Some interviews were undertaken during British Science Week, meaning schools had provided pupils with STEM challenges to take home. However, teachers from one school stated their surprise that only one pupil from their entire cohort had completed the STEM challenge at home. BFT2's perception of low pupil engagement with STEM outside school was evidenced by the recollection of a recent class trip to a local science centre, which she estimated a third of her pupils had visited before. BFT3 stated that pupils are particularly likely to engage with technology at home, as it has become more commonplace in society. BGT1 agreed that her pupils were likely to interact with technology at home, she suggested they might play online games that promote elements of engineering (e.g. Minecraft). BGT2 also noted that pupils' maths homework is completed online. NBT1 did not recall having heard children talk about STEM engagement at home, but was aware that some pupils attend STEM themed after-school clubs at a local secondary school.

SPT3: *they enjoy maths, if they're good at it*

SPT4: *with maths, the ones who are good at it, love it and the ones who are not good at it, hate it*

BFT2: *I think maths is one of those subjects that some children just find very – I don't know what the word is – I suppose difficult. I think for some children, they enjoy the challenge of trying to come to an answer. And I think other children, they find that a bit overwhelming.*

Excerpt 4.1: SP and BF teachers discuss differences in enthusiasm for STEM subjects.

The main factor that teachers associated with pupils' engagement with STEM at home was parental influence. They believed that children with parents in STEM-related careers were much more likely to engage with STEM outside of school. Confidence and knowledge in an area of STEM were deemed a major factor in whether a parent chose to facilitate or encourage engagement with their children. NBT2 felt that a parent must instil an appreciation for the relevance of STEM within their children, and that the children of people who do not *"see the point"* of STEM are unlikely to engage with it. A number of teachers referenced personal experiences (both positive and negative) with their own parents which impacted how they have engaged with STEM throughout their lives (Excerpt 4.2). BFT1 suggested that teachers could do more to increase STEM engagement outside school, by recommending activities that might be carried out at home. She also proposed that schools could invite parents to take part in some school-based activities, which could be continued at home. This idea would alleviate some of the concerns parents may have regarding subject knowledge, as they would receive an introduction to the activity. Both BFT2 and BFT1 felt there were very few STEM-based after school clubs for KS2 children in the local area, reducing opportunities to engage with STEM outside of school.

BFT2: *I remember my mum saying to me: "Don't worry, I was always bad at maths". And that gives you your get out clause doesn't it?*

SPT3: *I only like science because my father was a biology teacher, it's passed on isn't it?*

Excerpt 4.2: SP and BF teachers reflect on parental influences on their own engagement with STEM.

4.1.2 Teacher Engagement with STEM

Teachers were asked which STEM-related activities they had engaged with in the past year, and whether they held a personal interest in STEM. All had interacted with STEM to varying degrees, including: STEM on television, from nature documentaries to STEM-specific media coverage; logical puzzles and games; STEM-themed museums; mainstream media articles and magazines;

and STEM-themed podcasts. STEM hobbies and interests were also popular: health and fitness, running a small business, DIY projects and zoology. Five teachers had engaged with STEM via children in their families, from facilitating STEM activities to assisting with homework. NBT1 was studying for a maths A level at the time of the interview, and is registered on numerous STEM-themed mailing lists. NBT1's partner has a STEM-based career, creating an additional avenue through which she engages with STEM. All but three participants described themselves as having a personal interest in STEM, with many citing degree or A level qualifications as evidence. The range of qualifications and other pursuits was broad, covering many areas of the STEM spectrum: design, ICT and maths, as well as chemistry, biology and environmental sciences. Some teachers stressed that despite these qualifications, they do not consider themselves as actively engaged with STEM in their personal lives. Each respondent who was asked believed personal interest in STEM is reflected in individuals' teaching practice (Excerpt 4.3).

SPT1: *if you've got a natural background knowledge… it's about tapping into people's interests and their expertise*
SPT4: *if you've got a flair for the subject, and you enjoy it, and you've got a good knowledge – it's going to come out automatically in teaching*
NBT1: *I think if you're passionate about something outside of school, if you're passionate about something generally, then your teaching is more sparky, as a result*

Excerpt 4.3: SP and NB teachers discussed influence personal interest can have on teaching practice.

4.1.3 Pupil Enjoyment of STEM Learning

Responses to the question of what pupils enjoy most about STEM learning revealed a broad range of rationales (Excerpt 4.4). The 'practical' and 'hands on' nature of STEM was the most widely cited factor for pupils' enjoyment of a lesson. Having the opportunity to freely explore a concept was deemed a major source of enthusiasm, as was the chance to do something outside of 'normal' lesson style. Opportunities to generate conversation between pupils, and for pupils to collaborate and lead activities were also highly valued. Some teachers had reservations about the way science is currently taught, and its impact on the engagement and education of pupils. They believed that the curriculum shift to an emphasis on skill development and investigation has led to an overly "*diluted*" syllabus that does not teach enough scientific knowledge. They were concerned that pupils could leave school without understanding basic concepts, and that they show less enthusiasm for science than before the curriculum changed. This opinion appears to contrast with the general perception of all other teachers in this study, that children enjoy practical investigations in their lessons. This may relate to how resources are distributed across schools; unequal access to science resources may result in differences in pupil enthusiasm for science lessons.

BFT2: *I think the word 'investigation' or 'experiment' gets them excited – rather than just saying that it's going to be a science 'lesson'… trying to find the 'right' answer is more scary than just experimenting*

NBT1: *that challenge of problem solving, going beyond your normal limits… when they go beyond that level of resilience*

SPT1: *things that get them away from writing in books and are hands on… it gives them that chance to fidget about and investigate. That's definitely the key thing*

SPT2: *especially the ones that struggle with language, because when it's practical they're not thinking about what they need to say, how they need to say it – they just talk naturally in practical work*

BGT2: *hands on, first-hand experience… and they're all talking to each other – so if you came in, you might think "oh this is a bit noisy" but they're* ***all*** *engaged, they're all talking about what they're doing*

YPT1: *there is more of the pupils' voice, they have more of a say*
YPT2: *there's a lot more team work as well. So working in different groups and they all have to collaborate together, and work hard as a team to get things done.*

BFT1: *it's more child-led…* i*t's more them asking investigations and leading, and they get a big buzz around that… they love practical things, they love hands on, they love to try and work things out. Most of them really like working together, to solve problems as well*

Excerpt 4.4: Teachers discussed what they felt children like most about STEM lessons.

4.1.4 Teacher Enjoyment of STEM Teaching

Teachers were asked what they most enjoy about teaching STEM. The most common response was the opportunity to observe pupils engaging with novel content, and to see how they express creativity and curiosity in that context. BFT2 noted the excellent quality of conversations between pupils in STEM lessons, and their resulting sense of achievement following the lessons. Some participants were aware that pupil-led learning may represent a challenge for teachers; one was very open about their determination to improve in this area, and to allow STEM lessons to be "*more open-ended*". A number of teachers in the group, mentioned that STEM lessons provide an opportunity for pupils of lower ability to thrive in an alternative learning environment. They suggested that an emphasis on oral discussion and creativity in STEM lessons creates an atmosphere where pupils are more able to contribute and explore ideas (Excerpt 4.5). SPT2's assertion that STEM lessons can help circumnavigate pupil anxiety about language and writing is particularly relevant here (Excerpt 4.4).

YPT2: *I like seeing the children that wouldn't normally interact with other children – seeing them succeed, well contributing and actually enjoying some lessons*

YPT1: *and that it's not about recording on paper, it's more about ideas – sharing orally. And it's more practical, so there are children who are usually quiet in another lesson, they might be leading a situation*

Excerpt 4.5: YP teachers reflect on how STEM lessons value contributions from all pupils.

4.1.5 STEM Resources

Respondents were asked where they look for STEM ideas and resources, and how accessible they consider physical STEM resources to be. All teachers reported using the internet to varying degrees when gathering ideas for their STEM lessons, mentioning the STEM Learning website, the Times Educational Supplement (TES), and 'Primary Resources'. Non-education-specific websites such as YouTube, were also helpful to demonstrate concepts that are not replicable in a classroom. Teachers at a Welsh medium school expressed the concern that resources are rarely written in Welsh, and must translate things themselves instead. Participant opinions varied on how useful or appropriate they found these websites in lesson planning: some felt their needs were met, while others modify activities before use in lessons. This difference reflects the wide range of ability in pupils across the UK, even amongst those in the same year group. It is also likely that the personal preference and requirements of individual teachers plays a role in whether they choose to adapt resources or not. Participants also used previous planning: institutions and local education bodies often have standardised schemes of work, which outline what schools should cover with accompanying ideas and resources. External STEM organisations (e.g. British Science Association and See Science) were utilised by two teachers. Pupil parents were another valuable resource; numerous schools had previously invited parents in STEM-based careers to run activities with classes. Books and television documentaries were also helpful, as were links with local secondary schools to gain access to equipment and resources.

The majority of teachers thought that physical resources for STEM lessons were often 'hard to come by'. Two felt it was dependent on individual institutions, and only one teacher felt that they had easy access to resources. Difficulty in access was attributed to: a lack of funding, schools prioritising other subjects, and a lack of time to source them. Some teachers attempted to overcome the expense of materials and equipment by reusing and recycling materials, while others sometimes spend personal money on resources. One school highlighted logistical issues in accessing the resources already owned by their school; they felt that materials were frequently not topped up or returned, making them difficult to find and use. Other respondents expressed concern that resources, especially ICT or science equipment, can become quickly outdated. Despite this, one school was granted funding to improve their science resources, and another had a straightforward policy for replacing depleted materials.

Individual perceptions of what constitutes 'hard to come by' plays a part in participant satisfaction with resource procurement. Variation in personal circumstances factor in this, as people who are less able to source items outside of schools hours, or spend personal money on materials will be disadvantaged. Most teachers noted the impact of these issues on lesson planning and delivery. BFT3 cited the limited number of laptops within her school as a factor, and BFT1 and BGT2 emphasised increased demands for organisation when borrowing resources from an external institution (e.g. universities or museums). SPT1 referenced a recent science lesson, which was well received by pupils, but he felt unable to replicate often due to the high level of preparation it required.

4.1.6 STEM Satisfaction

Responses to the question of whether individuals were satisfied with the amount of STEM teaching they deliver were mixed. Most teachers were satisfied that their pupils cover all curriculum requirements, though opinions were divided as to whether these requirements were enough. While some teachers were satisfied that their pupils do "*maths every day*" and "*science once a week*", others felt that this did not provide children with a comprehensive STEM education. Some believed that Statutory Assessment Tests (SATs) place too much emphasis on English and maths, which could negatively influence timetabling for other areas of STEM, particularly for pupils in Year 6. One teacher believed that removing science SATs was a Government admission that science is a low priority. Another felt that SATs pressure reduces time to explore areas of STEM in lessons. It appears that both personal preference and the status of STEM from school to school affect teacher's opinions of what 'satisfaction in STEM' looks like. People who feel well supported by their school may be more likely to feel 'satisfied' with their lesson content. However, at schools where STEM is perceived to be a low priority, teachers with an interest in STEM may not feel satisfied with how they are able to teach it. Teacher satisfaction with coverage of other STEM subjects was also varied. Some were unhappy with their technology and ICT teaching, highlighting issues like quantity of ICT equipment, whereas other schools had access to ICT suites and regularly scheduled time to use them.

4.1.7 Making STEM Cross-Curricular

Respondents were asked if they ever try to make their STEM teaching cross-curricular; most had engaged with a cross-curricular teaching style to varying degrees. YPT2's approach was the most clearly pupil-led; he invites his class to list things they are interested in, which they then use to identify links across curriculum learning objectives. Other teachers also described how they address STEM themes across the whole curriculum (Excerpt 4.6). While interviewing BGT1 and BGT2, the researcher noted their use of 'Harry Potter' to engage with geography, maths and English lessons. These examples are an excellent illustration of how versatile STEM lessons can be, and the creativity of the teachers sampled. However, numerous teachers also felt that some curriculum requirements are less well suited to cross-curricular teaching. Additionally, some schools tend to focus on cross-curricular teaching in lower years, in these schools it is less common post-KS1.

BFT1: *so one of the topics we do is 'fun fairs', so we'd look at going to* [local theme park], *and they'll do a workshop about going on the rides and feeling the forces, and then we'd make funfair rides in our technology lessons. Then we'd link our English to it, and do persuasive 'Dragon Den' style pitching*

BFT3: *at the moment* [our topic] *is geography based, but then in IT with the debugging, we're learning about the journey of a little boy in a boat, so they're learning about debugging, and then creating their own instructional programs that they can copy: they're going to 'go on a journey' imagining it's a boat*

NBT2: *in English they'll be writing things like biographies of Charles Darwin, and Mary Anning. And also this year we had a science day. So they created their own fossils and then had to tell everyone about how the fossils are made and make a little storyboard. We've got futuristic writing as well, so how the world might change in the future. Making predictions based on what we can see from evolution so far*

NBT1: *I used to link it in with Sports Day – so in terms of heartrate and stuff like that. This term we looked at Alaska, and for our science day a few months later we looked at "what if you got stuck in the middle of nowhere?". And linked the science to that*

Excerpt 4.6: Teachers spoke about their cross-curricular approaches to teaching.

4.1.8 Influences on Pupil Engagement with STEM

Teachers were asked to identify potential influences for their pupils' STEM engagement. Responses can be broadly categorised as positive and negative influences. The most commonly cited positive factors were the presence of a passionate teacher, and individual enjoyment of a subject. It was also suggested that *liking* a teacher was crucial for some pupil's long-term engagement with a subject. Both SPT1 and BFT1 noted that primary aged children are at a very "*formative stage*", where they are open to new ideas and influenced by people around them. They believed that an enthusiastic teacher can be the catalyst for a life-long interest in education and individual subjects. NBT2 developed this further by discussing the importance of providing children with opportunities to build subject-based confidence to foster positive perceptions. SPT3 recalled his own experience with an enthusiastic science teacher as a positive influence on his pursuit of science. YPT1 and YPT2 believed that pupil-led learning is a key factor in creating an environment where children see the relevance of STEM. By asking pupils "*what they know*" and "*what they want to know*", they provide a framework of development that is directly related to their pupils' interests and lives. Ensuring that STEM is made relevant to children was deemed essential by a number of respondents, as was providing insight into how STEM skills might be useful to their futures. Participants also identified the role parents play in children's engagement with STEM, and noted that pupils with parents in STEM-related careers were more likely to be engaged with STEM themselves.

In contrast to this, teachers also emphasised that where parents do not have a background in STEM, opportunities for their children to explore STEM are reduced. Parents who are neither confident or interested in STEM were thought less able to facilitate their child's engagement with it. Additionally, it was suggested that negative perceptions of STEM can be passed from parent to child: *"I'm not very good at this, because I know that my parents can't do it"*. One teacher who had personally experienced this made a conscious effort to use that experience in a constructive way, to inform current teaching practice. SPT2 was concerned that many pupils receive inadequate career advice, and are unaware of STEM career possibilities or the qualifications required to pursue them. SPT4 and BFT1 outlined attempts to rectify this within their schools, by inviting STEM-based parents to speak with pupils, and focussing on aspirations and careers in class discussions.

NBT1 and BGT1 noted the influence of gendered stereotypes on pupils' engagement with STEM; neither had observed this in primary aged children, but suspected a greater impact on older children. In BFT1's experience, boys were more likely to "*risk*" a wrong answer, whereas girls "*are more perfectionist*" and do not like to get things wrong, despite being equally capable in a subject. As noted by a number of teachers in this study, people often avoid areas where they feel unsuccessful. As pupils move up through school and are given more autonomy over subject choices, it is likely that they will gravitate to those where they feel comfortable. Respondents also considered the perceived difficulty of many STEM subjects, especially beyond Key Stage 4. SPT3 suggested that this could be a major influence on what people choose to study at A Level or university. SPT1 highlighted that 'prohibitively' high grade requirements of many universities can be a barrier to students in pursuing STEM in Higher Education.

4.1.9 Key Challenge for Teachers

Respondents were also asked about the general challenges they believe teachers face in STEM provision. Most participants indicated that subject knowledge and confidence were key (Excerpt 4.7). Finding time to plan STEM lessons was another major challenge for many teachers in this study. YPT2 and BFT1 described the extended preparation, delivery and clean up time necessary for DT projects. SPT1 and SPT4 also felt that this was an issue, particularly with science investigations where multiple materials must be sourced and prepared. BGT1 and BGT2 were concerned that as teachers are increasingly expected to address issues outside the curriculum, such as emotional health and wellbeing, the time available to cover STEM is reduced. Access to resources was another challenging factor, though this was discussed briefly, likely due to the fact that respondents had talked about it at length in previous questions. Pressure of the curriculum was deemed prohibitive by three teachers who felt that there is very little space to explore STEM learning effectively. YPT1 noted that pupil output from STEM lessons is difficult to measure or record, and suggested that the fear of having nothing to demonstrate pupil progress may be a barrier to many teachers. This may be especially significant in schools where a high level of inspection and monitoring is carried out, such as those in 'special measures'.

SPT3: *if you spoke to most teachers, I don't think they'd say that science is a strength of theirs*
SPT4: *yeah, teacher subject knowledge*
SPT2: *like if you have maths, there's rules in maths that you can easily remember, but science is such a widespread subject*
SPT1: *it's no coincidence is it? That secondary schools struggle for maths teachers and sciences teachers. Because: a) there aren't that many people doing those subjects, and b) the ones who can do them can get better jobs elsewhere*

BFT2: *I think subject knowledge. I'm really comfortable teaching KS1 science, if you asked me to teach Year 6 science, I would have to read up and learn it myself - probably - before I taught it. Which is fine, I can do that, but if you're not 'a scientist' yourself, I think your subject knowledge can be a bit of a barrier – even to your enjoyment of it*

BFT3: *I would say subject knowledge and resourcing. It's all very well that we've now got to teach* ***'this'*** *– like the debugging – that I talk about, but I'm not confident with it*

NBT2: *I think sometimes subject knowledge. It's either something that you're strong at or something that you worry about*

Excerpt 4.7: Many teachers felt that subject knowledge is a major challenge when teaching STEM.

4.1.10 Personal Challenges

Teachers were also asked about their personal challenges in STEM provision, which are discussed via three themes: knowledge and confidence, access to resources, and time. These themes broadly mirror that which has already been discussed, but are presented from a personal perspective. Some teachers felt they had benefited from additional training opportunities to allow them to remain up to date with current subject knowledge and best practice (Excerpt 4.8). Others highlighted issues in accessing resources in school, both physical materials and support from other staff (Excerpt 4.10). Finally, time was discussed as a key issue, with many teachers expressing concern that curriculum pressures reduce the time they are able to spend on STEM learning (Excerpt 4.9).

BFT1: *I think it would be my subject knowledge, my confidence and knowing what best practice looks like… it's easy for people to say "This is how you do it", but then how does that transfer to when you've got 30 kids in front of you?… so yeah, guidance – how do we create the best STEM opportunities?*

BFT3: *subject knowledge… so, I haven't had that training, in that particular area, which is daft when you think about it, considering how much it moves on, that you just have to learn from other people. And everybody's busy – sometimes you just have to have a go*

NBT1: *being up to date on the best ways of teaching science, and best ways of delivering these theories and materials… for instance: with investigations, coming up with the most interesting, but also the best opportunity for children to learn about whatever we're covering, by developing their scientific skills*

Excerpt 4.8: Teachers describe their personal concerns with knowledge and confidence.

SPT4: *You don't have time for anything! Your lunch break is taken up with marking, and whatever else you've got to do, and by the time you've had your lunch you start again*

SPT2: *with schools, you know you need to get English done, you know you need to get maths done – so you know you need that specific time for those lessons… so if science and technology had a bigger priority, where you could spend more time focusing on activities – maybe that would make a difference?*

BGT1: *probably the science wouldn't be as open ended as I'd like it to be, because you want them to get to an end result?... so you're kind of guiding them the whole time, whereas if you had a little bit less time constraint, they could find out for themselves… even if they didn't come to the 'right' conclusion, it doesn't matter but you feel like you've got to tie everything up don't you?... if you don't tie that up and end that there, we can't get onto the next thing*

NBT2: *finding the time to cover everything you want to, in a short space of time. And making sure that you're giving it enough time, so that you can do it well… you don't want to just skirt over the top, you want to really embed that understanding, and love for it, rather than just a quick fleeting visit, then you've got to move on*

Excerpt 4.9: Teachers expressed concerns about the time they are able to spend preparing and delivering STEM content.

SPT1: *getting resources together. A large part of the reason* [they're] *not there is because you've not had the time to get them!*
SPT4: *yep! They're dotted around the school. It's usually the case that you'll go to get something and it's not anywhere it's meant to be. Someone hasn't put it back!*

YPT1: *maybe adult support as well, we're very short of… using things like kettles and boiling water and thermometers, and there's only one adult in the class, you tend to decide as a class "there's lots of risks involved here, let the teacher do the experiment and then we can all observe". Then in other situations, you try and avoid that… so that they get more involved, and they practice and develop their skills better*

Excerpt 4.10: Teachers outline personal issues with accessing resources and support.

4.1.11 Most Important Challenge in STEM Teaching and Learning

Participants were asked which of the challenges they had listed they felt was the most important factor in STEM engagement. Three areas were identified as influencing children's long term STEM engagement: pupils' own attitudes, influence of teachers, and a child's access to STEM. YPT2 and SPT1 suggested that a child's personal experiences are what shapes their world view, and ultimately decides whether they participate in STEM (Excerpt 4.11). Many participants mentioned the importance of a confident and enthusiastic teacher to facilitate a good STEM learning environment (Excerpt 4.12). BFT3 and NBT2 highlighted the relationship between these two factors, as someone who lacks confidence when teaching STEM may not provide an enthusiastic role model, and may spend less time teaching it all together. Additionally, it is crucial to consider whether a child has adequate opportunities to access STEM. Children who engage with extra-curricular and enrichment activities in STEM may be aware of more higher education and career options. Access to STEM was discussed in two ways: access to STEM careers advice, and access to STEM engagement mediated by parents. SPT2, BFT2 and BGT2 felt that children who do not get these experiences may be at a disadvantage when learning and pursuing STEM (Excerpt 4.13).

YPT2: *if they're engaged, that's obviously going to spark something inside of them to want to carry on. They might not know it at that time, but it's something that they will remember and take with them*

SPT1: *they need success… children don't tend to enjoy things that they don't do well at or they don't understand… they don't say "Maths is brilliant, but I got all those sums wrong", they like it because they got things right*

Excerpt 4.11: YPT2 and SPT1 felt that a child's own attitude has an impact on their STEM engagement.

SPT4: *I think it depends a lot on what the teacher is doing with them. If they've got a good enough knowledge and can provide exciting activities and engage – then it's going to rub off, and they'll want to continue with it*

BFT1: *I think teachers could have the biggest influence… if we can inspire them and provide them with opportunities now, I think they will then hold onto that when they move on*

BFT3: *I think our knowledge, our enthusiasm for it. Our confidence with it. Because then you're more inclined to not let it drop off of your week*

NB2: *if you don't feel confident enough, you won't make the time?... if you're anxious about it, or worried about it then* [you might think] *"I'll do this instead" and put it off*

Excerpt 4.12: Respondents highlighted issues of teacher confidence and enthusiasm.

SPT2: *they need to know as well – there's so many jobs out there – what they can apply for, because you don't really hear about it. You don't really hear about those certain jobs and how to get those jobs*

BFT2: *from my own personal experience, it is about your home situation, and how your parents feel about science… not only that interest, but also that "I can do science: because my parents understand science, I can understand science"*

BGT2: *I do wonder if it's not followed up at home then that doesn't help them. I think the children who go off the museum, they come in and they know things already, and they're already talking about something. So when they start the lesson, they've already got a bit of an idea of what's going on*

Excerpt 4.13: Teachers discussed issues of access to STEM opportunities and career advice.

4.1.12 Addressing the Challenges

Finally, teachers were asked what they felt educators could do to address these issues. Their answers focused on providing pupils with opportunities to explore avenues of STEM, and steps that teachers might take to modify their own practice and knowledge. Many suggestions for enhancing pupils' STEM engagement were ideas that individuals have implemented in their own schools. Using expertise of parents was the most commonly cited example, and some teachers were also attempting to gain access to local secondary schools to borrow equipment. One school in Hampshire developed links with a local university, where they take pupils for enrichment activities. Other teachers described placing a more general focus on careers and aspirations, with an emphasis on preparing pupils for jobs "*that don't even exist*" yet.

Continued professional development (CPD) was another suggestion put forward by some teachers, to access additional training. However, as these interviews have shown, teachers' time is extremely limited and the above ideas may be unrealistic. Additionally, the cost of CPD courses may be prohibitive to individuals and schools. One teacher found that being part of a "*science cluster group*" with other local schools was beneficial, as it created a space where teachers could provide support, advice and inspiration to each other. Three teachers also discussed techniques they use to create a learning environment where children are able to succeed in STEM subjects. This ranges from allowing pupils to direct their own learning, to using alternative approaches to teach a topic. Many teachers also choose to use real life examples in their lessons to instil an understanding of how learning is relevant to 'real' life and future careers. Teachers hoped that by using these techniques, they are able to challenge the negative perceptions of their pupils, and increase opportunities for their pupils to access subject content.

4.2 Discussion of teacher interview results

4.2.1 Pupil and Teacher Engagement with STEM

Respondents were united in their belief that their pupils enjoy STEM lessons and engage well in school, though they expressed less confidence that their pupils interact with STEM at home. Parental factors were discussed, with the assumption that those interested in STEM are more likely to facilitate its exploration with their children. It was suggested that schools could raise awareness of STEM opportunities by providing information on engagement opportunities and ideas to families with limited STEM access. Families play an important role in young people's long-term STEM engagement, which is best explained via the concept of 'Science Capital' (Archer *et al*. 2012; DeWitt and Archer 2015). This describes a family's ability to "*support and enhance their* [child's] *attainment, engagement and/ or participation in science"* (Archer *et al.*

2014a, 5). It is clear that for children whose families hold limited science capital, schools play a vital role in facilitating their engagement with STEM.

All participants had engaged with STEM recently, though some interactions were the result of professional or parental obligation. Most respondents expressed a personal interest in STEM, which is likely related to how they were recruited. When seeking participants for a project related to STEM, the researcher most frequently connected with STEM coordinators, which indicates a specific interest in STEM. Forms of STEM engagement were varied amongst respondents, covering both hobbies and professional or academic pursuits. It was notable that one participant did not describe themselves as having a 'personal interest' in STEM, despite having completed A level maths and stating that they enjoyed both learning and teaching it. It is interesting to consider the perceived difference between 'personal interest' and 'academic/ professional pursuit'. This person clearly distinguished between the things that they enjoy in their working life, and personal or leisure pastimes.

4.2.2 STEM in the Classroom

One respondent highlighted that personal reservations about STEM can be transmitted to learners, and that teachers must avoid perpetuating this cycle. Research has shown that factors influencing confidence amongst the wider population of teachers include: personal scientific knowledge and opportunities for professional development (Murphy and Beggs 2005, 35), personal experiences and curriculum pressures (Harlen and Holroyd 1997, 102). It is also widely assumed that an educator's personal interest in STEM will have a positive impact on lessons. Multiple studies have demonstrated that teachers with high levels of enthusiasm and passion have a positive impact on pupil motivation (Patrick *et al.* 2000, 225) and classroom behaviour (Carbonneau *et al.* 2008, 983).

All participants, regardless of professed STEM interest or confidence, believed that pupils most value the 'hands on' nature of STEM, and enjoy the freedom to explore new concepts in creative and practical ways. They also discussed the benefits of an open-ended learning environment, where ideas can be expressed and discussed without the pressure of producing written content. Pupil dialogue is a staple amongst education theorists, who believe that transmission of ideas amongst peers promotes a deeper level of interaction with a subject (Wood 1998, 29; Sawyer 2006, 12; Ford and Wago 2011; Slater and Bremner 2017). Seeing pupils respond positively to this learning style was important to respondents, particularly as it ensures children of all abilities have equal access and contributions to a lesson. The difference in pupil response to the phrase 'scientific investigation', as opposed to 'science lesson' is interesting. The word 'investigation' may indicate that they are about to engage with something novel or practical, whereas the word 'lesson' could be associated with more routine learning. Science curricula in Wales and England differ in their emphasis on practical investigations and factual information. The Welsh curriculum has a focus on developing scientific skills through investigations, whereas the English curriculum has a higher requirement for scientific knowledge (Royal Society 2010; DfCELLS 2008a; DfE 2013a). One Wales-based respondent felt that teaching via investigation had resulted in a less varied and more prescribed lesson style and declining pupil enthusiasm for science. Increased familiarity with 'investigations' (particularly those that are 'closed-ended') may reduce their novelty and interest to learners (Abrahams 2017, 408), however, this feeling was not unanimous across Welsh teachers in this sample.

4.2.3 Planning STEM lessons and resource access

The internet was a key tool for STEM resources amongst respondents. Specific teaching websites were most popular, though sites like YouTube were also highlighted. One respondent highlighted a need for STEM experts to develop resources using their specific expertise, though also noted such resources must meet logistical requirements of a classroom. All participants used cross-curricular teaching to varying degrees: for some it was integral to their pedagogy, while others were aware but used it intermittently. Examples of cross-curricular teaching demonstrated a creative approach to showing pupils the relevance of knowledge across multiple subjects, though some teachers remained unsure of how to apply subjects like maths in other areas of the curriculum.

Access resources appeared to differ between schools, broadly relating to the level of support and funding offered to teachers, and the personal expectations of individuals. Data available through the gov.uk and wales.gov.uk websites reveals the amount spent by each school per pupil in the academic year the teacher interviews took place (Table 4.1). These figures do not confirm what was spent on STEM resources, but they do indicate how well institutions were resourced in the context of their local authority. Three out of five schools spent less money per pupil than others in their local authority (Table 4.1), which may explain why teachers experienced difficulty in accessing STEM resources. These findings highlight the link between socio-economic status and STEM access: pupils may have access to fewer resources based upon the area they live.

School	Total spend per pupil	Local authority median spend per pupil
BF	£5416	£4556
NB	£4427	£4556
YP	£4218	£3763
SP	£3095	£3763
BG	£3192	£3763

Table 4.1: Total spend per pupil at all participating schools in the academic year 2017-18. Red and green text indicates budgets below or above the local authority median.

Time was another major consideration for teachers when approaching STEM resources. The 2013 Estyn report for one school confirmed that "*the provision of time for teachers to undertake preparation, planning and assessment* [PPA] *is slightly less than recommended*". Their most recent Estyn report[17], does not mention teacher's access to PPA time. While the inspection reports of the other three schools do not highlight any issues with teacher's PPA time, it is reasonable to assume that as the responsibilities of teachers increase (Timperley and Robinson, 2000; Selwood and Pilkington, 2005; Philipp and Kunter 2013), they have less time to spend on planning and preparation.

4.2.4 Teacher Satisfaction

Teachers' satisfaction in the amount of STEM they were able to cover was linked to differences in personal preference. Most schools reported spending an hour a day on maths, and then between 1-2 hours a week on other STEM subjects. It was highlighted that in some schools, the impetus to teach science and ICT comes from individual teachers, as there is no official requirement for when they must teach it. It could be assumed that this autonomy would result in high teacher satisfaction, however some respondents felt that this allows SATs subjects to dominate the timetable instead, a feeling that is supported by Ofsted observations (Spielman 2018). This could lead to dissatisfaction amongst teachers who are highly enthusiastic for non-statutory STEM subjects. It was notable from these discussions how infrequently technology and engineering were mentioned. This is likely due to the legacy of SATs; although science is no longer tested, science and maths have formed an integral part of the curriculum for many years. IT and DT have played a much smaller role within primary schools, and it is understandable that teachers are more mindful of 'core' subjects like science and maths. Engineering is largely absent from primary education, although the Royal Academy of Engineering seeks to address this by encouraging educators to consider 'Engineering Habits of Mind' (RAE 2014). RAE (2014, 59) proposed that equipping educators with an understanding of how engineers think will

[17] Undertaken in 2018 after these interviews had taken place.

empower them to construct curricula which effectively teach and assess engineering concepts. As technology and engineering become more prominent in education, it is likely that they will feature more heavily in these conversations.

4.2.5 Influence of Adults on Children's STEM Engagement

Most respondents highlighted the importance of influential adults in sustaining children's relationship with STEM. Parents and teachers were portrayed as facilitators of STEM engagement, with either a positive or negative impact. It was suggested that pupils' exposure to STEM might be affected by the personal interests of these adults; by engaging only within their own areas of interest, these adults could be indirectly reducing a child's opportunities to participate in STEM. Unsurprisingly, the majority of participants emphasised the impact of an inspirational teacher on pupils' pursuit of STEM. While there is undoubtedly truth in this, it is interesting to consider how this opinion might change if the sample were made up of people from a different demographic. For instance, parents may give more weight to influences within the home, and a policy maker might credit changes to the curriculum. Whether at home or in school, it is clear that adults are vital to promote the breadth and variety of STEM careers to children. STEM literature emphasises the importance of family on engagement, aspirations and persistence (Ong *at al.* 2011, 186; Archer *et al.* 2012; Harackiewicz *et al.* 2012; Macdonald 2014, 19; Smith and Tyler-Wood 2020), and teachers' impact on pupils' understanding of their STEM competence (Carlone *et al.* 2014; Guzey *et al.* 2019).

4.2.6 Main Challenges for Teachers

There is a relationship between the two main challenges teachers faced: time and confidence in subject knowledge. A perceived lack of subject knowledge was largely discussed in relation to science and technology, rather than maths or engineering. As maths is a statutory curriculum subject, it is taught in primary schools every day, which may result in greater familiarity (and therefore confidence) with subject content. Many primary schools have no official requirements for non-statutory subjects, and so teachers who feel pressured to cover statutory subjects are likely to spend less time on other STEM subjects (Harlen and Holroyd 1997, 103; Geist 2015, 333). Engineering was rarely mentioned by interview subjects, reflecting its absence from the primary curriculum (Finegold and Jones 2016; Lucas *et al.* 2014). Neither was archaeology discussed, despite the English curriculum requirement that prehistory is taught on the primary curriculum (DfE 2013, 190). Anecdotal evidence suggests that teachers find teaching this challenging (The Historical Association 2019, 19), though the fact that no participants highlighted archaeology in this discussion suggests that they do not consider it part of STEM education.

It is likely that teacher perceptions of timetable pressures differ between schools, depending on the specific focus of management staff. Therefore, it is likely that pupils' STEM engagement is affected by the individual concerns of the school they attend. Access to resources was another challenge linked to time, teachers' personal relationship with STEM, and individual school budgets. Preparing for STEM lessons can require many hours of planning and sourcing equipment, which may take even longer for people who do not connect with STEM on a personal level. School budgets are a major influence on the opportunities and experiences that a teacher is able to offer their pupils. This is another example of how opportunities for STEM engagement can differ on a local and national scale.

4.3 Chapter 4 summary

Interviewing the teachers of schools participating in this project revealed useful information about STEM provision in each institution, and provided insight into teachers' perceptions of the challenges faced in practicing STEM education. Overall, respondents were unconcerned about pupils' enthusiasm, with all asserting that their learners enjoy STEM lessons. Some reflected that pupils' may have limited access to STEM outside of school, and emphasised the importance of formal education contexts in creating STEM opportunities for young people. Identifying the impact of family relationships on the child participants of this research may shed further light on this. The interventions of this project are purely classroom-based, but archaeological education is frequently focused on community, or museum-based family engagements; there may be scope to strengthen the relationship between content young people encounter in school, and that of informal education opportunities.

This chapter suggested that respondents' opinions of successful STEM pedagogy were largely similar, with the majority of teachers citing practical, hands-on approaches to STEM education, regardless of their personal interest in STEM outside of school. This finding is promising; archaeology lends itself particularly well to the practical style of engagement preferred by these pupils. While respondents' preferences for STEM teaching were straightforward, the challenges they face in delivering it are complex. Although they aim to provide a comprehensive STEM experience to their pupils, teachers are impacted by time limitations, access to resources, and varying personal subject knowledge. Teaching broad skills and knowledge via interdisciplinary subjects such as archaeology represents a valuable opportunity to maximise time spent planning and delivering STEM. A cross-curricular approach can also address concerns about non-statutory subjects being squeezed from the curriculum by delivering multiple learning requirements under a single theme. Issues of planning time and teacher subject knowledge can also be navigated via consultation of external interdisciplinary subject specialists, who can provide expert knowledge and resources. Consulting with external partners represents a way for schools to provide robust cross-curricular engagements, though careful consideration of how this might be applied to current education structures, and how experts will be compensated for their knowledge and time is needed.

The above factors must be taken into account when devising archaeological interventions for this project, and also when considering broad-scale change for future STEM education. The value placed on practical learning is recognised through the development of hands-on experiences which encourage pupils to take on the role of archaeological researcher (see Chapter 5). Cross-curricular learning is emphasised to reflect the reality of modern archaeological research, and appropriate curriculum requirements are embedded into sessions to ensure their relevance to timetabled lesson content. The researcher provides expert knowledge and resources, with no expectation on schools to provide materials (e.g. graph paper, masking tape) in acknowledgment of restricted budgets. Archaeological interventions broaden children's understanding of STEM's relevance outside the classroom by presenting them with real world applications of STEM skills in a novel context. The following chapter outlines intervention content, and their reception by pupils.

5 Chapter 5: Intervention design and delivery

This chapter presents the content of the interventions used in this project, which were developed following a consultation of teachers at participating schools (see Chapter 4). Interventions comprised three classroom-based archaeology workshops, with specific emphasis on STEM. Session themes were: faunal analysis, identifying climate change through pollen analysis, and Roman-style aqueduct construction. Integration of curriculum requirements was crucial in the design of interventions, and these links are highlighted alongside session content. The chapter concludes by outlining the observable impact of interventions on participants, and how these reflections might impact future practice.

5.1 Intervention development

While it was essential that each intervention present an opportunity for pupils to engage with STEM in a novel way, it was also important for them to integrate with the curriculum to demonstrate to pupils how the skills they learn in school might be applied more widely. Other concerns were also identified when finalising intervention themes, such as the personal expertise of the researcher (zooarchaeology), the scope for pupils to engage in a range of activities, the resources available to the researcher and participating schools. In terms of logistics, it had to be possible for one person to deliver intervention content to 25-30 children at the same time. Consequently, sessions were comprised of cheap and easily replicable resources (such as laminated cards and images) that were archaeologically relevant but also suitable for repeated handling by school children (such as unstratified archaeological specimens and modern 'replicas' e.g. charred hazelnut shells). Three main themes were decided: faunal analysis, climate change, and a construction task involving Roman aqueducts. Sessions were developed in discussion with class teachers, who were particularly helpful during the pilot series in ensuring that opportunities for pupil voice were maximised (see Chapter 3). Numerous teachers highlighted concerns of timetable limitations and curriculum pressures in the consultation interview (Chapter 4). Consequently, activities were devised in conjunction with Welsh and English curricula, to ensure pupils built upon relevant skills and knowledge requirements. Each session plan outlines the activities, equipment needed and correlating requirements from the maths, science, DT and history primary curricula for Wales and England.

Faunal analysis is an excellent way to demonstrate the application of mathematical skills in humanities (Grayson 1984) whilst also having a firm basis in the 'hands on' experience that archaeology provides. The researcher's background in zooarchaeology made this an appropriate choice, in both the level of expertise that could be offered, and access to resources. Climate change is frequently covered in schools, and both Welsh and English science curricula make specific reference to people and their environments (DfCELLS 2008a and 2008b; DfE 2013a). Prehistoric climate change allows pupils to consider the relationship between people and their environment in the past. This intervention was framed as a 'detective' task, where pupils used logical reasoning to identify plant types from pollen remains, and infer likely environments based on the evidence. Finally, Roman aqueducts provided an archaeological spin on a construction task which asked pupils to use collaborative design skills to solve an engineering challenge. This intervention was kept inexpensive and accessible by using household recycling as the primary building material. The following presents each intervention, accompanied by the session plan and corresponding curriculum requirements. See Appendix 16 to Appendix 21 for the resources presented in each intervention and accompanying PowerPoint presentations.

5.1.1 Faunal Analysis

Zooarchaeology is an excellent way to introduce young people to archaeological data analysis and interpretation via a universally relatable concept: food. At its core, zooarchaeology uses curriculum-related skills such as skeletal anatomy, data collection and interpretation, and communicating findings with an audience. Although 'what people ate' is an over-simplification of zooarchaeology (Sykes 2014), the time allotted to this intervention allowed only a brief introduction (Table 5.1). Pupils were challenged to analyse the faunal assemblage from a fictional Roman town. Resources introduced pupils to skeletal elements, generated discussions about food as nutrition and identity, and supported them with bone identification (Appendix 16 and Appendix 17).

Participants had the opportunity to handle real (unstratified) archaeological and modern faunal material, though laminated photos of the Cardiff Osteoarchaeology Research Group reference collection were used as 'specimens' for the main bone identification and data collection exercise. Using laminated photos was advantageous as, unlike real archaeological specimens, they are easily transportable and not susceptible to damage. They also provide a broad range of non-fragmented (therefore difficult to identify) taxa and skeletal elements to pupils. Aspects of the session were inspired by participating teachers' suggestions, such as the letter to pupils introducing a zooarchaeological challenge (Appendix 16). The intervention was also adapted during the main research period, following advice of teachers and lessons learned from each iteration. For example, the discussion about food as identity was removed, as was the section comparing pupils' urban dataset to a fictional rural assemblage (data comparisons were focused within a single dataset instead).

Theme:	Faunal Analysis	**Time:** 1.5 hours		
Outline:	In this intervention children are introduced to Zooarchaeology (the study of human animal relationships in the past). They will be asked by a group of archaeological excavators to help with the analysis of animal bones from a Roman town. They must work out which bones they have been given, then record and display data in an appropriate graph. They will then interpret their data and compare it to that of another Roman settlement.			
Learning objectives:	• Recognise that animals' skeletal structure differs according to their size, form and function • Describe the difference between primary and secondary products and how some people use them in their diet • Collect and analyse data from a faunal assemblage to infer the diet of people in a Roman town • Consider diet beyond 'nutrition' and how it can be used to express cultural identity			
Time	Activity	Resources	Welsh Curriculum	English Curriculum
5 mins	**Intro:** "What is a university?", and "What is zooarchaeology?" "What do we eat that leaves behind bones?". When zooarchaeologists look at a pile of bones, those bones might represent a meal.			
5 mins	**Challenge:** A letter has been sent to the class, ask a child to read it out. It is from some archaeologists who have found animal bones in a Roman town that they're excavating. They've asked us to help find out which animals were there and what that can tell us about the people who lived there.	Letter – image on PowerPoint	Study the daily life of people living in the time of the Romans Carry out investigations into the history around them and into the life of people at different times and places in the past	Pupils should be taught about the Roman Empire and its impact on Britain

Table 5.1: Faunal Analysis session plan with breakdown of timings, activities, resources and curriculum requirements (DfCELLS 2008a; 2008f; DfE 2013a; DfES 2016a). Activities highlighted in grey were dropped from intervention after first run in the main research period.

Time	Activity	Resources	Welsh Curriculum	English Curriculum
5 mins	**Recap** of the human skeleton: each group is given an outline of a skeleton, annotate where they think each element goes. Go through answers together.	Unannotated skeleton image with anatomy word bank		Identify that humans and some other animals have skeletons and muscles for support, protection and movement
5 mins	How do zooarchaeologists tell the difference between the bones we find? **Size:** volunteer children to 'act' out animal sizes (chicken, sheep, cow) **Shape:** is it a long bone? Look for sockets and joints **Function:** think about how bodies move and why bones must be shaped this way		Make comparisons and identify and describe trends or patterns in data and information	
5 mins	**Practise** being a zooarchaeologist: real specimens on each table, reference on PowerPoint.	Faunal specimens		
5 mins	What can bones tell us? **Discuss** what food you get from animals for two mins on tables – report back to class. What can animal bones tell us about diet? Discuss primary and secondary products		Understand the need for a variety of foods for good human health	Identify that animals, including humans, need the right types and amount of nutrition

Table 5.1 continued.

Time	Activity	Resources	Welsh Curriculum	English Curriculum
5 mins	**Food as identity:** discuss the food pyramid and expand on food as a way to express identity. Discussion within groups as to what 'identity' means, feedback to whole group. Show examples of local foods, discuss how people use these foods to tell something about themselves.	Image of food pyramid and British local foods on PowerPoint	Understand the need for a variety of foods for good human health	Identify that animals, including humans, need the right types and amount of nutrition
5 mins	What are our **research questions**? Discuss in groups, feedback to class. Back up questions: Which animals were eaten in our Roman town? Could they eat secondary products (milk, eggs)? How does our Roman town compare to other Roman sites?		Ask and answer relevant questions about the past	Ask relevant questions and use different types of scientific enquiries to answer them
10 mins	Turning data into **bar charts**. Run through an example of what should be on a bar chart, then create paper copies.	• Squared paper, pencils, ruler etc.	Represent data using bar charts labelled in 2s, 5s and 10s Select and construct appropriate charts, diagrams and graphs with suitable scales Communicate clearly by speech, writing, tables, bar charts, using relevant vocabulary	Gather, record, classify and present data in a variety of ways to help in answering questions Record findings using simple scientific language, drawings, bar charts, and tables Interpret and present discrete data using appropriate graphical methods, including bar charts

Table 5.1 continued.

Time	Activity	Resources	Welsh Curriculum	English Curriculum
5 mins	**Discuss findings** in groups, then report to whole class. • Which animals were present? How many were there of each? • Could the people in our town use secondary products?	Graph on PowerPoint	Make comparisons and identify and describe trends or patterns in data and information Draw conclusions from data and recognise that some conclusions may be misleading or uncertain Extract and interpret information from charts, timetables, diagrams and graphs. Communicate clearly by speech, writing, tables, bar charts, using relevant vocabulary	Report on findings from enquiries, including oral and written explanations Use results to draw simple conclusions Use straightforward scientific evidence to answer questions or to support their findings
5 mins	**Compare** findings from this Roman town, with the data from a rural site. What are some of the differences between a town and a rural site? **Discuss** in groups for 2 mins. • Towns have: shops/ industries, lots of houses close together, trade links. • Rural sites have: lots of fields and space for houses, less access to trade.	Image of reconstructed Roman urban and rural sites on PowerPoint	Make comparisons and identify and describe trends or patterns in data and information	

Table 5.1 continued.

Time	Activity	Resources	Welsh Curriculum	English Curriculum
5 mins	How do the two sites **compare**? What are the reasons for the differences? **Discuss** in groups for 2 mins • Fewer chickens in the countryside – chickens are new in the Roman period • Difference between cows and sheep in rural/ urban – why might this be? Practical reasons? Consumption as a symbol of status?	Urban - rural comparative graphs on PowerPoint	Make comparisons and identify and describe trends or patterns in data and information Draw conclusions from data and recognise that some conclusions may be misleading or uncertain	Use straightforward scientific evidence to answer questions or to support their findings Solve comparison, sum and difference problems using information presented in bar charts and other graphs
10 mins	Write a **summary** of findings: • Which animals were present? Which animals were most prevalent? • Could the people in our town use secondary products? • How was our town different to the rural site? Why? Pupils may write a fictional account of their findings (e.g. story or a letter) or draw something that displays the information.	Lined paper	Draw conclusions from data and recognise that some conclusions may be misleading or uncertain Identify differences between ways of life at different times Communicate clearly by speech, writing, tables, bar charts, using relevant vocabulary	Report on findings from enquiries, including oral and written explanations Use results to draw simple conclusions Use straightforward scientific evidence to answer questions or to support their findings

Table 5.1 continued.

5.1.2 Climate Change

Climate change is an increasingly important issue, reflected in both Welsh and English curricula; pupils learn about environmental issues, including the impact of people upon the environment (DfCELLS 2008a, 12) *and* how a changing environment may affect the people living in it (DfE 2013a, 161). Pupils learn about environmental requirements of living things, and how differences in environment affect what lives in them (DfCELLS 2008a, 12; DfE 2013a, 157). These two requirements are effectively combined in the study of archaeological environmental reconstruction via environmental indicators like pollen remains (Latalowa *et al.* 2003; Mercuri 2008). Considering plants' growing requirements makes it possible to infer environmental conditions, allowing researchers to understand climatic events in the past. The impact of climatic change on the prehistoric South Wales coast has been mapped using such methods, providing a comprehensive understanding of environmental change along the Severn Estuary (Bell and Neumann 1997). This research demonstrates how pollen analysis can reveal the impact of climate and tidal change on past populations, in many participants' local area. Using pollen to infer environments asks pupils to use botany-based logical reasoning, and represents a novel challenge in a primary education context.

This intervention challenged participants to extrapolate environmental change along the Welsh Severn Estuary between the Mesolithic and Romano-British period, using pollen evidence (Table 5.2). Pupils explored different elements of climate change (e.g. temperature change, sea level rise) via videos, maths tasks (Appendix 18 and Appendix 19), and handling artefacts from 'waterlogged deposits' (charred hazelnut shells, water-worn bone, flint and antler fragments). Content also covered environment types and the plants suited to them using flash and 'Top Trumps' cards[18], and hypothetical pollen samples based on Martin Bell's (2000; 2007; 2013) research on the Severn Estuary. Participants were encouraged to think about the impact of changing coastlines on past people and how the archaeological record can shed light on this.

[18] Based upon an original concept by Dr Rhiannon Philp and Prof Jacqui Mulville, and in conjunction with Tidal Lagoon Power Ltd. for the Footprints in Time Project, funded by Cardiff University City Exchange Project 2016-17.

Theme:	Climate Change	**Time:** 1 hour
Outline:	This session shows how pollen can be used as a proxy for climate change. The presence of different plants can tell us about climate change over many millennia. The class will be given artefacts from wetland archaeological sites, and asked to think about how they ended up under water. They will then look at how the British environment has changed since the last Ice Age. They will consider the effects of sea level rise on coastal vegetation environments. Then children will recap pollen, and how different plants thrive in different environments. Images of pollen (with a corresponding date) will be distributed amongst the class, and placed on a timeline. From this, we will be able to visualise how the environment of the Severn Estuary has changed over time.	
Learning objectives:	• Understanding that our climate has changed drastically over many thousands of years • The different requirements of plants (hot/ cold or wet/ dry climate) • Pollen differs in appearance from plant to plant and can be identified under a microscope • The effect that environment change can have on the people and animals living in an area, specifically the effect of sea level change in the Severn Estuary	

Time	Activity	Resources	Welsh Curriculum	English Curriculum
5 mins	What is climate change? Our climate can change for lots of reasons, we're going to have a look at how it changed in the past and what that meant for people living in Britain thousands of years ago.		Carry out investigations into the history around them and into the life of people at different times and places in the past	Recognise that environments can change and that this can sometimes pose dangers to living things
10 mins	These artefacts were all found underwater. Have a look at them, why do you think they were found here? We're going to be detectives today, and work out why they were found underwater.	Flint, pottery, antler, 'water-worn' bone charred hazelnuts/ peas		

Table 5.2: Climate Change session plan with breakdown of timings, activities, resources and curriculum requirements (DfCELLS 2008a; 2008f; DfE 2013a; DfES 2016a).

Time	Activity	Resources	Welsh Curriculum	English Curriculum
5 mins	About 22,000 years ago, ice covered most of the northern hemisphere. A lot of the UK was under ice, and it would have been very cold. About 12,000 years ago, the planet warmed up, and the ice started to melt. This made the sea level rise (VIDEO), which affected where people/ animals and plants could live	Video on PowerPoint	The environmental factors that affect what grows and lives in those two environments, e.g. sunlight, water availability, temperature	Explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant Recognise that environments can change and that this can sometimes pose dangers to living things
10 mins	How much has the temperature of the UK changed since the Ice Age? Work out the temperature difference between the different time periods.	Thermometer exercise sheet	Transfer mathematical skills to a variety of contexts and everyday situations Interpret temperature readings above and below 0°C Read and write numbers to 10,000	Learn about changes in Britain from the Stone Age to the Iron Age Recognise that environments can change and that this can sometimes pose dangers to living things Count backwards through zero to include negative numbers
5 mins	When sea levels rise, salty water ends up coming inland. This affects which plants can grow: salt water kills lots of plants. Can you work out how the environment changes in response to sea level rise and fall?	Flash cards with an image of each environment and a short description	The environmental factors that affect what grows and lives in those two environments, e.g. sunlight, water availability, temperature	Explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant Recognise that environments can change and that this can sometimes pose dangers to living things

Table 5.2 continued.

Time	Activity	Resources	Welsh Curriculum	English Curriculum
5 mins	What kind of plants can live in each of these environments? Use the plant/ pollen ID cards and the descriptions of the vegetation environments to work out which plants grow where. Report findings back to class	Plant/ pollen ID cards	The environmental factors that affect what grows and lives in those two environments, e.g. sunlight, water availability, temperature	Use results to draw simple conclusions Reporting on findings from enquiries including oral explanations
5 mins	What is pollen? It can survive for thousands of years. Pollen from each plant looks different so we can work out which plants were growing in an area. Archaeologists can gather samples of soil, and then use a microscope to look for pollen. We can try to work out what the environment might have looked like, based on what pollen we find.			

Table 5.2 continued.

Time	Activity	Resources	Welsh Curriculum	English Curriculum
10 mins	We want to see if we can reconstruct the environment from the Severn Estuary. Use the pollen ID cards to work out what is in each of your petri dishes, and work out where they fit on the timeline. How does the environment change over time?	• Timeline • Pollen petri dishes with dates	Make comparisons and identify and describe trends or patterns in data and information Use timelines to sequence events Identify differences between ways of life at different times Select, record, and organise historical information	Use results to draw simple conclusions Identify differences, similarities or changes related to simple scientific ideas and processes Use straightforward scientific evidence to answer questions or to support their findings Count backwards through zero to include negative numbers Order and compare numbers beyond 1000
5 mins	So what was happening to the environment? Go through the answers. Reflect back on initial question: in light of what you know now, how did these artefacts end up underwater?	Timeline on PowerPoint	Make comparisons and identify and describe trends or patterns in data and information Use timelines to sequence events Identify differences between ways of life at different times Ask and answer the questions: were there significant changes in people's lives at this time and, if so, why? What impact did people of this time have on their environment?	Use results to draw simple conclusions Identify differences, similarities or changes related to simple scientific ideas and processes Use straightforward scientific evidence to answer questions or to support their findings. Interpret continuous data using appropriate graphical methods, including time graphs.

Table 5.2 continued.

5.1.3 *Roman Aqueducts*

This session did not imitate archaeologists' work, instead it brought practical design and construction to the intervention series by drawing upon maths and design technology curriculum requirements in an archaeological context (Table 5.3). The session aimed to emulate other 'real life' aspects of STEM careers such as research-based design, budget and material management, and prototype testing. The collaborative and interdisciplinarity nature of 'real world' STEM careers was reflected by individual job roles within teams. At the suggestion of a teacher, the intervention drew inspiration from Practical Action's, numerous design and construction 'STEM challenges' (Practical Action n.d.). Pupils researched, designed, constructed and tested a 'Roman-style' aqueduct (Appendix 20). Materials for the session were sourced from pupils, who brought recycled items from home (Appendix 21).

Pupils worked through the challenge to connect a water source with Rome in teams, where each child enacted a specific job role (Figure 5.1). Assigning job roles served two functions; to mirror the collaborative nature of real life design and construction projects, and – at the suggestion of the YP teacher – to ensure that pupils focused on individual tasks. Job roles were supported by resource packs and design prompts to guide pupils through planning and construction (Appendix 21). Each class established a personalised set of success criteria and method to test their structures fairly and were invited to assess each other's structures during testing.

Budget Manager **Resource Manager** **Aqueduct Expert**

Architect **Engineer**

Figure 5.1: Job role titles used in Roman Aqueduct session.

Theme:	Aqueduct construction	**Time:** 2 hours		
Outline:	Challenge: a Roman town has no access to water! A water source has been identified in the mountains nearby, but how can we make sure it reaches the town? Children will be given opportunities to research aqueducts (form/ function etc.) and then use their knowledge to create an aqueduct of their own, using recycled household items. They will need to use their understanding of materials to select the best tools for the job, and ensure that the water can get from one end to the other - without the aqueduct leaking or collapsing!			
Learning objectives:	• Describe the form and function of aqueducts, particularly those built by the Romans • Select success criteria for a design and recognise if they have been met • Explain the properties of construction materials and choose those most appropriate for the task • Reflect on the results of your design test to decide how you would adapt the design in the future			
Time	**Activity**	**Resources**	**Welsh Curriculum**	**English Curriculum**
5 mins	Images of aqueducts with a list of questions to be considered by children in pairs: What do you think this is? What do you think it does? What is it made of? What do you notice about its shape? Follow up with a YouTube clip about **Roman** aqueducts	YouTube video clip about aqueducts	Identify differences between ways of life at different times	Pupils should be taught about the Roman Empire and its impact on Britain
5 mins	**Challenge:** A water source has been found near Rome, and inhabitants would like to transport the water into their town. Can you design and build an aqueduct to help them?			

Table 5.3: Roman Aqueduct session plan with breakdown of timings, activities, resources and curriculum requirements (DfCELLS 2008a; 2008d and DfE 2013a).

Time	Activity	Resources	Welsh Curriculum	English Curriculum
10 mins	Pupils are introduced to the **job roles** needed for their project. Descriptions of each role are provided, which pupils match to the role title. Children then choose which role they would like to undertake.	• Sticky labels with job roles • Role descriptions		
10 mins	How will we know if our designs are successful? Pupils will be asked to think about and feedback **success criteria**. They will also devise a **fair test**: discuss ideas in groups, then decide test as a class.	Board to list success criteria and test conditions	Pupils outline the planned approach/method recognising: the choice of success criteria; when carrying out a fair test the key variables that need to be controlled; the observations or measurements that need to be made; the equipment and techniques required for the enquiry Select and use suitable instruments and units of measurement	Set up simple practical enquiries and fair tests Use research and develop design criteria to inform design

Table 5.3 continued.

Time	Activity	Resources	Welsh Curriculum	English Curriculum
20 mins	Aqueduct **planning**. Each group gets a planning pack, which they will use to design their structure. Each job title has a role. Aqueduct expert: use info pack to learn about aqueducts. Architect: work with aqueduct expert to design the structure. Resource manager: investigate materials and equipment. Budget manager: work out the projected cost and keep track of spend throughout build. Engineer: use construction pack to decide methods to build the architect's design.	• Construction pack • Aqueduct info pack • Planning sheet	Know the properties of materials relating to their uses Develop a simple specification for products indicating their intentions and approach	Generate, develop, model and communicate ideas through discussion and annotated sketches
40 mins	**Build** aqueducts: groups will build their designs.	• Recycling items • Scissors • Masking tape • Material cost list	Measure, mark out, cut, shape, join a range of materials using appropriate tools/utensils, equipment and techniques	Select from and use a wider range of materials and components according to their functional properties Apply understanding of how to strengthen, stiffen and reinforce more complex structures

Table 5.3 continued.

Time	Activity	Resources	Welsh Curriculum	English Curriculum
30 mins	**Test** aqueducts on the playground according to predetermined method. Pupils will use the evaluation sheet to track how effective they think each design was. Children will be asked to reflect on each design – what was good? What might be improved? Are there any really good ideas you could use next time?	• Measuring jugs • Evaluation sheet	Measure capacities to the nearest 50ml or 100ml Select and use suitable instruments and units of measurement Decide whether the approach/method was successful and describe any amendments made to the planned approach/method Suggest how the approach/method could have been improved Discuss products, and evaluate work, e.g. explain why and how they made their product and what they think about its function, features, performance	Make systematic and careful observations and, where appropriate, take accurate measurements using standard units Report on findings from enquiries, including oral explanations Use results to draw simple conclusions and suggest improvements Evaluate ideas and products against design criteria and consider the views of others to improve work

Table 5.3 continued.

5.2 Intervention delivery and impact

Understanding the reception and impact of interventions on participants is key to recognising which elements of sessions were most effective, and which might require revision in future iterations. Reflecting on the specific context of each participating group is also essential to understanding how archaeological engagements can be most impactful. Therefore, the following will consider how each intervention was received by participants and reflect on how successfully (or otherwise) they met the intended impact.

5.2.1 Faunal Analysis

For this session, some prior knowledge of skeletal anatomy was useful, though not essential. Pupils with prior anatomical knowledge were in a position to draw upon previous STEM learning and apply it in this novel archaeological context. Some were familiar with scientific names for large elements (e.g. tibia, humerus): YP pupils benefitted from classroom displays of previous work on skeletal anatomy; one SP pupil described an anatomy game they owned; NB pupils retained knowledge from stretch exercises in gymnastics/ dance clubs. Pupils without prior knowledge were still able to participate, but for them the skeleton labelling task represented a new learning experience rather than an opportunity to embed previous STEM learning into new scenarios. Following this exercise, all participants demonstrated ease with technical anatomical language through its appropriate use in verbal discussions, specimen identification and recording tasks. Asking pupils to devise research questions to guide their analysis was intended to meet the curriculum requirement of 'asking relevant questions' and provide an element of self-directed problem solving. However, many pupils seemed to lack confidence in doing this (or perhaps required more guidance than was allocated to the timing of this session), and while others *were* confident asking questions, their questions were not always relevant to methods of faunal analysis. If the sessions were delivered over a longer time frame it may have been possible to explore all avenues suggested by pupils. A limitation of this style of intervention is that there is little flexibility in the session plan and they are therefore less able to facilitate pupil exploration.

Drawing graphs to display and interpret data took longer and required more support than anticipated with all classes. As a result, many groups did not have time to write up their findings and verbal discussions were used instead. Advice from a teacher during the main research period led to further streamlining of this session; discussions of food as identity were removed to ensure more time was available for data analysis (graphs). Removing this aspect of the session reduced the frequency of curriculum-archaeology cross-over, though this decision was taken to maximise the impact of applying school-based STEM skills (graph drawing) in an archaeological context (faunal analysis), which is central to this thesis. This approach proved valuable, as it created space for participants to respond to the graph challenge in unanticipated ways. One group of BG participants took a creative approach and devised a fun, but informative way to display the data on their bar chart (Figure 5.2). This activity clearly represented an opportunity for these participants to explore STEM content in an artistic way, which may have appealed to their personal skillsets and interests[19]. Numerous SP pupils opted to draw pie charts rather than bar charts following an IT lesson using MS Excel the previous day (Figure 5.3). Their choice is a clear demonstration of individuals applying prior STEM skills and knowledge to the current archaeological context. In doing this, pupils further embedded STEM knowledge and skills into their self-concepts, and exhibited their understanding of archaeology as a method to engage with STEM.

Additional time devoted to the graph activity also improved its accessibility; two pupils with additional needs (at YP and BG) were able to engage effectively via increased time and support. The YP pupil was noted by the class teacher as unusually engaged in data analysis: '[they're] *happy to talk about it, but hate recording it'* (Figure 5.4 and Figure 5.5). This result was likely a result of the novel content and the child's experience of 1:1 learning with the class teacher, who might usually be otherwise engaged with leading the lesson. The BG pupil was supported by their class teacher to make a graph in MS Excel on the class tablet (Figure 5.6), and to access an activity that might have otherwise proved challenging. In both cases having an external expert lead the session created time for school staff to work closely with pupils with known additional needs. The expertise of both educators was valuable here: knowledge of archaeology and a deep understanding of individual pupils' needs. In the case of the YP pupil, it appears that the novel application of data collection and analytical skills in an archaeological context enabled them to connect with this task more deeply than was previously possible.

Two pupils made links between session content and personal experiences, demonstrating their retention of skills and knowledge from the session. One SP pupil elected to use their 'rainy break' time creating a further bar chart detailing toys owned at home (Figure 5.7). An NB pupil spoke to the researcher about their collection of natural objects (including animal teeth), and their plan to organise them '*like an archaeologist'* when they got home. By relating newfound skills or knowledge to other aspects of their lives, these pupils identified the relevance of archaeology and STEM in their personal experience, which is a key aspect of learning (Glancy and Moore 2013, 7; Godec *et al.* 2017, 27). Despite issues with timing of activities in this session

[19] See Chapter 6 for results of how participants understood their skill usage in this intervention.

participants were enthusiastic and engaged, and there was clear evidence that the session was accessible and encouraged pupils to apply STEM skills and knowledge in a novel archaeological context.

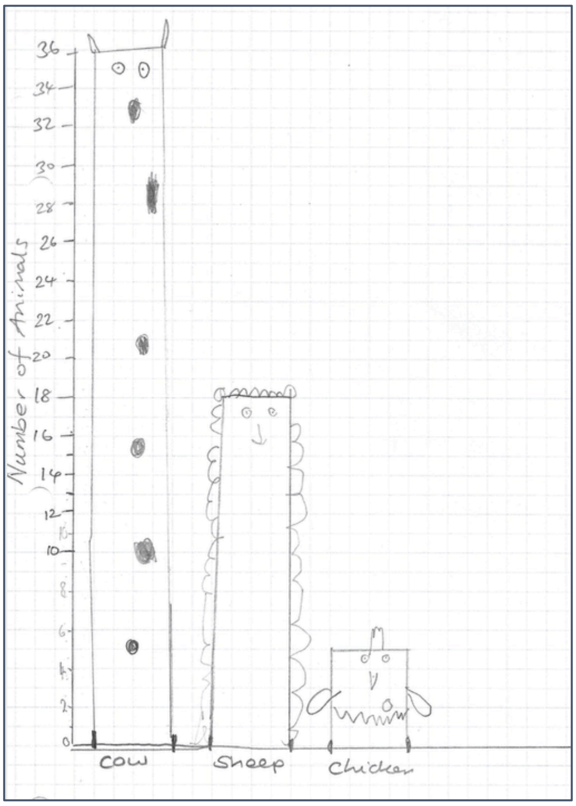


Figure 5.2: BG pupils took a creative approach to displaying the data on their bar chart in the faunal analysis session.

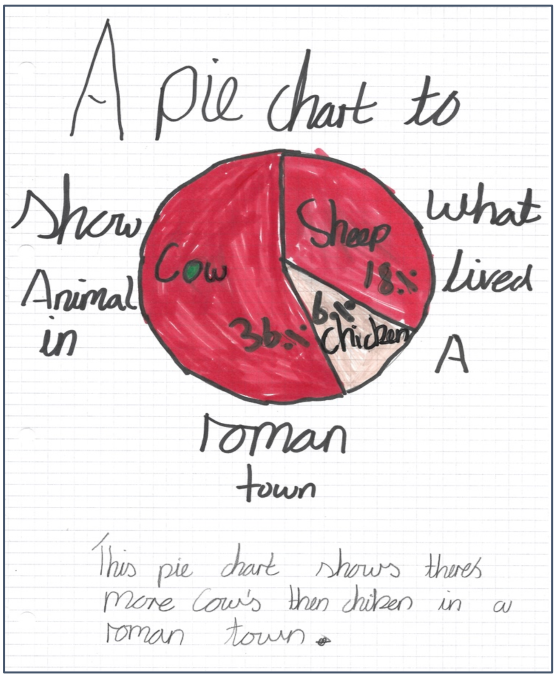


Figure 5.3: Pie chart drawn by SP pupils, showing the number (incorrectly represented as percentage) of identifiable specimens by taxon from a fictional Roman town.

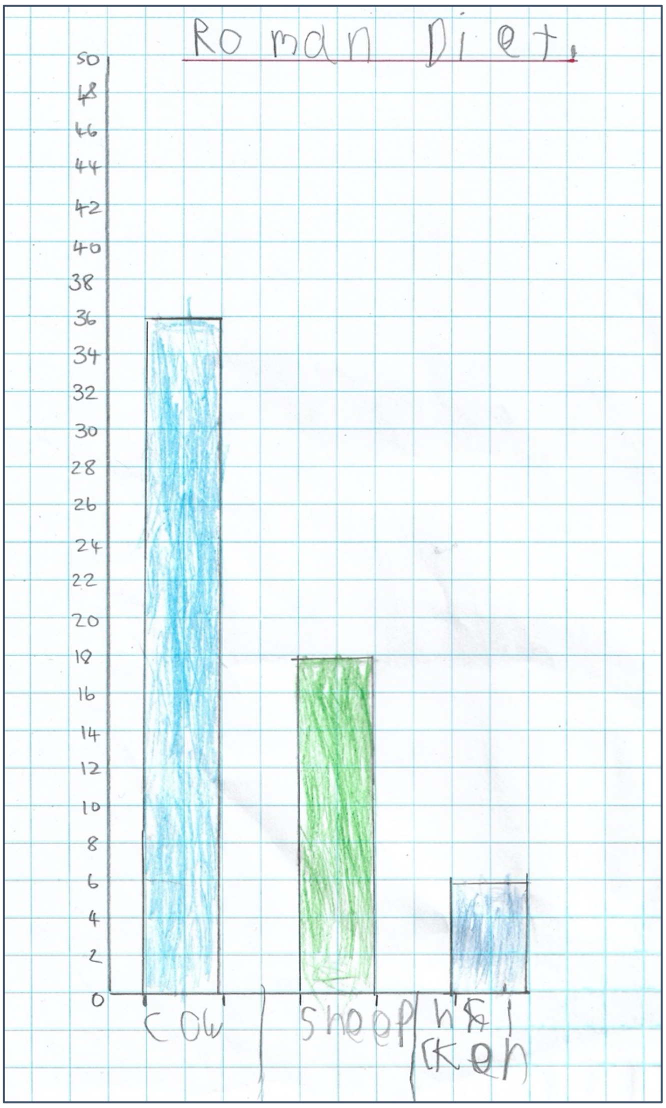


Figure 5.4: Graph of a YP pupil noted by the class teacher as being unusually well engaged with the data collection and analysis task in the faunal analysis session.

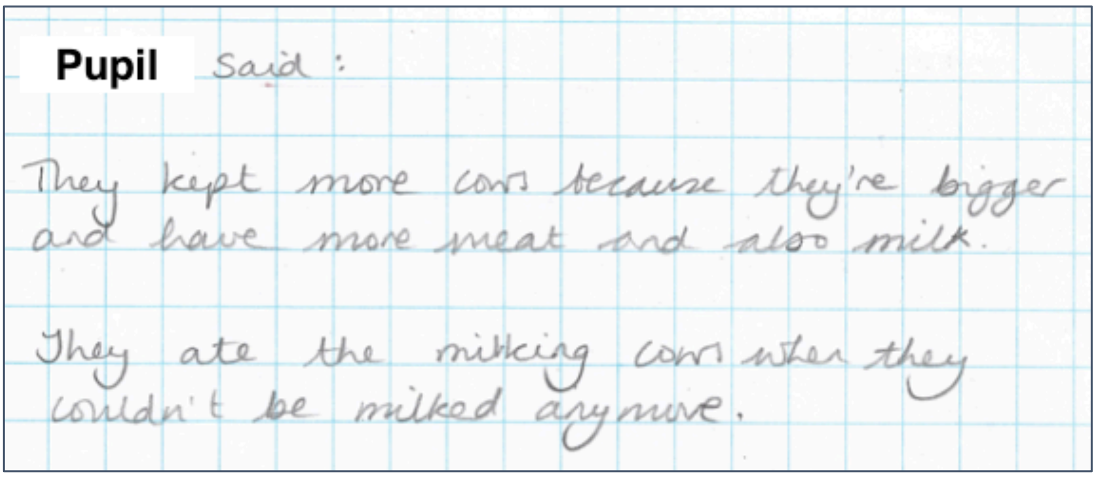


Figure 5.5: Interpretation of faunal data by a YP pupil noted by the class teacher as being unusually well engaged with the data collection and analysis task in the faunal analysis session.

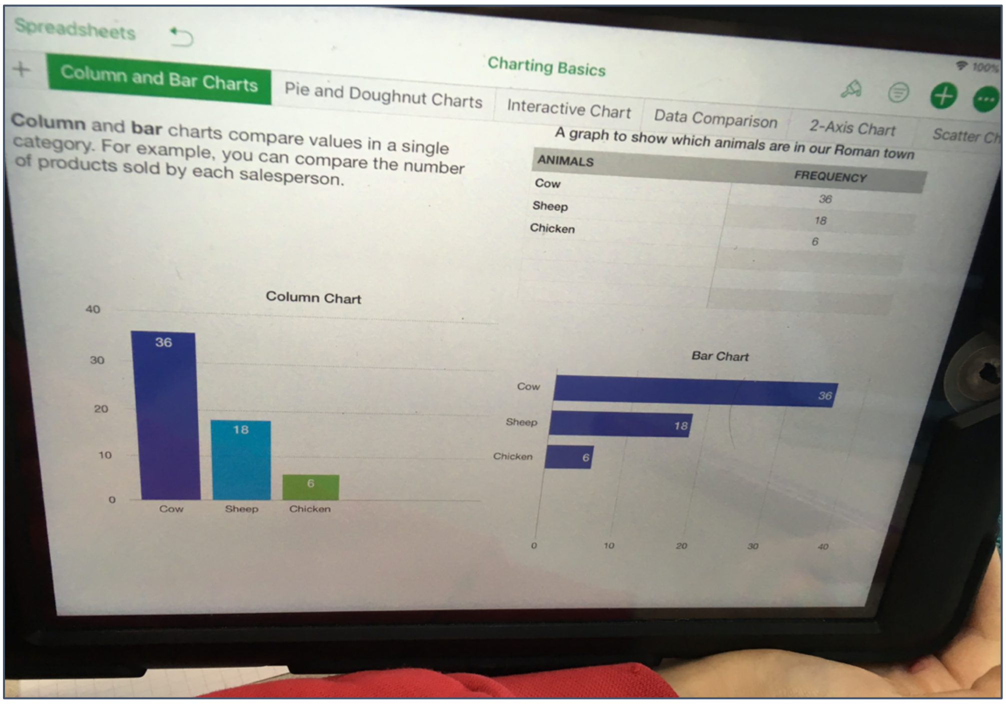


Figure 5.6: Work of a BG pupil with additional needs who was supported by the class teacher to complete the graph task on MS Excel in the faunal analysis session.

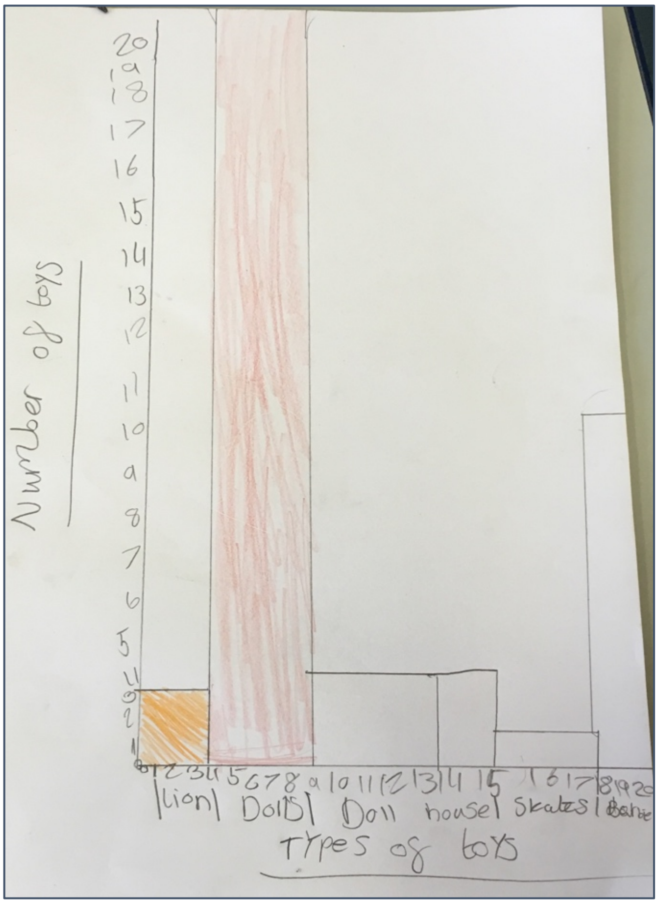


Figure 5.7: Graph drawn by an SP pupil following the faunal analysis session. The graph shows how many toys (by type) the child had at home.

5.2.2 Climate Change

The concept of climate change was particularly well received by BG pupils who drew upon previous knowledge in their descriptions of key concepts (e.g. pollution, hole in ozone layer). Prior engagement with climate change was evidenced by extensive work around the classroom and school. All participants responded well to the archaeological handling activity, making suggestions for what the 'underwater' artefacts might be. Pupils' comments about the faunal specimens in this activity were particularly noteworthy, as they had some prior experience from the faunal analysis intervention session. Despite having interacted with similar specimens in the previous intervention, some of the specimen suggestions from participants were outlandish. These included the suggestion that deer antler might be 'dinosaur teeth' or a 'triceratops horn', indicating that these participants had not retained knowledge from the previous session. Other participants recognised that the faunal specimens were '*from an animal*', and used skills from the previous session to make educated guesses about the form and potential function of each specimen (such as: the foramen of a pelvis might be an 'eye hole'). These differing levels of knowledge retention highlight the complexity of attempting to effect change in large groups of participants; varying individual engagement with content may result in inconsistent long-term impact.

Participants found two exercises in the climate change intervention particularly challenging: thermometer reading and vegetation environment tasks. The thermometer task represented an archaeology-themed application of science and maths skills: reading scientific equipment, addition and subtraction. However, the use of 'degrees centigrade' and minus numbers proved challenging. YP pupils were an exception to this, as they had practised these skills recently in class. This finding highlights the pitfalls of making assumptions about participant ability; although interpreting temperature readings and dealing with numbers below 0 are lower key stage 2 curriculum requirements, the majority of classes had not yet covered these skills in the academic year. Therefore, despite intentions, this exercise did not provide an opportunity to apply prior STEM skills and knowledge to an archaeological context as were largely working from a limited knowledge base. The vegetation environment task presented another challenge, this one largely stemming from the requirement for pupils to read a description rather than solely relying on the accompanying images. As a result, almost all participants made the same error in this activity by incorrectly ordering the vegetation environments (Figure 5.8).

Figure 5.8: The majority of participants in all schools incorrectly ordered vegetation environments in the climate change session by placing the 'raised bog' after the 'salt marsh', likely a result of similarity between images rather than reading descriptions. Correct order: salt marsh, reed swamp, raised bog, Carr woodland, deciduous woodland.

Participants' preference for images over text was also reflected in their limited use of technical language (such as 'raised bog', 'reed swamp') which they should have encountered in the vegetation environment descriptions, preferring to describe environments with more familiar words ('warm', 'wet') instead. Pupils' ease of adoption of technical language was demonstrated in the previous intervention, raising some points for consideration. Firstly it is possible that pupils did not engage with the written descriptions that used these terms, preferring to rely on the images to complete the task instead. Second, it may be that technical terms relating to abstract environments are less accessible than those relating to the more personal, such as mammalian skeletal anatomy. Third, organising pre-written information (in this case types of vegetation environment) into a particular order may be a less engaging action than labelling a diagram and recording specimens; both of which require the learner to reproduce technical language in addition to reading it. It is likely that a combination of these factors contributed to this exercise's limited impact on participants.

Closing discussions about why archaeological artefacts are found underwater revealed the extent to which participants had understood a core concept of the session: that environmental change impacts human habitation. Most pupils understood that sea level rise can affect "*where the land is*", though many suggested that artefacts were 'washed away' by rising tides. One SP class proposed that a destructive climatic event may have drowned people with their artefacts; a possible outcome of the sea level rise video they were shown, which sped up the process over many millennia, creating the impression of a single event. Another suggestion from BG pupils was of past communities using the sea for waste disposal. While these suggestions are not necessarily inaccurate, it implies that pupils did not fully consider the impact of changing coasts on human lives. It is possible that these children were thinking about sea level rise in terms of a temporary impact, as is commonly seen in news footage and other entertainment media, rather than as bringing about substantial lasting change to a landscape. Only a few individuals suggested that the occurrence of archaeological objects underwater might be the result of people having lived in places that are now underwater. In this case applying previous knowledge of climatic events to archaeological content inhibited pupils' understanding of the scale and impact of prehistoric events.

Overall the reception of this intervention was enthusiastic, though opportunities for participants to apply prior STEM knowledge and skills were limited, due to researcher assumptions about pupils' knowledge base, and their preconceptions of climatic events relying on present day, temporary events. Although this session presented a clear problem to be solved and supported pupils through each stage of solving it, content was fixed with limited opportunity to pursue individual lines of enquiry or engage with content creatively. Additionally the session relied heavily on laminated cards with physical artefacts present only in the introductory exercise. Despite attempts to present information cards in the style of a popular game (Top Trumps), some children may have found this approach less engaging than the physical objects. Consequently, the climate change intervention appears to have had either: limited impact on participants *or* limited opportunity for participants to demonstrate notable impact (such as that observed in the faunal analysis session).

5.2.3 Roman Aqueducts

This intervention had the greatest potential to present challenges, such as: not having enough recycled objects for construction; running out of time to build and test structures; structures falling far below the quality needed for the experiment to work. Steps were taken to pre-empt these issues: the researcher collecting additional recycled resources; collaborating with class teachers to highlight and address issues that might arise (such as including a 'construction pack' in the resources for pupils with limited experience at the suggestion of a BG teacher); emphasising the importance of learning constructively from mistakes and applying this to future work. All groups began by deciding on a set of success criteria (Figure 5.9) and a method to test their aqueducts (Figure 5.10), these varied between schools but similar themes were present throughout. Responses highlight pupils' ability to apply prior scientific skills to a novel archaeology-themed context.

Participants displayed a lot of enthusiasm for building structures, sometimes at the expense of planning them; multiple groups' preference for verbal discussion resulted in uncompleted planning sheets. While the written sections of planning sheets were frequently left blank, the majority of plans were accompanied by a drawing. These drawings revealed varied responses to the source material, with some plans mirroring genuine aqueducts (Figure 5.11), and others more clearly based on the construction materials available (Figure 5.12). One group suggested that their 'realistic' aqueduct plan would be built from stone, suggesting that the specifics of the challenge were unclear, but also demonstrating good recollection of the discussion at the start of the session. One group included mathematical details on their plan, demonstrating the application of prior knowledge in this new scenario, however they did not account for available building materials (Figure 5.14). During planning, a child acting as 'budget manager' made personally relevant links with content by converting projected construction costs from pounds sterling to Polish zloty (Figure 5.13). Recognising and validating individual expertise is key to supporting pupils in their development of a STEM identity (Dou *et al.* 2019, 625; Godec *et al.* 2017, 19); this was an opportunity for that child to recognise the value their experience added to a STEM scenario.

NB	SP	BG	BF	YP
• It will not leak water	• The aqueduct must carry water from one end to the other without leaking and must be strong enough to be carried from the classroom to the playground.	• The aqueduct must be strong and not leak water • It carries water, it doesn't break and the water doesn't escape.	• To build an aqueduct that can carry water without leaking or breaking.	• It will be strong, it will be waterproof, and it will be about one metre long.

Figure 5.9: Success criteria for the aqueduct session as determined by pupils at each participating school.

NB	SP	BG	BF	YP
• Pour 500ml of water • Measure how much water comes out the end	• Pour 1 litre of water in one end of the aqueduct and measure how much water reaches the other end	• Treat everyone's work the same • Every group has a go at testing their aqueduct • Measure water in and out (700ml) • Pour water carefully • Pour water from the same height each time (5cm) • Don't let it splash	• Use 300ml of water to test it • Pour water into the aqueduct from a height of 15 cm • Measure the water at the end of the aqueduct with a jug	• We will test our aqueducts by measuring the amount of water we put in and the amount of water that comes out the other end • We will pour in 1 litre of water from a height of 15cm

Figure 5.10: Methods for a fair test as decided by groups at each participating school.

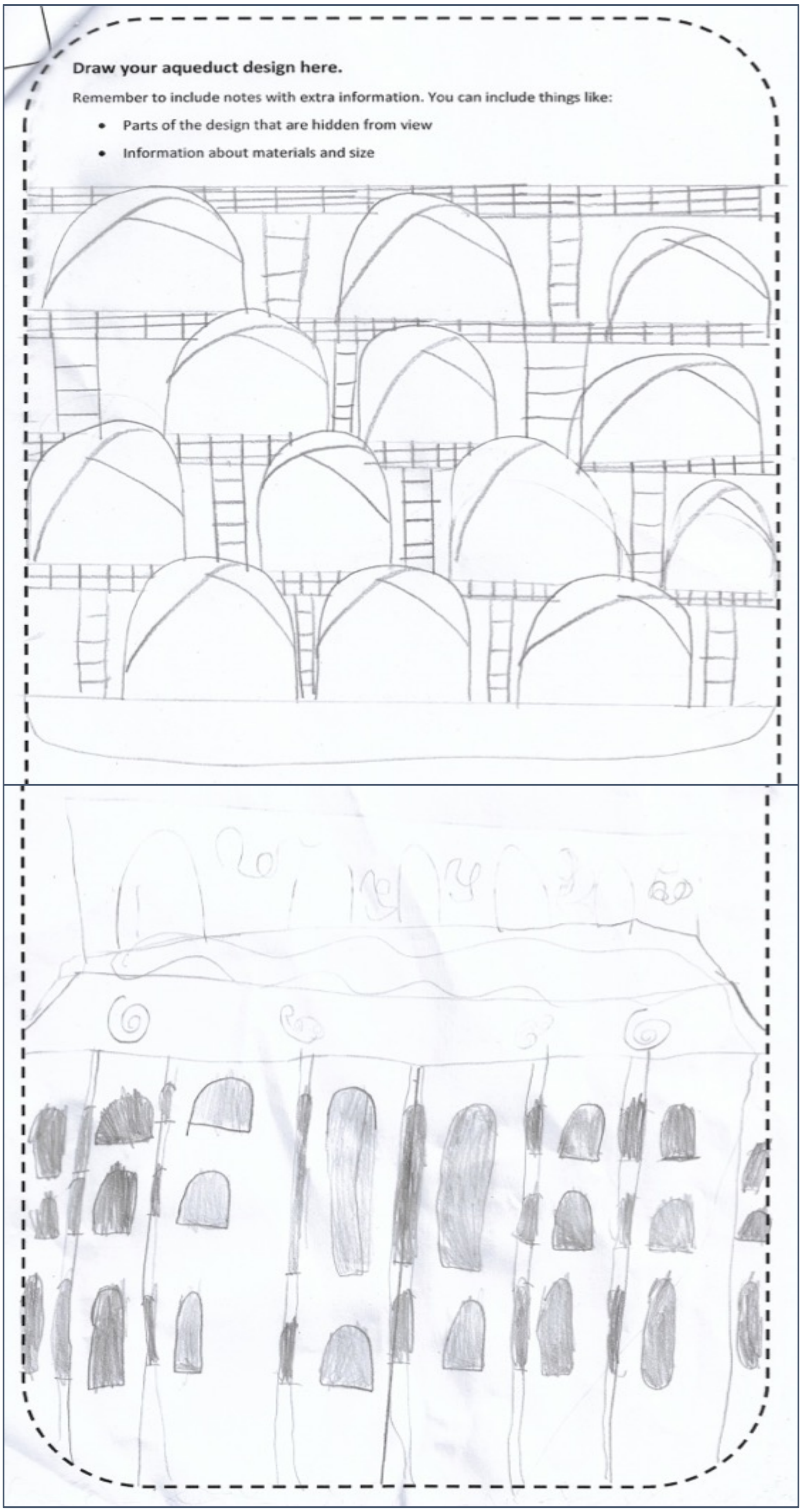


Figure 5.11: Some plans focused on realistic images of aqueducts, rather than reflecting the reality of the materials available.

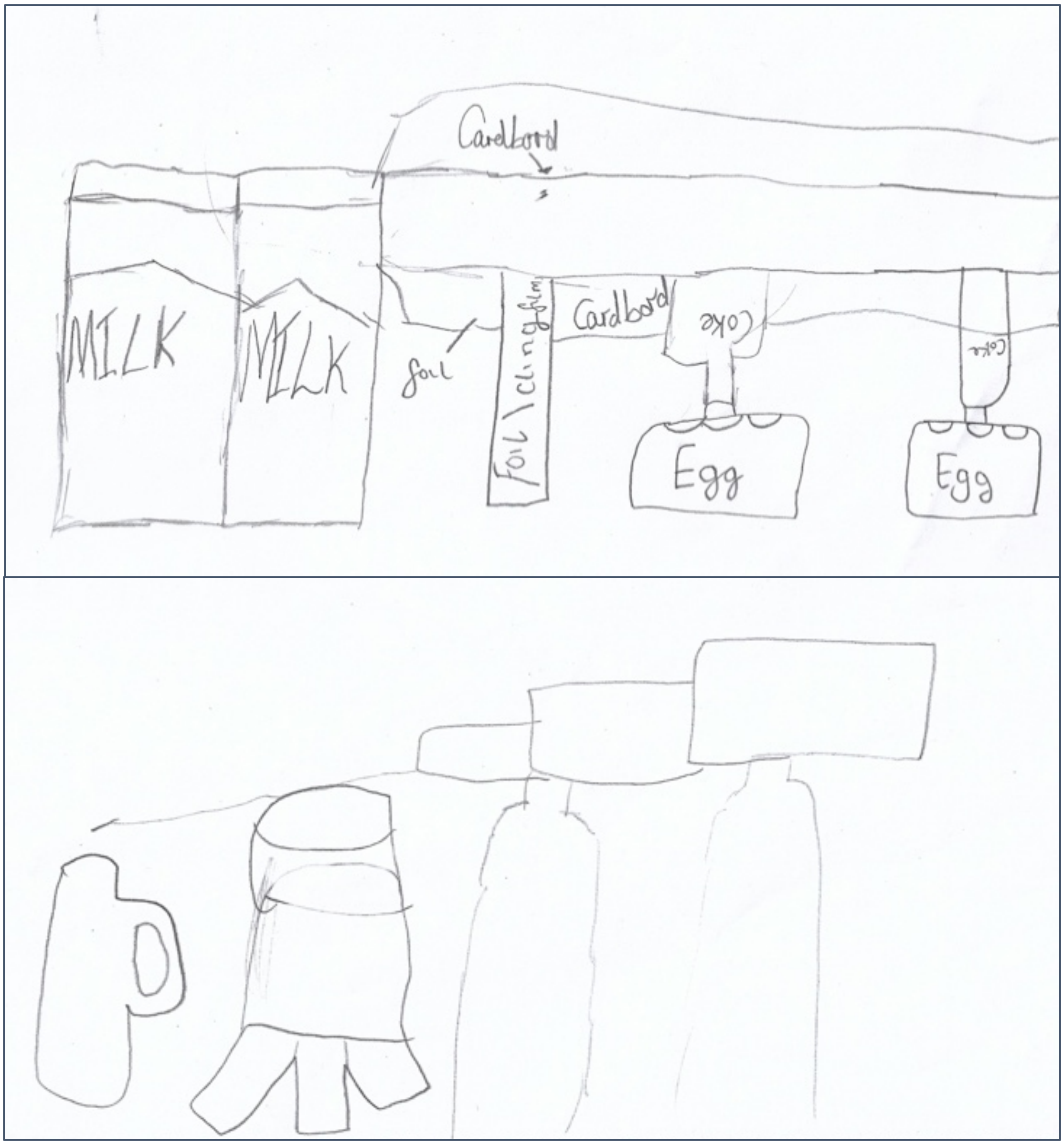


Figure 5.12: Some drawn plans were based on the materials available to participants.

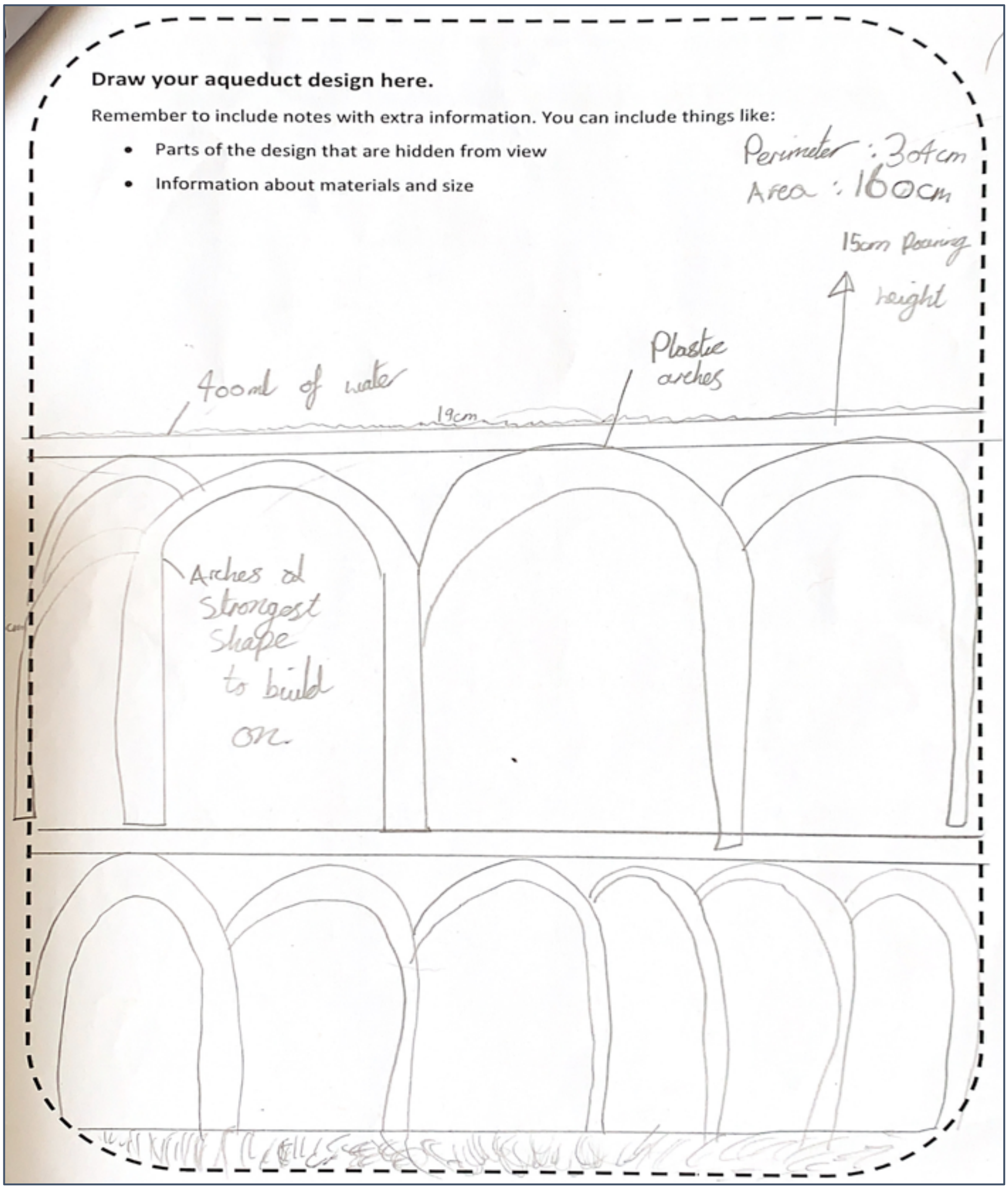


Figure 5.14: One group annotated their plan with measurements.

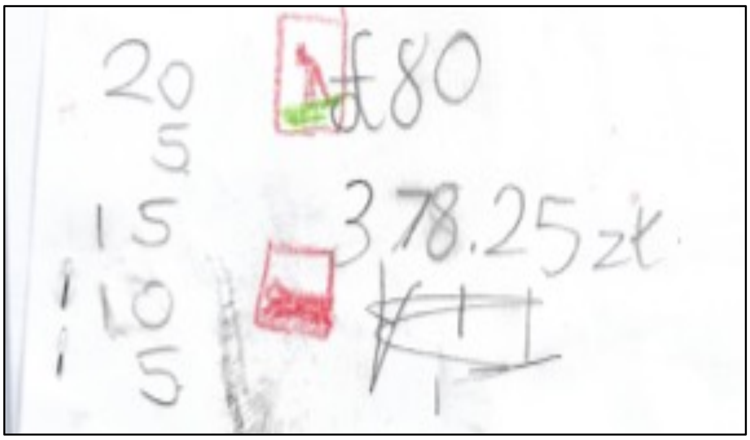


Figure 5.13: A pupil chose to calculate their group's budget in pounds sterling and Polish zloty.

‘Trial and error’ style experimentation was a major feature of most groups’ construction work, as evidenced by the volume of materials that had been manipulated in some way (e.g. cutting, adapting) but discarded from the final structure. This indicated a level of inexperience amongst participants in engaging with this kind of construction activity (confirming assumptions of the BG teacher). Despite this, participants made limited use of construction packs, which is consistent with their previous preference to ‘have a go’ over reading something (see section 5.2.2). Those who used construction methods from the packs (Figure 5.15) did so following discussions with the researcher, and some went on to add methods of their own (Figure 5.16). Adding methods to the construction pack was an opportunity for pupils to share expertise and reinforce their retention of ‘trial and error’ discoveries. Finished structures revealed creative approaches to the task, some practical and others artistic. One group weighted their aqueduct with a bottle of water placed in a cereal box (Figure 5.17), while others incorporated arch shapes into their design (Figure 5.18), though in some cases the focus on producing the arch shape came at the cost of the structure’s effectiveness (Figure 5.19).

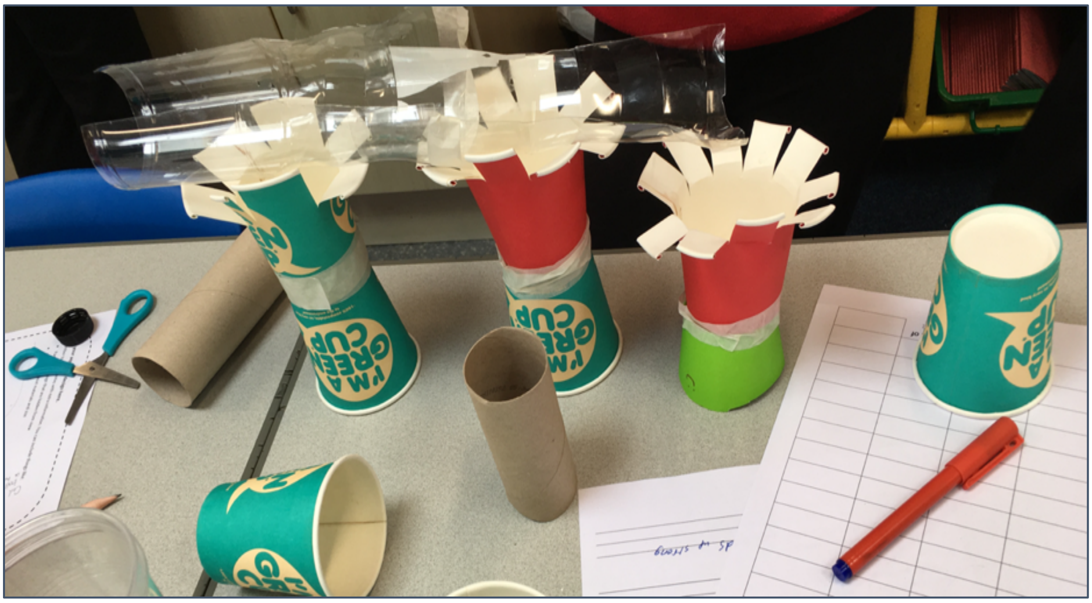


Figure 5.15: Pupils used a method for connecting materials from the construction pack in the aqueduct session.

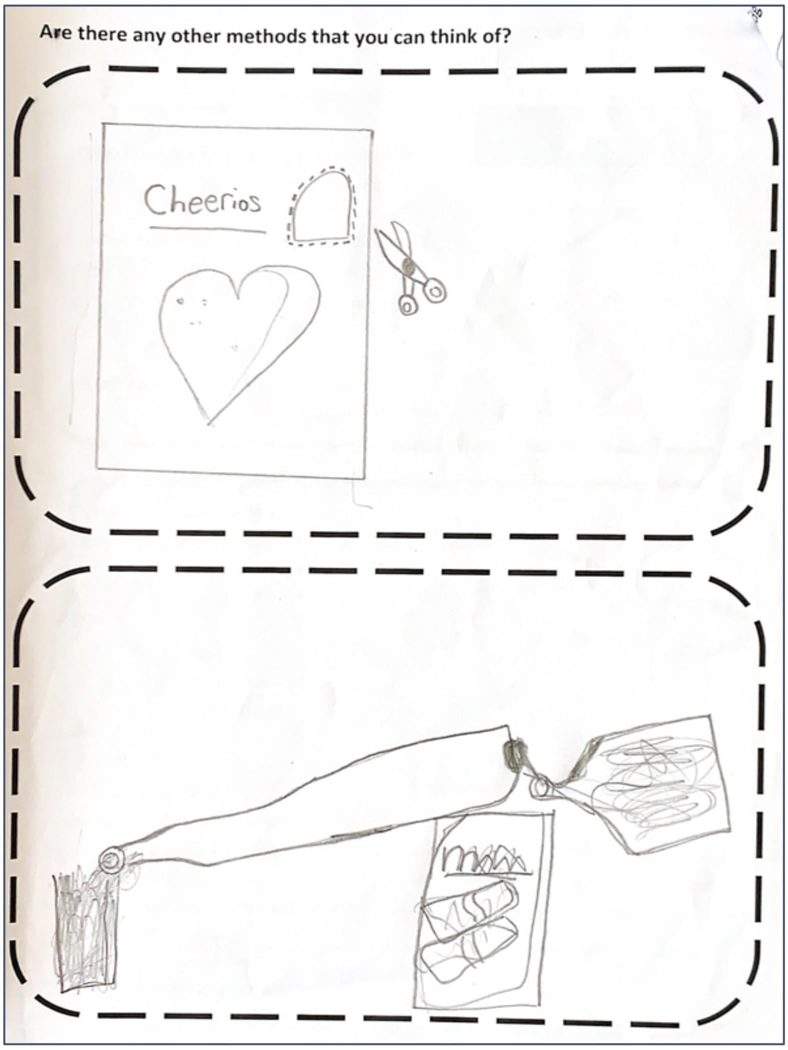


Figure 5.16: A group added their own methods to the construction pack.

Figure 5.17: Pupils used a bottle filled with water inside a cereal box as ballast for their design.

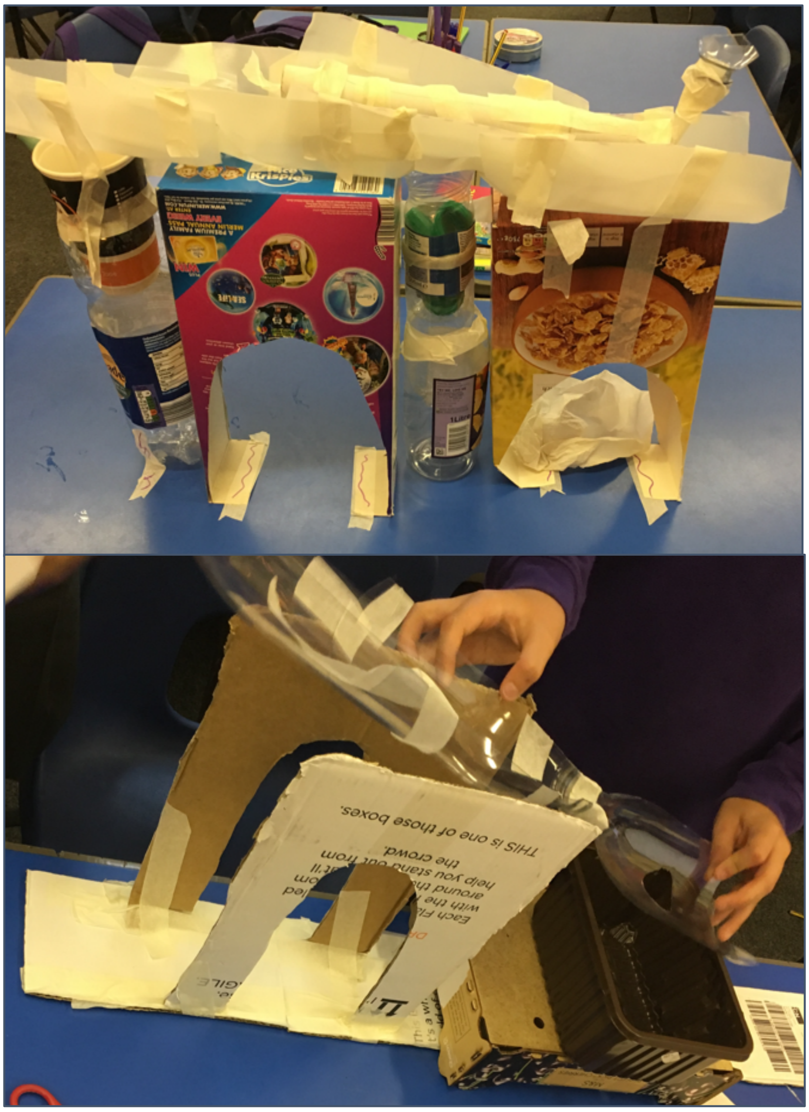


Figure 5.18: Some groups incorporated arches into their aqueduct design.

Figure 5.19: This aqueduct had an arched design but did not carry water effectively.

Timing was an issue for all groups: incomplete plans, and unfamiliarity with construction methods resulted in the need for additional time to complete the challenge. This impacted the time available for testing and reflecting on the structures. Testing structures presented additional challenges: some designs broke during transportation and others were blown about on a windy day. Levels of success varied across groups, structures that were simple and well connected performed well (Figure 5.21), while those that were complex or ill-fitting experienced issues (Figure 5.20). Groups reflected on the performance of their designs by discussing things that had gone well and things that might be improved if they were to try again (Figure 5.22).

The majority of participants approached this challenge from a position of relative inexperience, meaning that rather than applying prior STEM skills (such as planning, design, construction) to a novel archaeological context they were acquiring them instead. However, by reflecting on their practice and success of structures participants prepared themselves for their next encounter requiring such skills, where they will be in a position to apply the lessons learned from this session. Reflections also presented the opportunity to discuss real STEM industries, where failure and subsequent improvement are a common element of product design, and to emphasise the relevance of participants' experience in 'real' STEM contexts. Reflecting on possible improvements also maintained accessibility of the session; even groups with unsuccessful structures were able to finish with constructive contributions for future practice.

Figure 5.21: Designs which were simple and fit together well performed well in the aqueduct test.

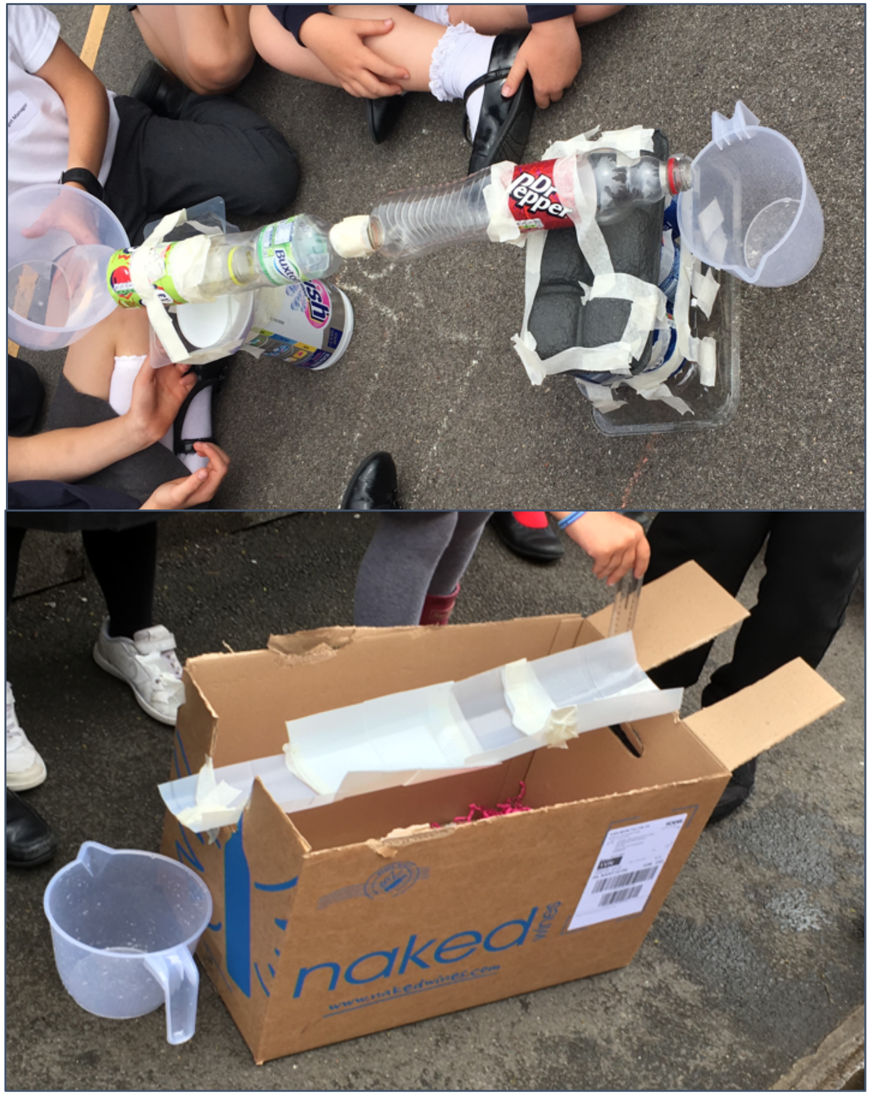


Figure 5.20: Complex or fragile designs experienced issues during testing.

NB

- Pupils noted that the cost of structures did not guarentee their success. Some 'cheap' designs had performed better than 'expensive' ones.

SP

- Reflective discussions were limited due to time, but the researcher emphasised the importance of making mistakes during tests so they can be fixed for the final product.

BG

- Most reflections focused on the need for more sturdy and windproof structures in the future.

BF

- Pupils noted that two designs transported the same amount of water, but one was much sturdier than the other. They decided that simple designs could be more effective than complex ones.

YP

- Pupils liked: the colours and appearance of their structures
- They wanted to improve by: finding and taping up holes in their designs, increasing the angle to improve water flow

Figure 5.22: Reflections on the performance of aqueducts at each participating school.

5.3 Chapter 5 summary

Two objectives of this thesis were addressed in this chapter. It outlined the content of each archaeological intervention with corresponding curriculum requirements, and detailed their delivery throughout the main research period. Some initial consideration was also given to the impact of interventions on pupils, as was observed from their practice and work produced during sessions. The scope to combine learning objectives from across the curriculum (in this instance: maths, science, DT and history) and archaeological content is vast; interventions explored themes of zooarchaeological analysis, climate change, and construction of Roman-style aqueducts. Intervention activities challenged participants to take STEM skills and knowledge and apply them in an archaeological context. Engaging pupils through practical, interactive content was intended to produce meaningful learning engagements that would empower them to recognise the value of their STEM abilities in a 'real world' scenario. In doing this, participants had the opportunity to embed 'STEM' into their self-concepts and identity. Intervention delivery revealed multiple insights about their impact on participants and implications for future archaeological education. The full extent of interventions' impact on participants' STEM perceptions and self-concepts is explored in Chapters 6 to 9, which detail results of the multi-modal data collection methods. However, some interactions with participants and/or observations of the work they produced also demonstrated impact, which was highlighted throughout this chapter.

The success of activities in supporting participants to apply STEM skills and knowledge to novel contexts was inconsistent. Participants were not always fully equipped with relevant prior knowledge or skills, meaning those exercises acted as learning opportunities instead. In these cases, the process of understanding archaeology's relevance to STEM may work in reverse: participants experience something in an archaeological context which is then recalled during another STEM educational engagement. Pupils may also approach that alternative STEM context from a position of greater confidence than if they had not experienced the necessary skills and knowledge during this project's interventions. Instances where pupils *did* have the necessary prior experience saw individuals translate archaeological and STEM skills into personally relevant practice, particularly in the faunal analysis and aqueduct construction sessions. Future archaeological education opportunities which incorporate specific curriculum requirements ought to recognise that schools cover material at varying paces throughout an academic year, and prior knowledge cannot always be assumed. In addition to this, curriculum requirements are subject to change, particularly those in the Welsh curriculum which is currently being reformed. In/formal educators must ensure their content remains relevant in light of such changes.

Participants' confidence in directing sessions also varied: while most were unconfident in generating appropriate research questions for the faunal analysis, almost all were able to devise success criteria and a fair test for their aqueduct designs. This likely reflects differences in content familiarity. Faunal analysis was a totally new concept and therefore challenging to develop research questions for, whereas success criteria and fair tests are frequently encountered in primary education (as evidenced by curriculum requirements, see Table 5.1 to Table 5.3) and may represent more familiar lines of enquiry. Therefore future engagements with primary level pupils ought to consider how compatible technical language and terminology are with primary educational experiences. This is not to say that children are unable to adapt to new concepts or terms, but there may be steps educators can take to smooth the transition between familiar and novel content. Asking participants to generate research questions also highlighted a limitation of short-term individual engagements: time constraints did not allow for genuinely pupil-led exploration of those questions. An alternative is to develop future engagements which are long-term (e.g. embedded into mainstream education) and open ended, to allow pupils to lead and co-construct their learning.

The climate change session generated the least observable evidence (during delivery or via work produced) of impact on participants (see Chapter 6 for details of session impact via questionnaires). Unlike the faunal analysis and aqueduct construction sessions, no participants appeared to identify personal links with content and no exercises produced individual pieces of work (other than verbal discussions) that could demonstrate varied approaches to the task. Engagement with key concepts in this session also appeared reduced, which may be a result of the activities themselves, which were more theoretical than those in the faunal and aqueduct sessions. This sheds light on the kind of resources that should be taken forward to future engagements: physical artefacts and practical activities are likely to produce deepest engagement. Participants who *did* make connections between intervention and personal experiences demonstrated key opportunities for pupils to implant STEM and archaeology into self-concepts and identity.

The insights recounted here only consider what was directly observable in sessions or from the work pupils produced in them. This project applied a multi-modal approach to data collection which was designed to gain deeper understanding of how interventions influenced participants' STEM self-concepts and identity. The following chapters will consider the findings of these mixed data collection methods, beginning with the results of questionnaires which were completed by participants prior to and following each intervention.

6 Chapter 6: Pupil questionnaire results

A questionnaire was devised to observe potential change in participants' perceptions of STEM skills, aptitudes and identity. Quantitative data reveals trends over time and is suitable for large scale data collection (Goertzen 2017), making it the most appropriate method to study 233 children. Questionnaires were devised, data was collected and analysed according to the methods in section 3.4.3, Chapter 3. It is hypothesised that questionnaire responses will reflect more positive perceptions of STEM, and a broadened understanding of STEM-based skills and aptitudes following participants' engagement with archaeological interventions. In this chapter, results are contextualised with wider literature on STEM engagement to generate context-specific interpretations for participating schools, and to explore implications for future STEM participation.

6.1 Results

233 participants returned questionnaires prior to and following each of the three interventions. NB is an exception to this; due to timetable constraints, post-intervention 1 and 2 questionnaires were completed in the weeks following those interventions. The implications of this are addressed where pertinent. Questionnaire results are presented below in three sections, each relating to an individual question.

6.1.1 Question One: Do you know what STEM stands for?

This question was designed to ensure questionnaire validity by removing responses from pupils who did not know what 'STEM' means. Questionnaires with this question unanswered were not considered for further analysis. This approach risks failing to capture perceptions of pupils who are negative (or ambivalent) towards STEM, and therefore unmotivated to remember the acronym. In an attempt to negate this, and to generate as much usable data as possible (the aim of the questionnaire was to understand pupils' perceptions of STEM, not to test their memories), teachers were asked to recap the acronym before completing initial questionnaires. Consequently, the number of questionnaires that were not subject to further analysis was relatively low throughout the main research period (see Table 6.1 to Table 6.2). For the pre-intervention questionnaire, BG teachers elected not to recap the acronym to better demonstrate the efficacy of intervention 1 in reminding pupils of it. As Table 6.1 shows, the number of BG pupils answering this question more than doubled following the first archaeology session. Aside from this instance, the number of questionnaires with incorrect responses to this question remained below n=20 throughout. While attempting to understand the perspectives of participants with low motivation to remember the STEM acronym may have been of interest to this project, statistical analysis is not recommended for samples under 30 (Cohen *et al.* 2013, 101), meaning it was not possible to investigate these responses further.

The sample size was fluid throughout the series of questionnaires, reflecting the dynamic nature of primary school attendance. It was impossible to guarantee participant attendance on days when questionnaires were completed, especially in cases where the pre and post-intervention questionnaires were not completed on the same day. Only surveying pupils present in school on the day of researcher visits risks inadvertently excluding children with long-term patterns of absence from school (either due to illness or other unauthorised absence) from the final dataset. However, as demonstrated in Chapter 3, the rate of pupil absence at each school across the research period was very low. There is also some discrepancy between the pre and post-intervention samples even in cases where both questionnaires were completed on the same day (e.g. YP on Table 6.2; SP on Table 6.3). This further reflects the flexibility of a school day, where individual children often move around the school in accordance with particular learning opportunities, such as one to one learning outside their main classroom.

The results of Q1 indicate that the majority of surveyed pupils had a basic understanding of the STEM acronym, meaning almost all of the returned questionnaires could be subject to further analysis of questions two and three. A further note is that the number of children at NB who answered Q1 correctly was lower *after* the first intervention than it was prior to the archaeological STEM engagement (Table 6.1 and Table 6.2). This result demonstrates how the time-lapse between the first and second interventions and completing questionnaires at NB may have impacted participants' ability to respond to the questionnaire effectively. This finding supports the decision to not subject certain NB data to any further analysis (the results to question one are presented here for the sake of completeness).

School	Pre-intervention 1			Post-intervention 1		
	Q1 answered	Q1 unanswered	Total responses	Q1 answered	Q1 unanswered	Total responses
BF	11 100%		11	11 100%		11
BG	27 46%	32 54%	59	56 98%	1 2%	57
NB	60 100%		60	53 93%	4 7%	57
SP	70 99%	1 1%	71	65 96%	3 4%	68
YP	29 97%	1 3%	30	30 100%		30
Total participants	**197** **85%**	**34** **15%**	**231**	**215** **96%**	**8** **4%**	**223**

Table 6.1: Participant responses to Q1 on pre-intervention 1 and post-intervention 1 questionnaires.

School	Pre-intervention 2			Post-intervention 2		
	Q1 answered	Q1 unanswered	Total responses	Q1 answered	Q1 unanswered	Total responses
BF	4 50%	4 50%	8	7 88%	1 12%	8
BG	50 89%	6 11%	56	51 93%	4 7%	55
NB	59 97%	2 3%	61	58 98%	1 2%	59
SP	66 94%	4 6%	70	70 97%	2 3%	72
YP	26 96%	1 4%	27	26 100%		26
Total participants	**205** **92%**	**17** **8%**	**222**	**212** **96%**	**8** **4%**	**220**

Table 6.2: Participant responses to Q1 on pre and post-intervention 2 questionnaires.

School	Pre-intervention 3			Post-intervention 3		
	Q1 answered	Q1 unanswered	Total responses	Q1 answered	Q1 unanswered	Total responses
BF	9 90%	1 10%	10	10 100%		10
BG	50 89%	6 11%	56	56 100%		56
NB	58 92%	5 8%	63	55 92%	5 8%	60
SP	64 91%	6 9%	70	63 95%	3 5%	66
YP	27 93%	2 7%	29	28 97%	1 3%	29
Total participants	**208** **91%**	**20** **9%**	**228**	**212** **96%**	**9** **4%**	**221**

Table 6.3: Participant responses to Q1 on pre and post-intervention 3 questionnaires.

6.1.2 Question Two: What do you think about STEM? Tick the box that matches your opinion.

Question two was made up of six separate statements for participants to consider; results are presented in six sections according to those statements. Each section outlines results for the relevant pre and post-intervention questionnaire. Sample size differs between some statement responses, even on the same set of questionnaires. This is due to respondents' decisions to leave a section blank, or unclear responses (e.g. ticking both 'yes' and 'maybe' for one statement). Q2 data for 'All schools' is combined throughout these sections, but is disaggregated by school in instances where individual school data shows a change that is not visible in the entire sample data. Q2 data was tested for significance using the Mann Whitney U test and significance threshold was set at p=0.05 (Table 6.4, see Chapter 3 for further details). Samples with fewer than 30 participants are not recommended for statistical analysis within the Social Sciences (Cohen *et al.* 2013, 101); those smaller than this can generate patterns that appear substantial, but in fact reflect only a few individuals' change in opinion (Gorard 2001, 17). Data from YP (with frequently fewer than 30 participants) will be discussed, but are heavily caveated by the acknowledgement of this phenomenon. Data from BG is also impacted by this, as the dataset from the first questionnaire is only 27, but is 50+ for the rest of the project. Schools with very few participants (e.g. BF n= <10) are unsuitable for individual statistical analysis.

In the case of questionnaires returned by NB participants, only those completed before and after intervention 3 were included in the 'All schools' dataset (Figure 6.1, Figure 6.6, Figure 6.8, Figure 6.9, Figure 6.11 and Figure 6.24). Potential concerns about comparing datasets which contain two different samples are addressed by the following. Where there was potential for NB data to skew the overall results, statistical tests were run twice: once with the NB data included and a second time with it excluded. There were no instances where including NB data affected the outcome in terms of statistical significance, though different p values were recorded and are indicated in the results. Additionally, NB responses to the pre-intervention 1 questionnaire are an important 'baseline' for participants' STEM perceptions. Therefore this data was included in statistical analyses considering potential change between the very start and end of the project (comparisons of pre-intervention 1 to post-intervention 3 responses). While the NB data for interventions 1 and 2 cannot be used to assess impact of the sessions, in some cases they do indicate changes to pupil perceptions within the wider context of STEM engagement in that institution. These examples are highlighted and discussed further in the following results section.

Question	Group 1	Group 2	Participants	p value	MWU
2a	Pre-intervention 1	Post-intervention 1	All excl. NB	.539	10594
2a	Pre-intervention 2	Post-intervention 2	All excl. NB	.551	10618
2a	Pre-intervention 3	Post-intervention 3	All excl. NB	.938	11718
2a	Pre-intervention 3	Post-intervention 3	All incl. NB	.757	21693
2a	Pre-intervention 1	Post-intervention 3	All incl. NB	.274	19600
2a	Pre-intervention 1	Post-intervention 3	All excl. NB	.471	10207
2a	Pre-intervention 1	Post-intervention 1	BG	.456	679
2a	Pre-intervention 3	Post-intervention 3	BG	.349	1270.5
2a	Pre-intervention 3	Post-intervention 3	NB	.451	1470
2a	Pre-intervention 3	Post-intervention 3	SP	.529	1896
2a	Post-intervention 1	Pre-intervention 2	YP	.121	299.5
2b	Pre-intervention 1	Post-intervention 3	All incl. NB	.836	20485
2b	Pre-intervention 1	Post-intervention 3	All excl. NB	.825	10498
2b	Post-intervention 1	Pre-intervention 2	NB	.070	1262
2b	Pre-intervention 2	Post-intervention 3	NB	*.019*†	1220
2b	Post-intervention 1	Pre-intervention 2	YP	*.032*†	288
2c	Pre-intervention 1	Post-intervention 3	All incl. NB	.631	20112.5
2c	Pre-intervention 1	Post-intervention 3	All excl. NB	.261	9932
2c	Pre-intervention 1	Post-intervention 3	NB	.297	1478
2c	Post-intervention 1	Pre-intervention 2	NB	.776	1518
2d	Pre-intervention 1	Post-intervention 1	All excl. NB	*<.001**	8180
2d	Pre-intervention 1	Post-intervention 3	All excl. NB	.886	20113
2d	Pre-intervention 1	Post-intervention 3	All incl. NB	.655	10031.5
2d	Pre-intervention 1	Post-intervention 1	SP	*<.001*†	1350
2d	Pre-intervention 1	Post-intervention 1	BG	.186	629
2d	Pre-intervention 1	Post-intervention 1	YP	.495	363
2d	Post-intervention 1	Pre-intervention 2	YP	.098	291
2d	Pre-intervention 2	Post-intervention 2	BG	.435	1136
2d	Pre-intervention 2	Post-intervention 2	YP	.723	317
2d	Pre-intervention 3	Post-intervention 3	YP	.938	377
2d	Post-intervention 1	Pre-intervention 2	NB	*.002*†	1053
2d	Pre-intervention 2	Post-intervention 2	NB	*.006*†	1199
2e	Post-intervention 1	Pre-intervention 2	All excl. NB	*.022**	10198
2e	Pre-intervention 2	Post-intervention 2	All excl. NB	.905	11082.5
2e	Pre-intervention 1	Post-intervention 3	All incl. NB	.166	18956
2e	Pre-intervention 1	Post-intervention 3	All excl. NB	.364	10002.5
2e	Pre-intervention 2	Post-intervention 2	BG	.563	1196
2e	Post-intervention 1	Pre-intervention 2	NB	.885	1497
2e	Post-intervention 1	Pre-intervention 2	YP	*.015**	252
2e	Pre-intervention 2	Post-intervention 2	YP	1.000	337.5
2e	Post-intervention 2	Pre-intervention 3	YP	.710	325.5
2e	Pre-intervention 3	Post-intervention 3	YP	.510	338
2e	Pre-intervention 3	Post-intervention 3	SP	.418	1861

*Table 6.4: Test for statistically significant changes Question 2 data using Mann Whitney U to compare Group 1 and Group2. *Indicates p values that remain statistically significant with Bonferroni correction. †Indicates statistically significant p values that do not require Bonferroni correction.*

Question	Group 1	Group 2	Participants	p value	MWU
2f	Pre-intervention 1	Post-intervention 1	All excl. NB	.472	10362.5
2f	Pre-intervention 2	Post-intervention 2	All excl. NB	.359	10302.5
2f	Pre-intervention 3	Post-intervention 3	All incl. NB	.905	21891
2f	Pre-intervention 3	Post-intervention 3	All excl. NB	.869	11655
2f	Post-intervention 2	Pre-intervention 3	All excl. NB	.181	10517
2f	Pre-intervention 1	Post-intervention 3	All incl. NB	.528	19609
2f	Pre-intervention 1	Post-intervention 3	All excl. NB	.141	9566.5
2f	Post-intervention 1	Pre-intervention 2	NB	.124	1292
2f	Pre-intervention 3	Post-intervention 3	NB	.634	1509
2f	Pre-intervention 1	Post-intervention 3	NB	.535	1444.5
2f	Pre-intervention 1	Post-intervention 1	YP	.560	356
2f	Post-intervention 1	Pre-intervention 2	YP	*.024*†	260.5
2f	Pre-intervention 2	Post-intervention 2	YP	.883	330.5
2f	Post-intervention 2	Pre-intervention 3	YP	.449	313.5
2f	Pre-intervention 3	Post-intervention 3	YP	.649	354

*Table 6.4 continued. *indicates p values that remain statistically significant with Bonferroni correction. †Indicates statistically significant p values that do not require Bonferroni correction.*

6.1.2.1 'I want to be a scientist when I grow up'

The number of respondents agreeing with this statement was low (less than 20%) across the entire research period (Figure 6.1). Despite an overall increase in those answering 'yes' to this statement following each intervention, these changes were not significant: Intervention 1: p= .539 MWU= 10594; Intervention 2: p= .551 MWU= 10618; Intervention 3 (NB included): p= .757 MWU= 21693; Intervention 3 (NB excluded): p= .938 MWU= 11718. The number of respondents agreeing with this statement was lower on the post-intervention 3 questionnaire than the pre-intervention 1 questionnaire, though response changes were also statistically insignificant (p= .274 MWU= 19600 [NB included]; p= .471 MWU= 10207 [NB excluded]). It appears that the majority of students remained undecided about specific 'scientist' aspirations.

At BG, the first and last interventions appear to have had an impact on positive responses to this statement (Figure 6.2). The style of learning in those two interventions may have produced a greater impact on individual students. Both the faunal analysis and aqueduct interventions had substantial elements of practical and 'hands on' learning, whereas the Climate Change intervention relied more on theoretical puzzles. However, neither of these changes were statistically significant (Intervention 1: p= .456 MWU= 679; Intervention 3: p= .349 MWU= 1270.5). In the case of the first intervention, the shift in response may reflect an increase in sample size rather than a change in opinion (n=27 to n=56).

All schools

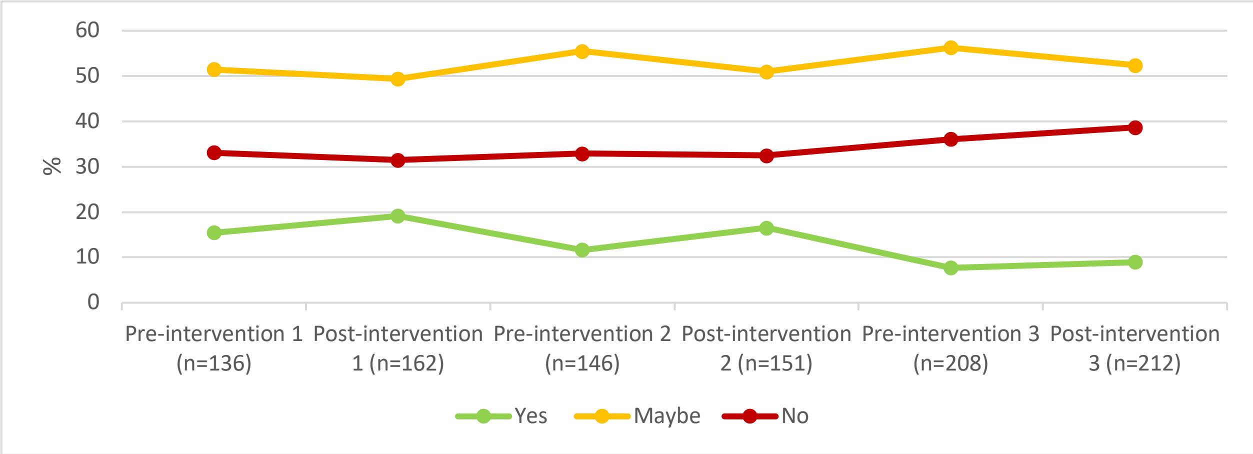


Figure 6.1: Relative percentage of responses to the statement 'I want to be a scientist when I grow up' from all questionnaires across research period. NB data included for pre/ post-intervention 3 only.

BG

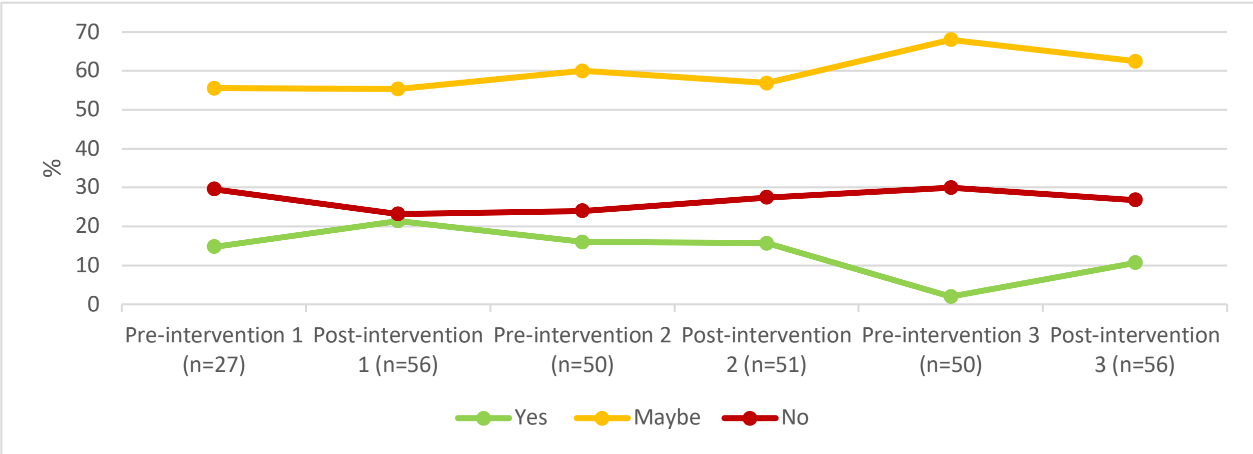


Figure 6.2: Relative percentage of responses to the statement 'I want to be a scientist when I grow up' on questionnaires from BG across the research period.

A similar impact was observed following the final intervention on the number of respondents from NB (Figure 6.3) and SP (Figure 6.4) disagreeing with this statement, which may indicate lowered enthusiasm for a science specific career following the aqueduct intervention. It is notable that pupils at these two schools experienced limited success when their aqueducts were tested. It is possible that feelings of failure following this experiment led pupils to feel less positively towards science specific aspirations. However, responses changes from both schools following Intervention 3 were not statistically significant (NB: p= .451 MWU= 1470; SP: p= .529 MWU= 1896).

Responses to this statement at YP changed substantially between post-intervention 1 and pre-intervention 2, with fewer pupils expressing agreement (Figure 6.5). This shift might highlight the need for more consistent messaging to pupils, as enthusiasm for the project may be reduced when they are not actively engaging with it[20]. Regardless of possible reasons for the apparent change in response to this statement, the shift from positive to negative responses between post-intervention 1 and pre-intervention 2 is not statistically significant (p= .121 MWU= 299.5).

[20] Though this interpretation precludes the possibility that pupils engage with STEM outside of this project.

NB

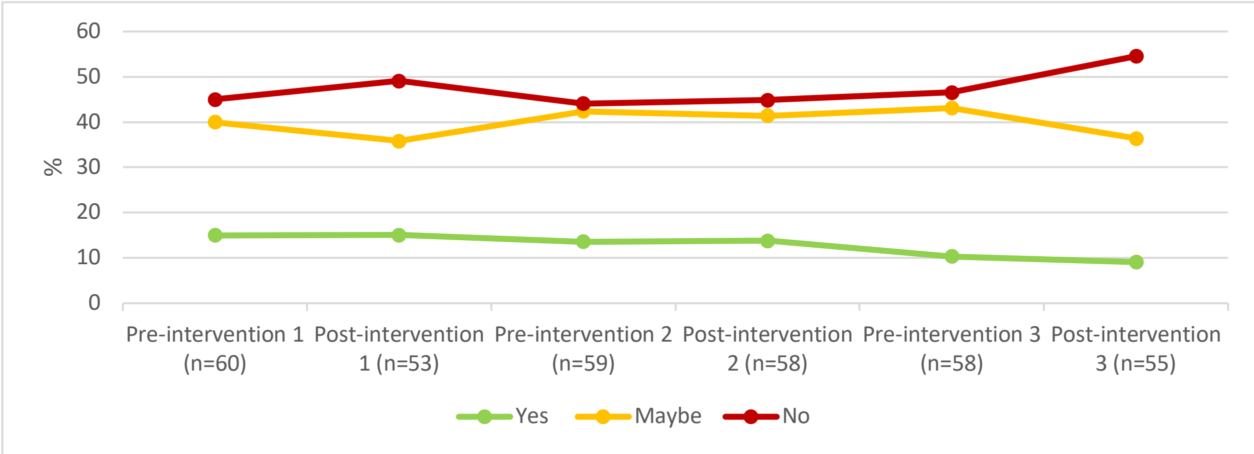


Figure 6.3: Relative percentage of responses to the statement 'I want to be a scientist when I grow up' on questionnaires from NB across the research period.

SP

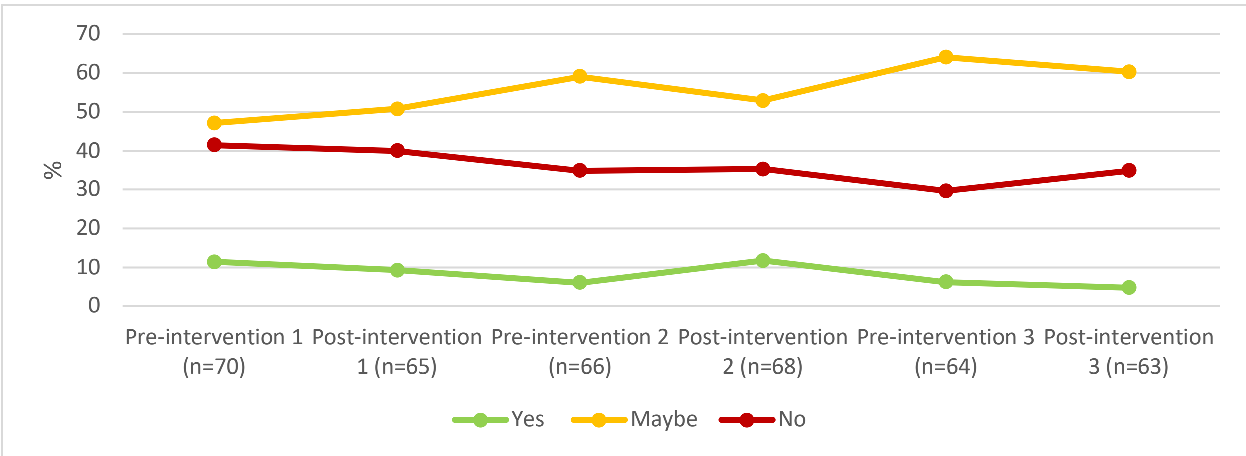


Figure 6.4: Relative percentage of responses to the statement 'I want to be a scientist when I grow up' on questionnaires from SP across the research period.

YP

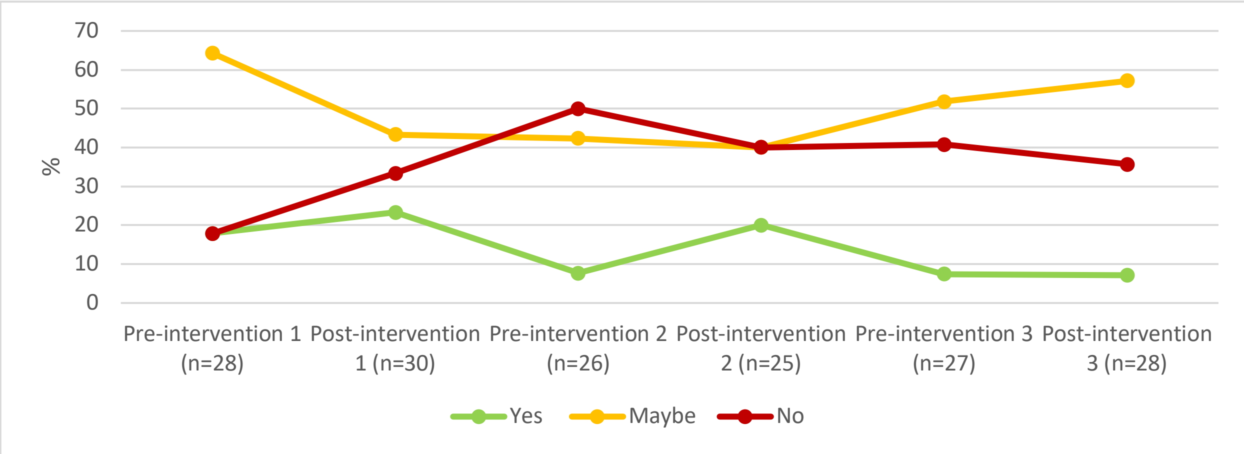


Figure 6.5: Relative percentage of responses to the statement 'I want to be a scientist when I grow up' on questionnaires from YP across the research period.

6.1.2.2 'I enjoy science lessons'

The level of agreement with this statement was high amongst pupils across the entire research period (Figure 6.6). While the interventions appear to have had little impact on responses to this question, it is clear that the majority of pupils enjoy science lessons within their schools. When all five schools are considered together, there were no statistically significant changes in participant responses to this question between the first and final questionnaires: $p = .836$ MWU= 20485 (NB included); $p = .825$ MWU= 10498 (NB excluded). Science lessons are one of the most frequent ways that young people engage with STEM in school, and these results demonstrate a generally positive (if slightly declining) perspective towards school-based science by participants of this project.

However, on an individual school level there were some changes that are worth highlighting. Although the post-intervention 1 data collected from NB participants cannot indicate the impact of the intervention on pupil perceptions, it does suggest a lower level of enthusiasm for science lessons (only 51% of pupils agreed with the statement 'I enjoy science lessons') amongst respondents at the end of January 2019 (Figure 6.7). This result is then followed up by a substantial (but statistically insignificant $p = .070$ MWU= 1220) change in opinion less than two months later on the pre-intervention 2 questionnaire. The increase in respondents who felt positive about science lessons was recorded at the end of NB's celebration of British Science Week; where pupils had undertaken a number of scientific challenges. It is likely that increased enjoyment of science lessons is a result of the focus that had been placed upon science at the school that week. Following the second intervention, pupils' reported enthusiasm for science lessons diminished significantly between the pre-intervention 2 and post-intervention 3 questionnaires ($p = .019$ MWU= 1220).

The inverse of this can be seen in the data from YP (Figure 6.8), where between the post-intervention 1 and pre-intervention 2 questionnaires, the percentage of pupils agreeing with this statement dropped significantly ($p = .032$ MWU: 288). This may reflect a change in participants' experiences of science lessons between the first and second interventions, resulting in lower confidence in the question of whether they enjoy science lessons.

All schools

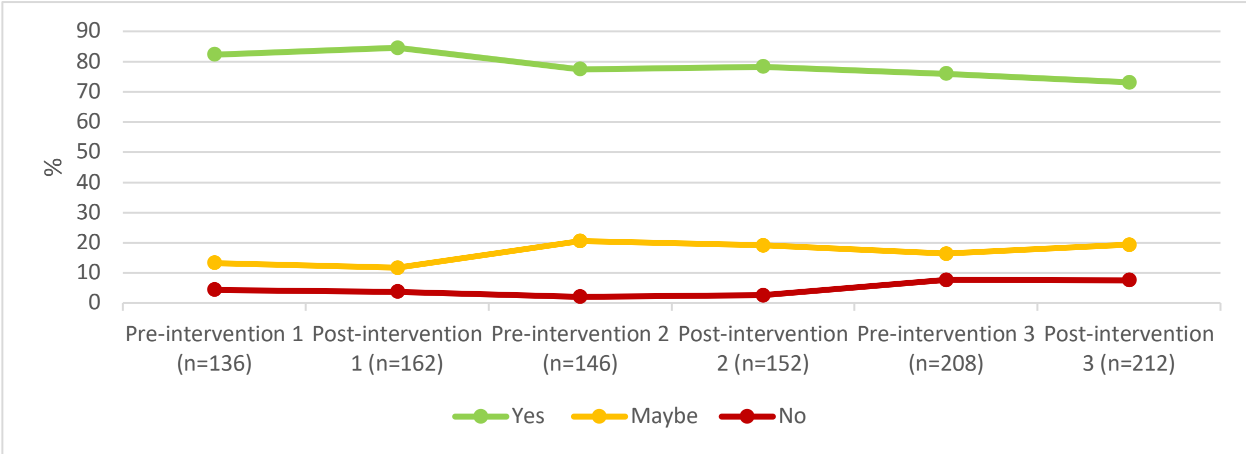


Figure 6.6: Relative percentage of responses to the statement 'I enjoy science lessons' from all questionnaires across research period. NB data included for pre/ post-intervention 3 only.

NB

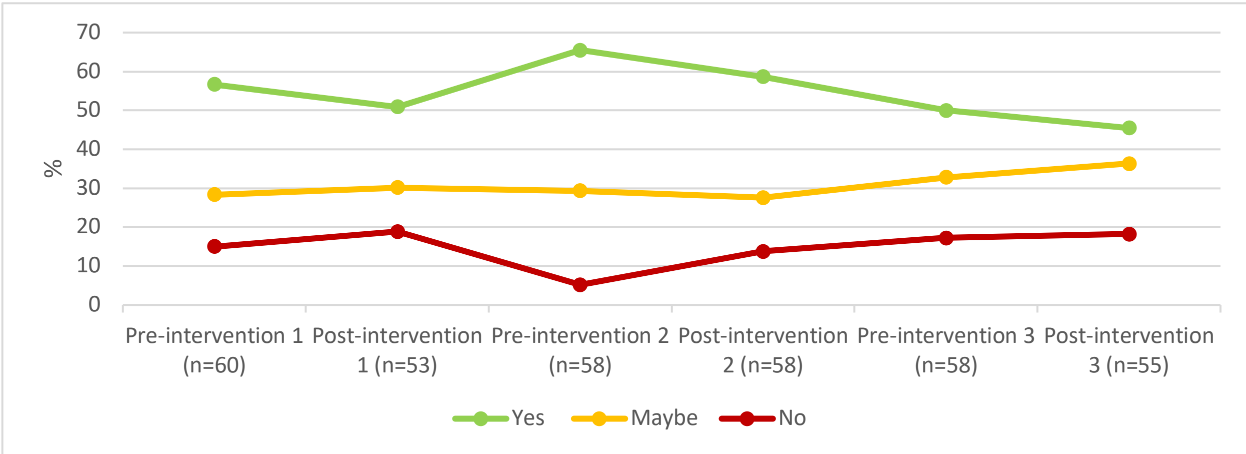


Figure 6.7: Relative percentage of responses to the statement 'I enjoy science lessons' on questionnaires from NB across research period.

YP

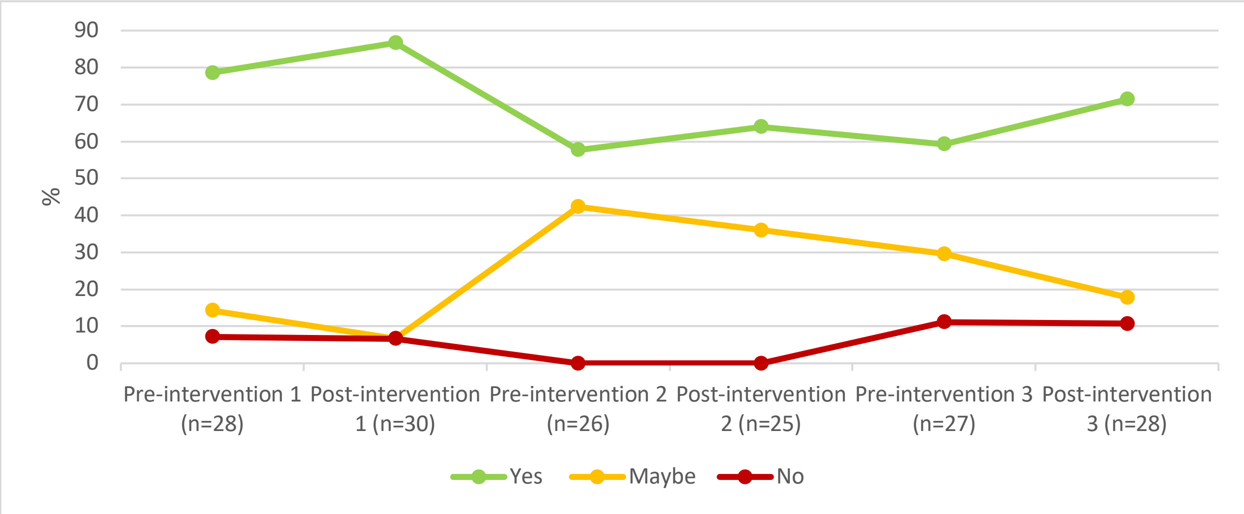


Figure 6.8: Relative percentage of responses to the statement 'I enjoy science lessons' on questionnaires from YP across research period.

6.1.2.3 'I enjoy maths lessons'

There was very little variation in responses to this statement across the entire research period (Figure 6.9). The majority of pupils consistently reported enjoying maths lessons, and those that were unsure or did not enjoy maths lessons were equally consistent in their response. There was no significant change in response to this statement between the pre-intervention 1 and post-intervention 3 questionnaires: p= .631 MWU= 20112.5 (NB included); p= .261 MWU= 9932 (NB excluded). This finding is similar to the previous one regarding science lessons: participants of this study are largely engaging with school-based STEM in a positive way.

When the data is disaggregated by school, two schools stand out: BG and NB. BG pupils' reported enjoyment of maths lessons was consistently higher than the average seen across the entire group of participants. Throughout the main research period, 'yes' responses to this statement ranged from 67%-71% (Figure 6.9), whereas within the BG cohort it was 85%-95% (Figure 6.10). The NB data reveals a much less consistent response to this question, but does appear to show a steady increase in pupil enthusiasm for maths lessons across the academic year (Figure 6.11). However, the apparent increase in positive ('yes') NB responses to the subject of maths lessons between the pre-intervention 1 and post-intervention 3 questionnaires is statistically insignificant (p= .297 MWU= 1478). The rise in reported enjoyment of maths lessons at NB between post-intervention 1 and pre-intervention 2 questionnaires is not statistically significant (p= .776 MWU= 1518).

All schools

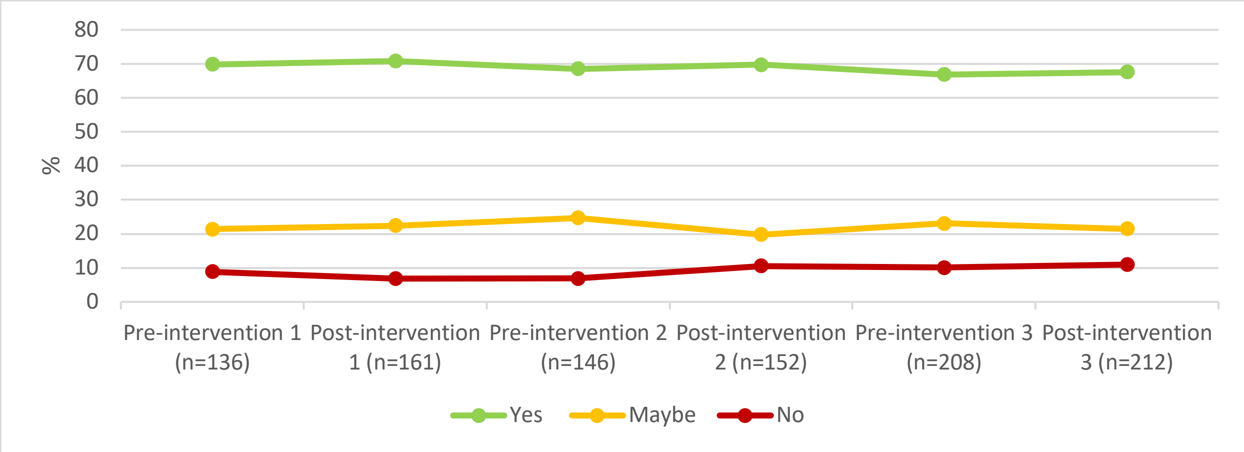


Figure 6.9: Relative percentage of responses to the statement 'I enjoy maths lessons' from all questionnaires across research period. NB data included for pre/ post-intervention 3 only.

BG

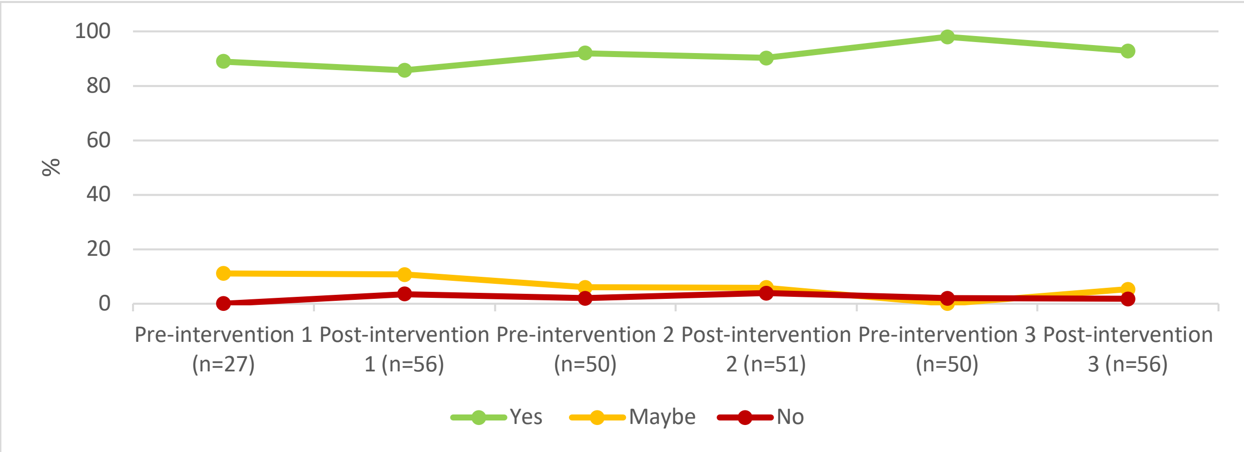


Figure 6.10: Relative percentage of responses to the statement 'I enjoy maths lessons' on questionnaires from BG across research period.

NB

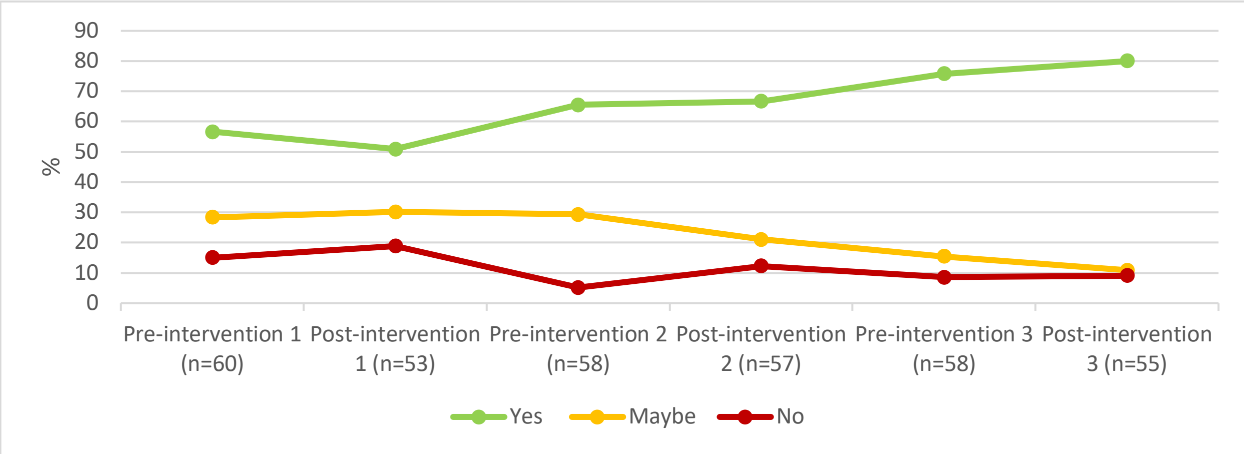


Figure 6.11: Relative percentage of responses to the statement 'I enjoy maths lessons' on questionnaires from NB across research period.

6.1.2.4 *'STEM is an important part of my life'*

Following the first archaeological intervention the percentage of participants agreeing with this statement doubled (Figure 6.12), representing a statistically significant shift in perception between pre-intervention 1 and post-intervention 1 questionnaires (p= <.001 MWU= 8180 [NB excluded]). However this change in perception was not long-term, and pupil responses returned to 'pre-intervention' levels on the pre-intervention 2 questionnaire. Neither intervention 2 or 3 elicited a similar shift in perception of this statement at any of the sampled schools. In addition to this, there was no significant difference in response to this statement between the pre-intervention 1 and post-intervention 3 questionnaires: p= .886 MWU= 20113 (NB included); p= .655 MWU= 10031.5 (NB excluded). It appears that the archaeological interventions had an extremely limited impact on the way in which participants perceived the importance of STEM to their lives. By the end of the research period the majority of pupils were unsure of the relevance of STEM to their lives.

When this data is disaggregated by school, it appears that the main driver of the positive change in opinion came from the pupils at SP, where 'yes' responses more than doubled (p= .<001 MWU= 1350) between the pre-intervention 1 and post-intervention 1 questionnaires (Figure 6.13). The increase in positive response to this statement is present in other institution-specific datasets, but to a much lesser extent. Both BG (Figure 6.14) and YP (Figure 6.15) shifts in response to this statement were insignificant (BG: p= .186 MWU= 629; YP: p= .495 MWU= 363). There was no observable change in response from the 11 BF respondents following the first intervention (Figure 6.16).

All schools

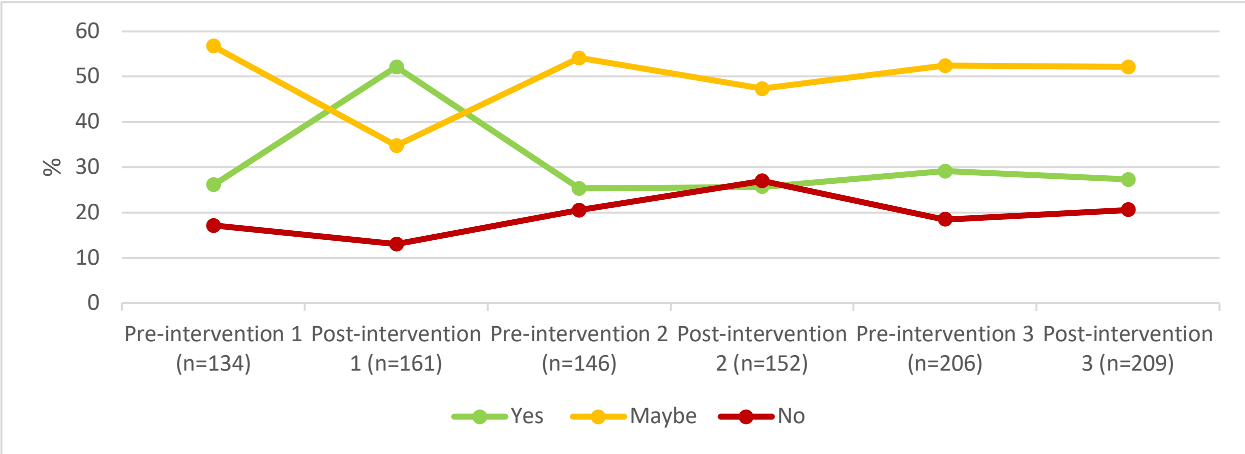


Figure 6.12: Relative percentage of responses to the statement 'STEM is an important part of my life' from all questionnaires across research period. NB data included for pre/ post-intervention 3 only.

SP

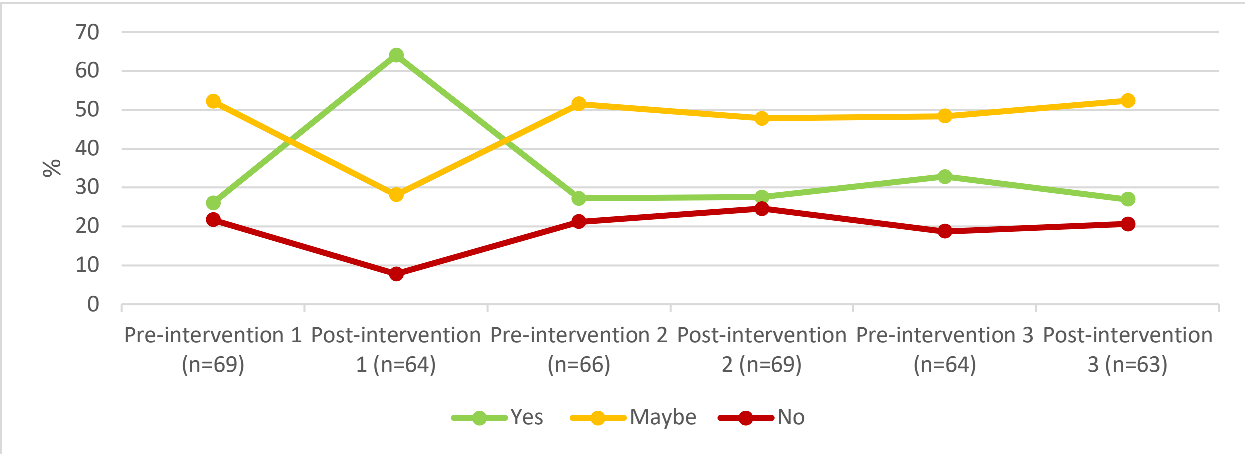


Figure 6.13: Relative percentage of responses to the statement 'STEM is an important part of my life' on questionnaires from SP across research period.

BG

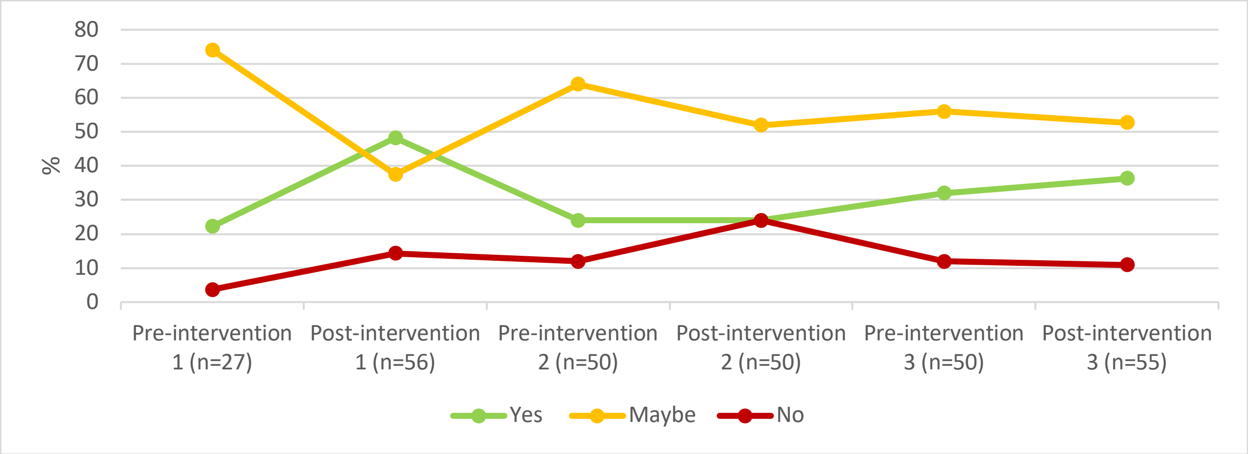


Figure 6.14: Relative percentage of responses to the statement 'STEM is an important part of my life' on questionnaires from BG across research period.

YP

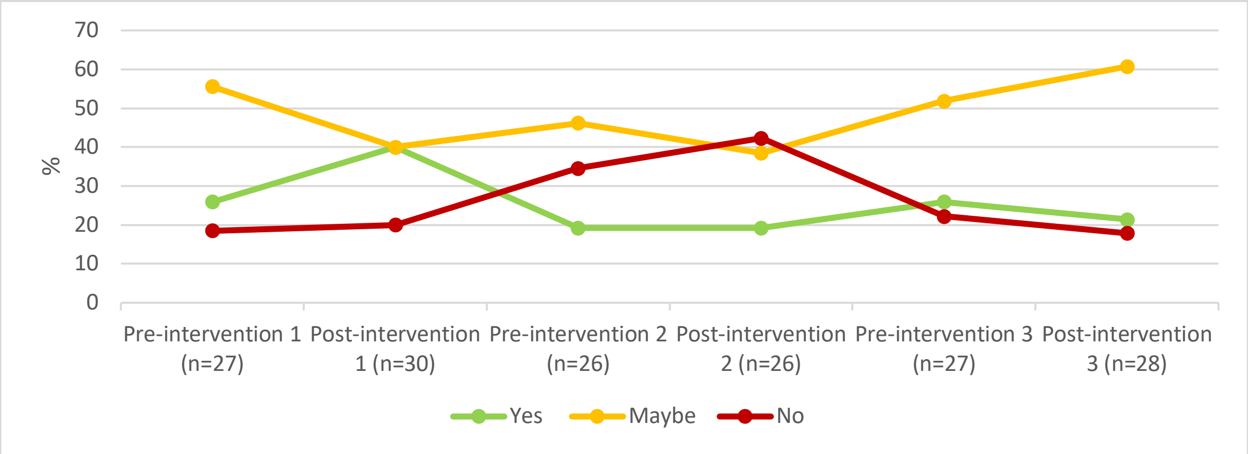


Figure 6.15: Relative percentage of responses to the statement 'STEM is an important part of my life' on questionnaires from YP across research period.

BF

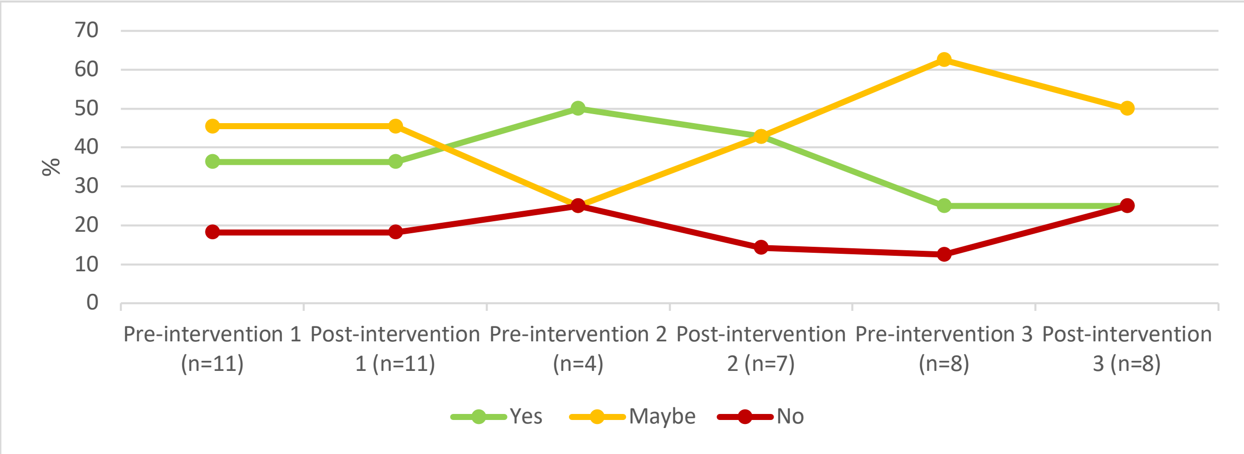


Figure 6.16: Relative percentage of responses to the statement 'STEM is an important part of my life' on questionnaires from BF across research period.

NB

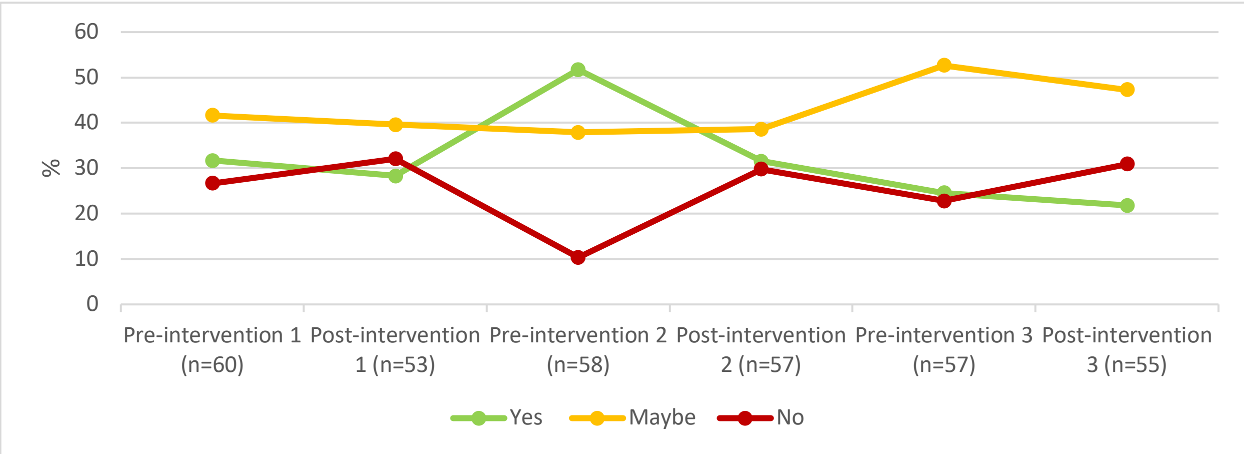


Figure 6.17: Relative percentage of responses to the statement STEM is an important part of my life' on questionnaires from NB across research period.

A decline in positive responses in the YP data between the post-intervention 1 and pre-intervention 2 questionnaires was statistically insignificant (p= .098 MWU= 291). Interventions 2 and 3 had a limited impact on responses to the question of STEM's importance to participants' lives when the data is divided by school. A slight rise in 'no' responses between pre-intervention 2 and post-intervention 2 questionnaires at BG and YP suggests that the session had a negative impact on pupils' perceptions of this statement (Figure 6.14 and Figure 6.15). However, neither of these increases were statistically significant (BG: p= .435 MWU= 1136; YP: p= .723 MWU= 317). A rise in 'maybe' responses between pre-intervention 3 and post-intervention 3 questionnaires at YP suggests that pupils were less certain of their feelings towards this statement after this session, however this response change was not statistically significant either (p= .938 MWU= 377). The increase in 'maybe' responses combined with a decline in both positive and negative responses between pre-intervention 2 and post-intervention 2 questionnaires at BF indicates that pupils were less sure of the importance of STEM to their lives after undertaking the session (Figure 6.17). The third intervention appears to have a different effect, where pupils became more certain of their feelings towards this statement resulting in a rise in negative responses between pre-intervention 3 and post-intervention 3 questionnaires. However, the number of respondents from BF is very small and it is not possible to draw robust conclusions from this data.

The data from NB for this statement may not be suitable to examine the effects of interventions 1 and 2 on pupil perceptions, but it does once again highlight the potential impact of NB's celebration of British Science Week (Figure 6.17). The percentage of pupils agreeing with this statement increased significantly (p= .002 MWU= 1053) between the end of January 2019 (post-intervention 1 questionnaire) and the end of Science Week (pre-intervention 2 questionnaire), followed by a significant drop (p= .006 MWU= 1199) in agreement a few weeks later (post-workshop 2 questionnaire, which was completed in the weeks following the second intervention). This finding is an additional indication of the apparent short-term nature of the impact that individual interventions have on pupils' STEM perceptions.

6.1.2.5 *'I would like to learn more about STEM in the future'*

Responses to this statement did not change substantially following the first intervention (Figure 6.18). There was however, a significant change in participant response to this statement between post-intervention 1 and pre-intervention 2 questionnaires (p= .022 MWU= 10198). The second intervention failed to have an impact upon participants' enthusiasm for learning more about STEM in the future, though the slight rise in pupil uncertainty between pre-intervention 2 and post-intervention 2 data is not statistically significant (p= .905 MWU= 11082.5 [NB excluded]). The final intervention had an equally limited impact on pupil responses to this statement. While enthusiasm for learning about STEM in the future amongst participants appears slightly decreased by the end of the research period, the shift in response between pre-intervention 1 and post-intervention 3 data is not statistically significant: p=.166 MWU= 18956 (NB included); p= .364 MWU= 10002.5 (NB excluded).

The impact of the second intervention on pupils responding 'maybe' to this statement appears even more pronounced in some schools when they are considered as individual institutions. Both BF (Figure 6.19) and BG (Figure 6.20) appear to have a substantial rise in participants who responded 'maybe' to the question of studying STEM in the future between pre-intervention 2 and post-intervention 2 questionnaires. It may be the case that the style and content of Intervention 2 was less appealing to pupils, resulting in their uncertainty as to whether they would wish to engage with STEM again in the future. However, the data from BF ought to be treated with extreme caution due to the sample size, and the shift in responses at BG was not statistically significant (p= .563 MWU= 1196).

All schools

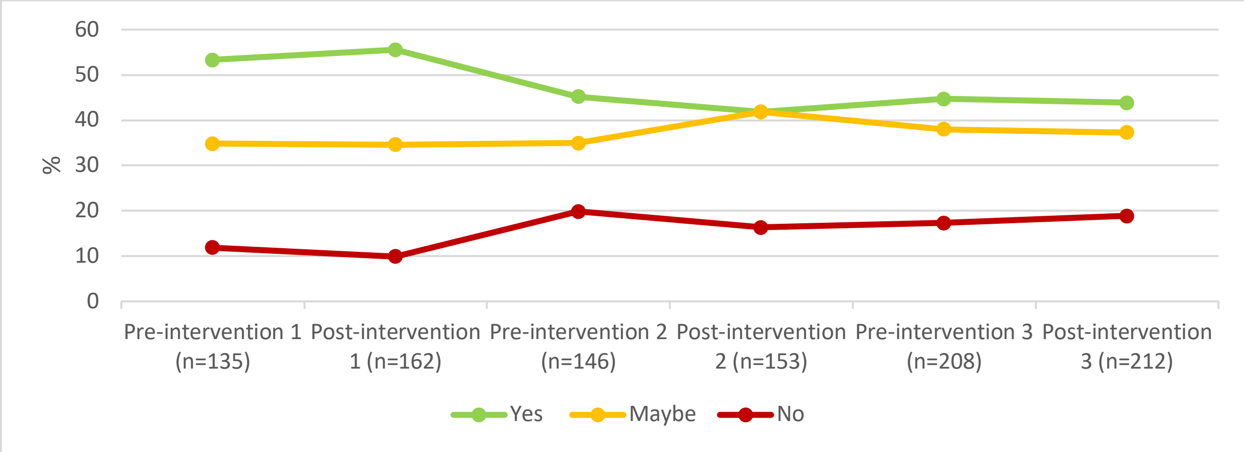


Figure 6.18: Relative percentage of responses to the statement 'I would like to learn more about STEM in the future' from all questionnaires across research period. NB data included for pre/ post-intervention 3 only.

BF

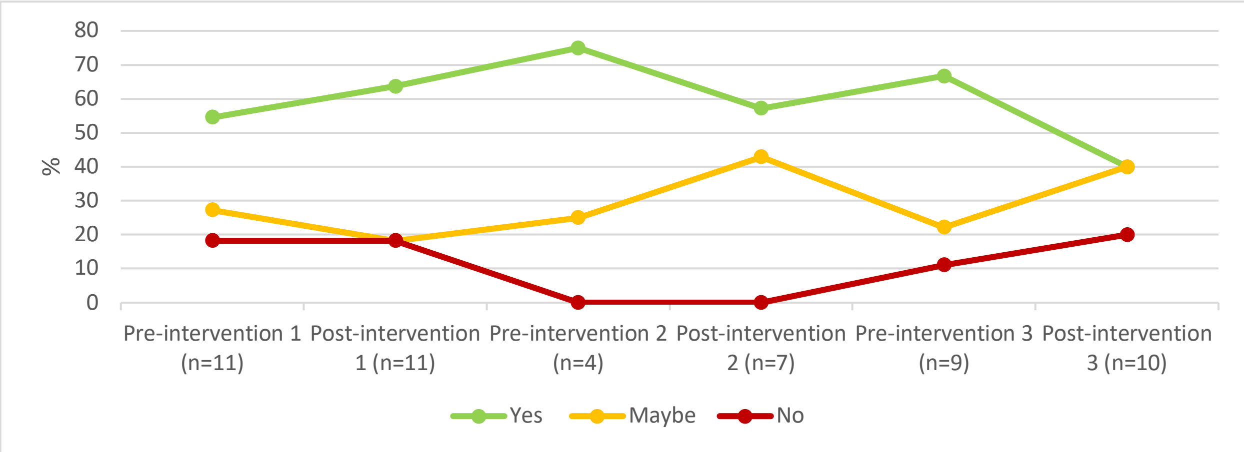


Figure 6.19: Relative percentage of responses to the statement 'I would like to learn more about STEM in the future' on questionnaires from BF across the research period.

BG

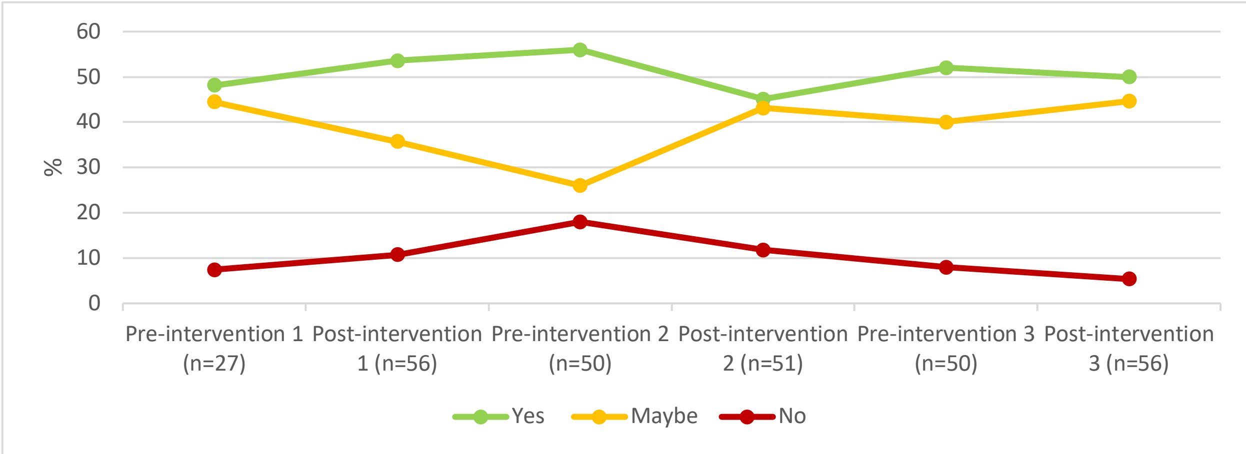


Figure 6.20: Relative percentage of responses to the statement 'I would like to learn more about STEM in the future' on questionnaires from BG across the research period.

The potential impact of NB's British Science Week (BSW) celebration on this statement can be observed in the NB dataset (Figure 6.21), although the change here is to the 'maybe' responses between post-intervention 1 and pre-intervention 2 questionnaires, which saw a minor increase ($p= .885$ MWU= 1497). A significant drop ($p= .015$ MWU= 252) in YP pupils responding 'yes' to this statement between the first and second intervention was observed (Figure 6.22), though the rise in pupils responding 'maybe' at the end of their second intervention is not replicated in this dataset. Instead it appears that following Intervention 2 pupils were more certain of their desire to learn about STEM in the future (whether positive or negative), though this change was not statistically significant ($p= 1$ MWU= 337.5). There was another rise in 'maybe' responses between the second and third interventions ($p= .710$ MWU= 325.5), followed by an increase in 'yes' responses after the third intervention ($p= .510$ MWU= 338).

At SP the final intervention resulted in an increase of participants responding 'no' to this statement between the pre-intervention 3 and post-intervention 3 questionnaires (Figure 6.23). As highlighted above in section 6.1.2.1, a number of SP pupils had limited success with their aqueduct design, which may have resulted in more negative feelings towards participating in STEM in the future. However, this change in perception is not statistically significant ($p= .418$ MWU= 1861).

NB

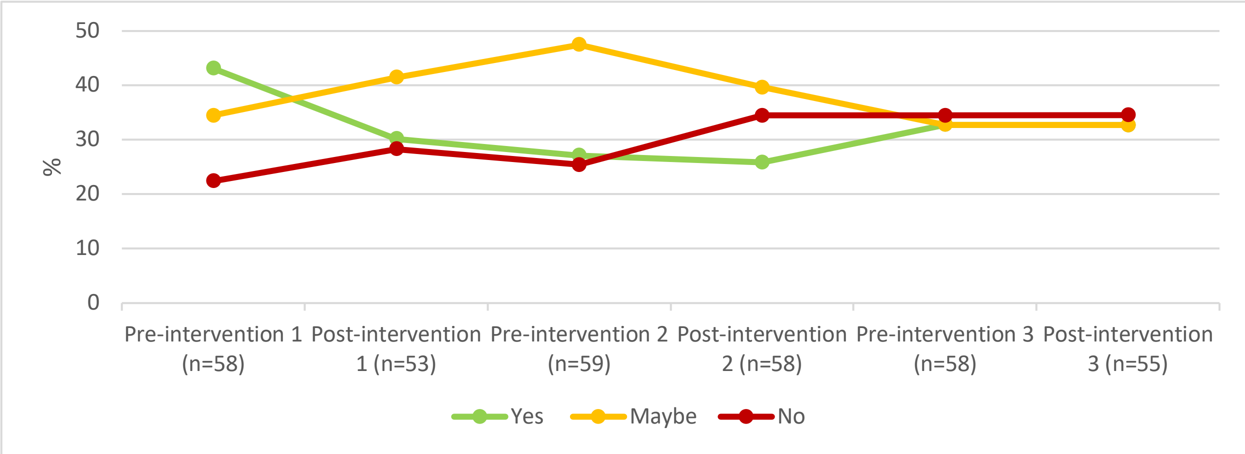


Figure 6.21: Relative percentage of responses to the statement 'I would like to learn more about STEM in the future' on questionnaires from NB across the research period.

YP

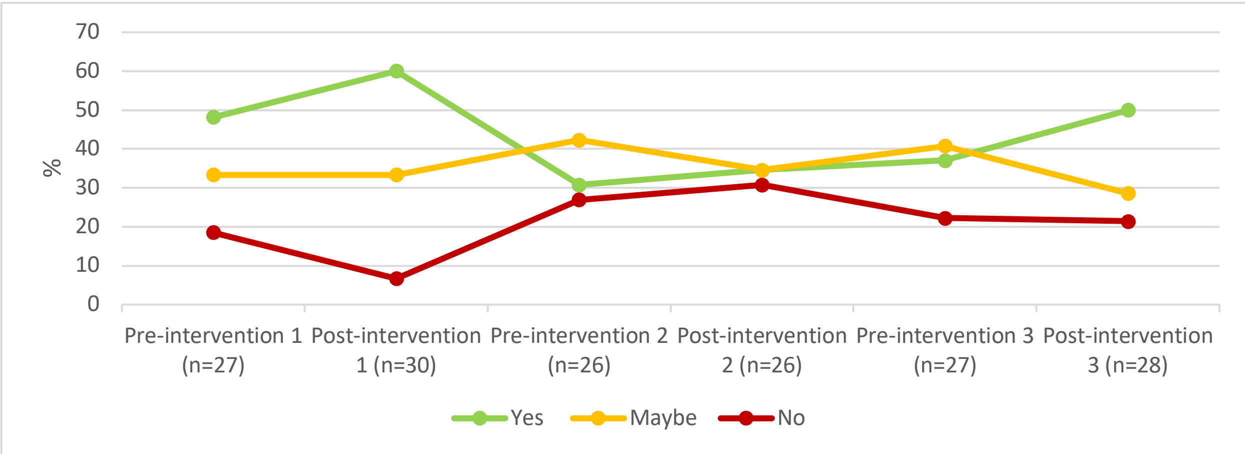


Figure 6.22: Relative percentage of responses to the statement 'I would like to learn more about STEM in the future' on questionnaires from YP across the research period.

SP

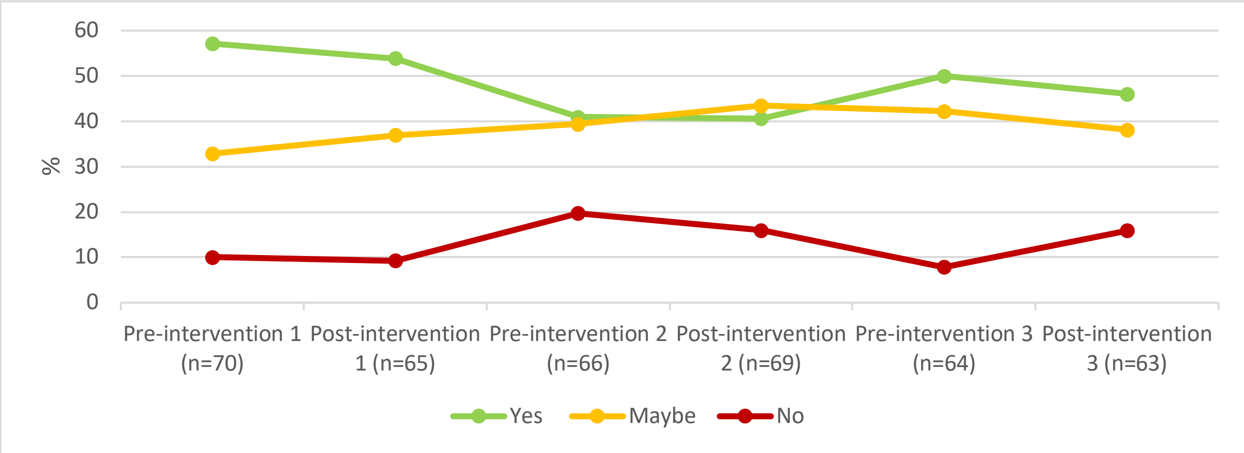


Figure 6.23: Relative percentage of responses to the statement 'I would like to learn more about STEM in the future' on questionnaires from SP across the research period.

6.1.2.6 'I would like to use STEM in my job when I'm older'

The majority of pupils responded 'maybe' to this statement response throughout the entire research period (Figure 6.24). A small increase in 'yes' responses to this statement between each pre and post-intervention questionnaire is apparent, though these changes were not statistically significant: Intervention 1 p= .472 MWU= 10362.5; Intervention 2 p= .359 MWU= 10302.5; Intervention 3 (NB included) p= .905 MWU= 21891; Intervention 3 (NB excluded) p= .869 MWU= 11655. There was a moderate increase in 'maybe' responses between post-intervention 2 and pre-intervention 3 data, however these two figures cannot be accurately compared as the NB dataset is only considered in the pre-intervention 3 responses. When NB data is not considered, the apparent increase in 'maybe' response between these two questionnaires is statistically insignificant (p= .181 MWU= 10517). There was no significant change in pupil response between the pre-intervention 1 questionnaire and post-intervention 3 questionnaire: p= .528 MWU= 19609 (NB included); p= .141 MWU= 9566.5 (NB excluded).

NB's celebration of British Science Week appears to have impacted responses to this statement, as indicated by a rise in positive responses from the end of January to Intervention 2 in March (Figure 6.25). While a greater percentage of pupils answered 'yes' to the question of using STEM in their job when they're older, this change was not statistically significant (p= .124 MWU= 1292) and was relatively short-lived. The slight rise in 'yes' responses to this statement following the third intervention is statistically insignificant (p= .634 MWU= 1509). There was no significant change in opinion between the first (pre-intervention 1) and last (post-intervention 1) set of data collected for this school (p= .535 MWU= 1444.5).

The data from YP for this statement appears to show substantial shifts in opinion following and in between each intervention (Figure 6.26). Pupils appeared more certain in their responses (positive or negative) to this statement after undertaking each intervention, and then became less certain of their feelings in the interim between each intervention. The increase in positive responses to this statement between the pre-intervention 1 and post-intervention 1 questionnaires suggests that the first intervention may have had an impact on pupils' STEM aspirations, but this shift in opinion was not statistically significant (p= .560 MWU= 356). The subsequent steep decrease in 'yes' (p= .024 MWU= 260.5) responses to this question recorded before intervention 2, indicates that pupils' enthusiasm for STEM careers was diminished in the time between the two interventions.

All schools

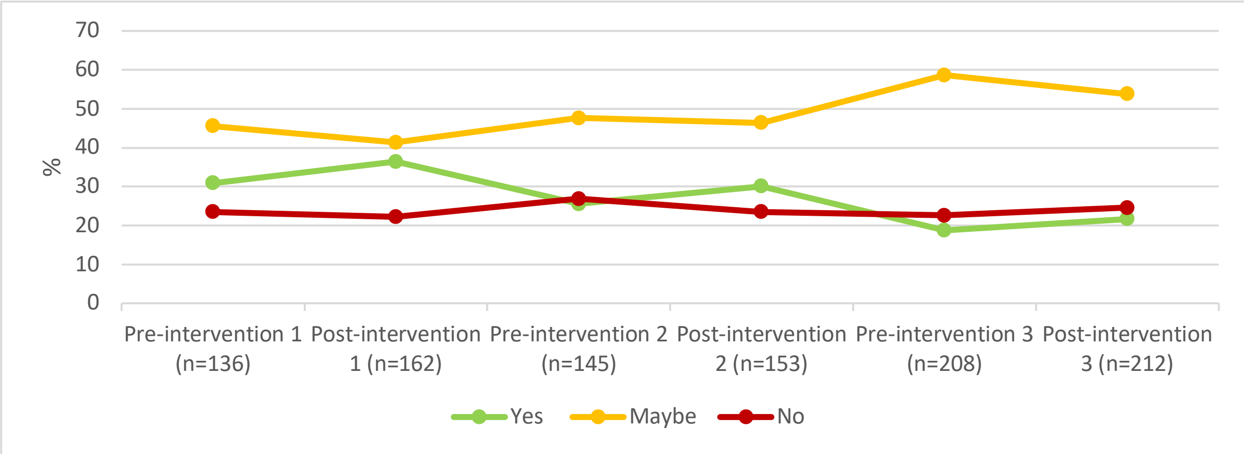


Figure 6.24: Relative percentage of responses to the statement 'I would like to STEM in my job when I'm older' from all questionnaires across research period. NB data included for pre/ post-intervention 3 only.

NB

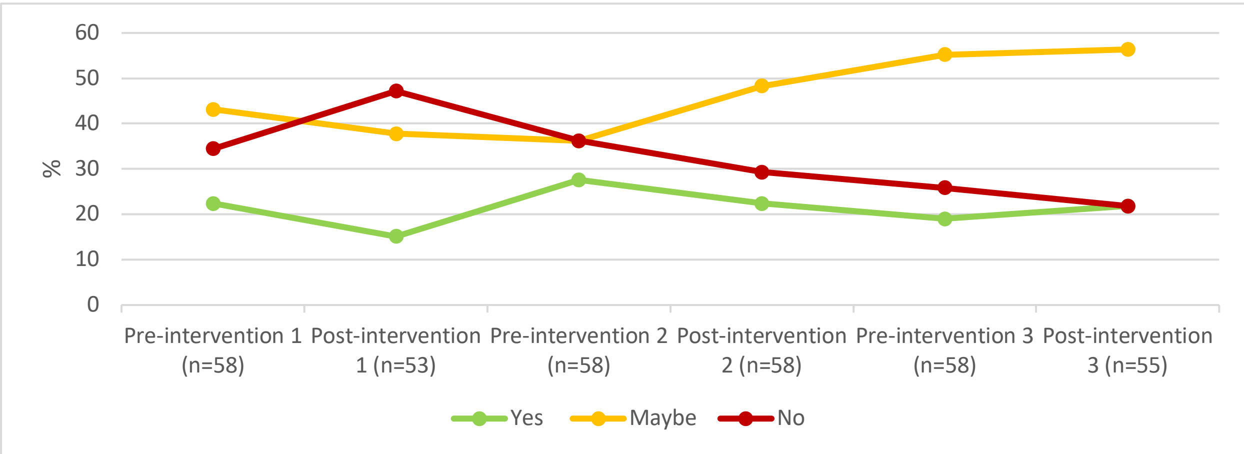


Figure 6.25: Relative percentage of responses to the statement 'I would like to use STEM in my job when I'm older' on questionnaires from NB across the research period.

The decrease in ‘maybe’ YP responses between pre and post-intervention 2 questionnaires suggests that the session enabled pupils to answer the question of pursuing STEM in their future careers more decisively (Figure 6.26). However, this shift was statistically insignificant (p= .883 MWU= 330.5). The apparent continuation of this pattern of rising and falling uncertainty amongst respondents is also statistically insignificant. There is no statistical significance in the increase in ‘maybe’ responses between post-intervention 2 and pre-intervention 3 data (p= .449 MWU= 313.5) or in the subsequent drop in ‘maybe’ responses between pre-intervention 3 and post-intervention 3 data (p= .649 MWU= 354). These apparently large yet statistically insignificant shifts in opinion are likely due to the small number of participants in the YP dataset.

YP

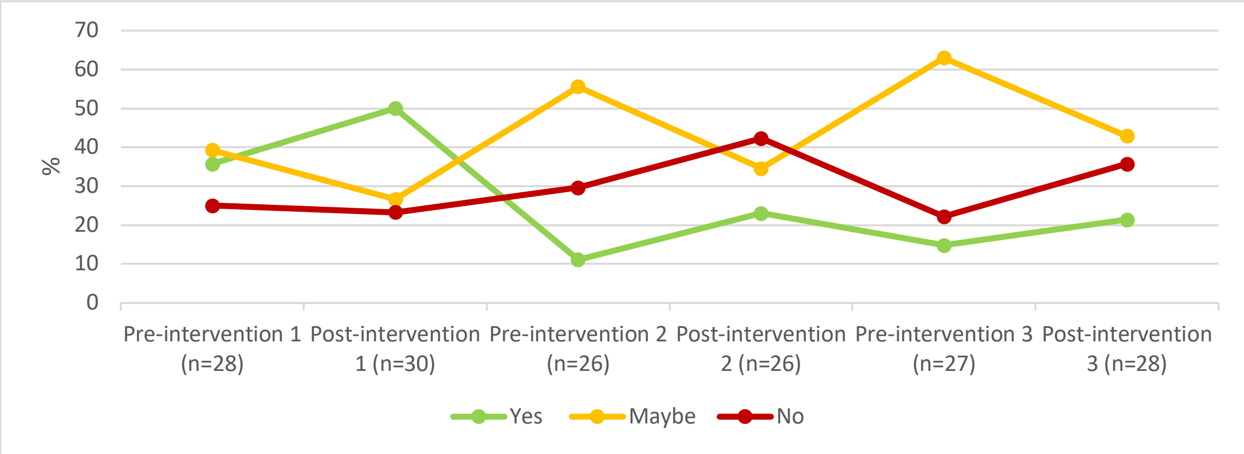


Figure 6.26: Relative percentage of responses to the statement 'I would like to use STEM in my job when I'm older' on questionnaires from YP across the research period.

6.1.3 Question Three: STEM skills

This question was framed differently on the pre and post-intervention questionnaires to encourage reflective practice after each session. Before undertaking each intervention, pupils circled skills they felt were most important for a person working in STEM and following each intervention they circled skills they had used in that session. It was anticipated that by doing this pupils would recognise how a wide range of skills are useful in the pursuit of STEM, and also develop an understanding of how their own attributes might be valuable in the pursuit of STEM. As each question asked something different, they are dealt with separately in this section. Pre-intervention responses from NB pupils were considered in this analysis, as those pupils experienced the same interventions as the rest of the sample and so were in an equally informed position to give their opinions before each intervention. However, the questionnaires completed by NB pupils following the first and second intervention are *not* analysed here, as those responses were not given immediately following each session and were completed in the following weeks instead. NB questionnaires following the third intervention *are* considered below.

*6.1.3.1 'Which **three** skills do you think **are the most important** for someone working in STEM? Circle the skills you think they will need'*

As this question was framed slightly differently the first time it was answered (see Chapter 3, section 3.4.3.1), only responses from the second and third intervention are directly compared, although the initial questionnaire also reveals broadly comparable trends, which are outlined here. Intervention 2 and 3 questionnaires with more than three responses circled for question 3 were not included in this analysis. On the initial questionnaire, the majority of pupils (n=165) elected to circle five or more skills (Table 6.5), which produced relatively unnuanced results (Figure 6.27). However, even within this restricted data it is clear that some skills were more frequently perceived as valuable. Over 70% of respondents selected 'logical thinking', 'problem solving', 'working as a team' and 'investigation', whereas 'imagination' was the least frequently selected skill (selected by 44% of respondents, Figure 6.27). 'Curiosity', 'independent working', 'organisation' and 'creativity' were also chosen less frequently; all four skills were selected by 55% (or fewer) of respondents.

No. skills circled	12	11	10	9	8	7	6	5	4	3	2	1	0
No. pupils	24	12	15	24	21	24	25	20	14	9	2	5	2
% pupils	12	6	8	12	11	12	13	10	7	5	1	3	1

Table 6.5: Breakdown of how many skills were circled by pupils from all participating schools in their pre-intervention 1 questionnaire.

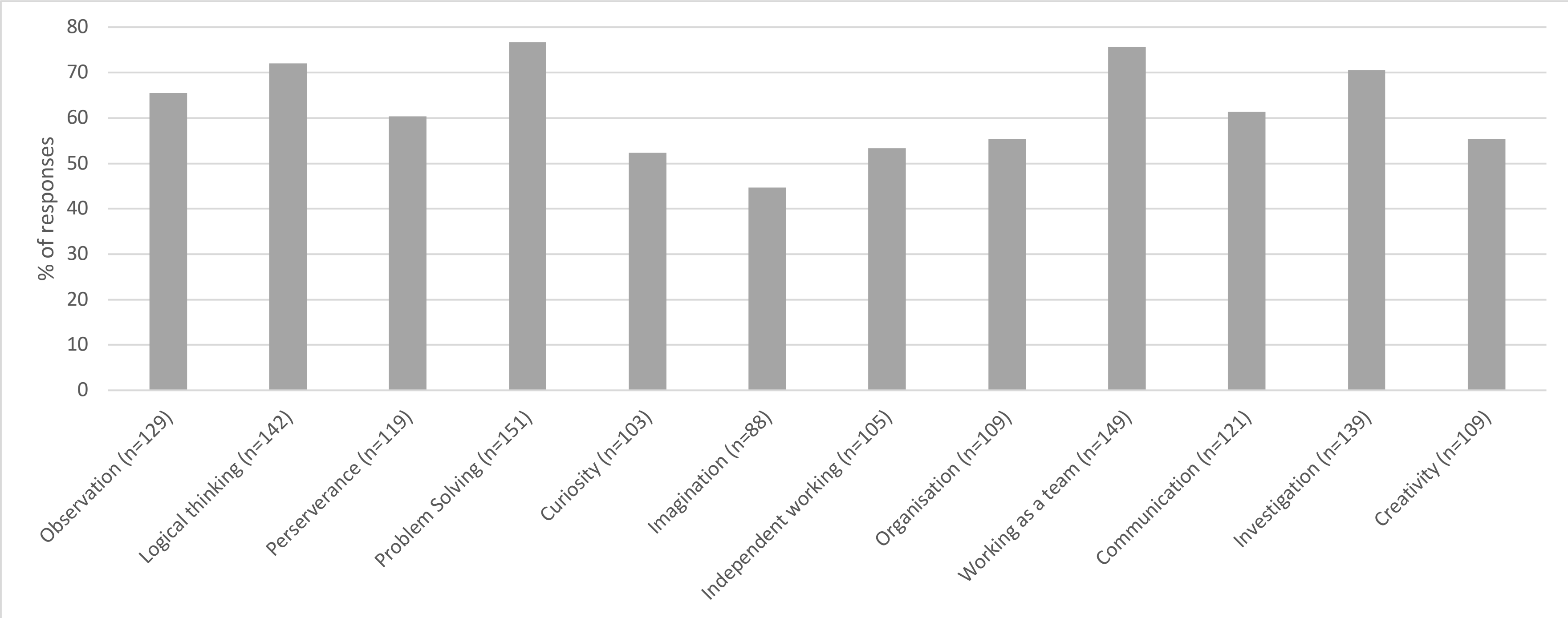


Figure 6.27: Relative percentage of skills that were selected by respondents from all participating schools as being 'most important for someone working in STEM' in pre-intervention 1 questionnaire.

Responses to the pre-intervention 2 and 3 questionnaires were directly compared as respondents were asked to complete the same task: to circle three skills that they felt were 'the most important to a person working in STEM'. This data was collected in three separate stages across three academic terms: Autumn, Spring and Summer. Therefore, pre-intervention questionnaires 2 and 3 cannot demonstrate any specific effect of the interventions that came before them. Instead they provide insight into potential long-term effect of pupils reflecting on their STEM practice.

Directing pupils to circle only three skills on the pre-intervention 2 and 3 questionnaires produced distinct differences between which skills were most frequently selected (Figure 6.28). These results followed a similar pattern to the initial questionnaire: 'logical thinking', 'problem solving' and 'working as a team' remained the most frequently selected traits, though 'investigation' was less frequently circled. 'Curiosity', 'imagination', 'independent working' and 'organisation' remained some of the least frequently selected skills, and though the percentage of pupils circling 'creativity' did decrease, this was not seen to the same extent as these other skills. Organisation was the least frequently circled trait, indicating that few pupils placed it in the 'Top 3' skills for a STEM worker (Figure 6.28). It is apparent that asking pupils to consider the importance of STEM skills more carefully (i.e. a maximum of 3 skills) revealed a more nuanced picture of how these skills were perceived by participants. There were some observable differences in how frequently particular skills were considered to be 'most important' between the second and third intervention. 'Observation', 'problem solving' and 'communication' all shifted in how often they were perceived as important by pupils before their second and third interventions. However, none of these changes were statistically significant, and no significant changes were present for any of the remaining nine skills (Table 6.6).

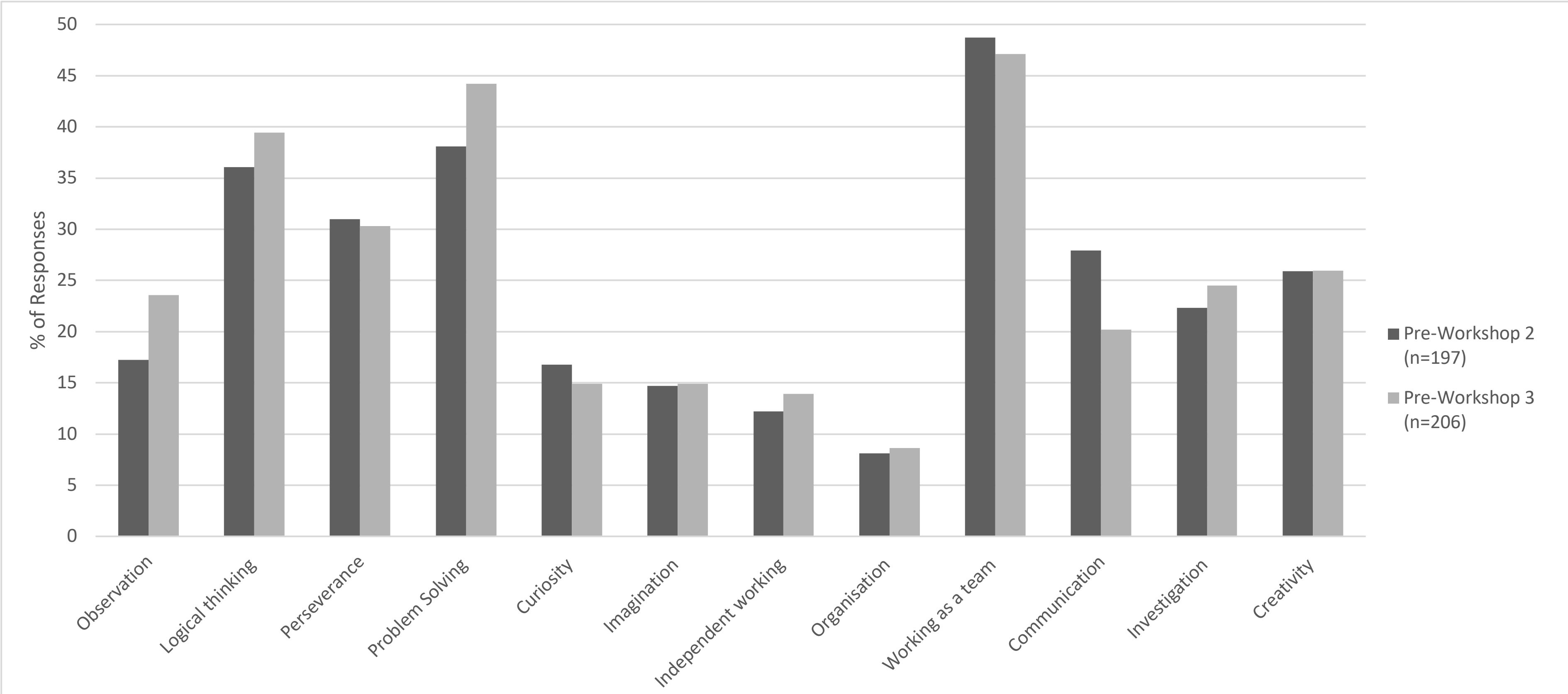


Figure 6.28: Relative percentage of skills that were selected by respondents from all participating schools as being 'most important for someone working in STEM' in pre-intervention 2 and 3 questionnaires. Pupils were instructed to choose three skills from a possible 12.

Skill or aptitude	p value	Chi-square
Observation	0.105	2.624
Logical thinking	0.436	0.606
Perseverance	0.934	0.007
Problem Solving	0.180	1.802
Curiosity	0.640	0.219
Imagination	0.926	0.009
Independent Working	0.574	0.317
Organisation	0.824	0.049
Teamwork	0.816	0.054
Communication	0.077	3.125
Investigation	0.567	0.328
Creativity	0.941	0.006

Table 6.6: Test for statistically significant changes Question 3 data using Chi-squared to compare pre-intervention 2 and pre-intervention 3 data.

*6.1.3.2 'Which STEM skills did **<u>you use</u>** in the archaeology intervention? Circle all the skills you used'*

This question asked participants to reflect on their practice during the intervention by considering which of the STEM skills they had used (Figure 6.29). There was no limit to how many skills individuals could circle. As NB pupils did not complete their post-intervention questionnaires immediately following intervention 1 and 2, those responses are not included in this analysis. Only their responses to the post-intervention 3 questionnaire are considered. It was hoped that by reviewing the skills used in each session, students would develop a wider understanding of which skills might be useful for a STEM career and how those skills might be applied. For example, it might not be immediately obvious to a person how to bring creativity or imagination into science (Hadzigeorgiou and Fotinos 2007, 15), but they may more easily do so after repeatedly identifying it within their own practice. In addition to this, by reviewing their work through the lens of 'STEM specific skills', pupils may be more likely to identify which of their own abilities are suited to a future in STEM, and may encourage them to consider how STEM might be appropriate for '*people like me'* (Archer *et al.* 2013, 18; MacDonald 2014, 26).

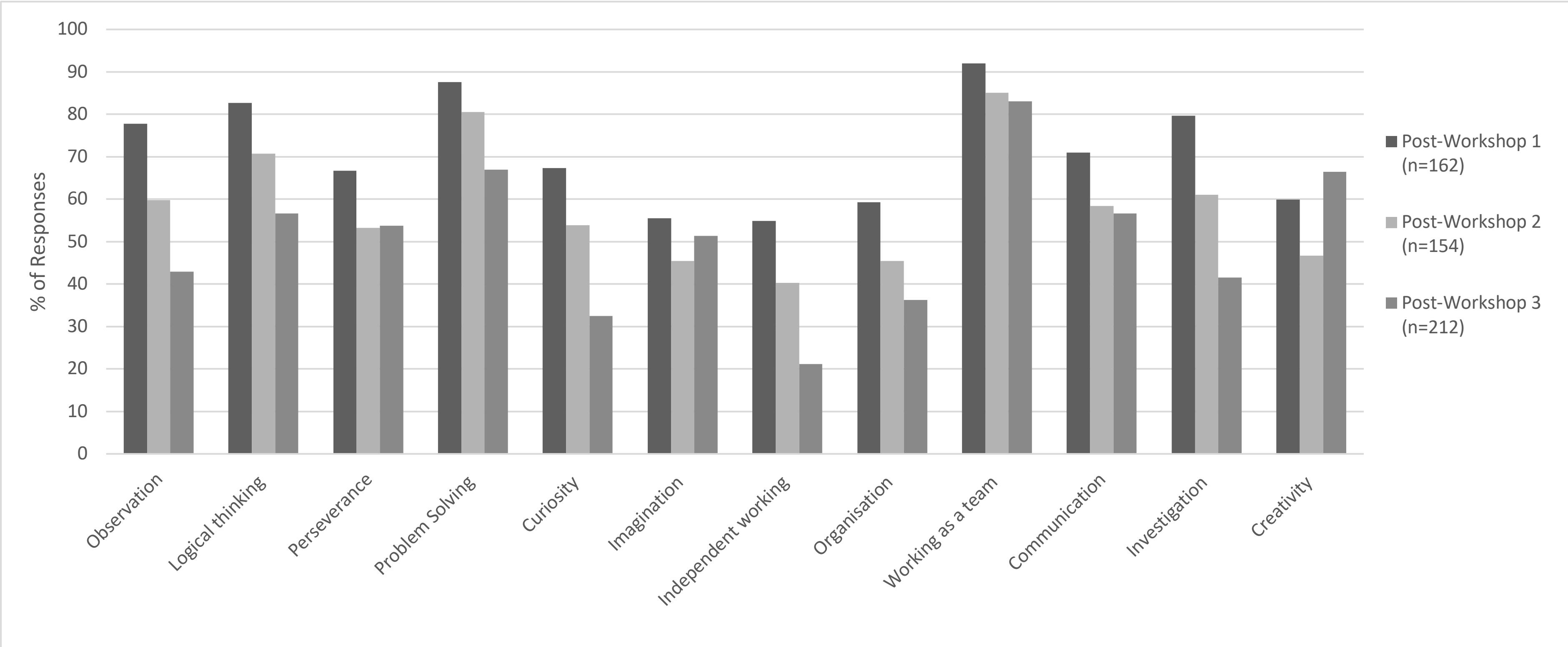


Figure 6.29: Relative percentage of skills that were selected by respondents in response to the question 'Which skills did you use in the archaeology intervention?' on post-intervention questionnaires. NB data is included in post-intervention 3 results only.

Although respondents were not restricted in how many skills they could circle for this exercise, there appears to be a reduction in the number of skills circled in the post-intervention 2 and 3 questionnaires. It is possible that encouragement to be more discerning on their pre-intervention questionnaires, led children to think more carefully about their use of skills also. There is some indication of a trend in which skills pupils most frequently identified as being used in each intervention. ‘Problem solving’, ‘working as a team’ and ‘logical thinking’ were selected most often as skills that pupils felt they had used, aside from the third intervention, where pupils chose ‘creativity’ more frequently than ‘logical thinking’. The least frequently selected skills were ‘organisation’, ‘imagination’ and ‘independent working’, though following the third intervention, pupils selected ‘curiosity’ less often than ‘imagination’.

Responses to this question reveal the efficacy of each intervention in terms of whether pupils felt they had used the skills that were intended. ‘Working as a team’ was consistently reported as being used by a large proportion of participants (Int.1: 92%, Int.2: 85% and Int.3: 83% of pupils reported using this skill, Figure 6.29), which is unsurprising as each intervention had a heavy focus on group and partner work. Almost every task given to the pupils required them to consult with others on their table or in their team. Use of ‘problem solving’ and ‘investigation’ was also widely reported by pupils, particularly for the faunal analysis and climate change interventions where pupils were presented with explicit investigations and problems to solve (see Chapter 5). It is interesting that ‘investigation’ was less commonly reported by pupils following the aqueduct intervention (42%), which followed an investigation format (see Chapter 5). However, pupils were not specifically told that that they were doing *was* an investigation, and they may have perceived the activity as a different kind of task (e.g. a creative activity). ‘Problem solving’ was widely selected in the aqueduct intervention (67%), which is likely a reflection of the problems pupils encountered during the construction of their aqueducts. The researcher observed many pupils grappling with issues in their designs (e.g. difficulty in connecting or attaching specific elements), and rotated around each group asking questions to prompt problem solving (e.g. “how will you make sure water doesn’t come out of this part?”).

‘Curiosity’ might readily be associated with ‘investigation’ and ‘problem solving’, but pupils reported having used this skill much less frequently across all interventions, particularly the third one. This skill can also be interpreted as a feeling, so while pupils may be compelled to investigate or problem solve by a set task, their actions may not have been matched by a feeling of curiosity. ‘Curiosity’ was one of the least frequently reported skills following the aqueduct session (33%), despite the fact that this intervention was intended to provide many opportunities to express curiosity. However, it appears that many pupils did not consider their practice through the lens of 'curiosity' and instead perceived it in a different way (e.g. 'problem solving').

'Observation' followed a similar pattern to 'investigation' in that it was more commonly reported by pupils in the first two interventions (78% and 60%) than the third (43%). Opportunities for observation were present throughout all three interventions in the form of: watching videos, observing differences during bone identification, observing patterns in pollen representation, and peer reviewing aqueducts. While the peer review of aqueduct structures was intended to be a crucial element of the third intervention, it appears that pupils did not view it as 'observation' and infrequently reported having performed this skill. This may be partly due to how the aqueduct tests were conducted, particularly at NB, where both participating classes (n= 63) ran tests at the same time. While pupil enthusiasm for testing their own aqueduct was high at all schools, observation of others' structure tests was often obstructed by the bodies surrounding each aqueduct.

This does not reveal the whole picture: where pupils at NB may have found it difficult to observe each other's work in such a large group, it might be assumed that BF pupils (n= 23) would not have experienced this. Disaggregating the results to Q3 by school reveals that BF students reported using this skill less often than any of the other participating schools: only one of ten respondents indicated that they had used observation in the session (Figure 6.30). This finding highlights the complexity of relying on self-reflection as a method to convey a message about skill usage: this can only be successful if the participant is cognisant of the skills that they have used. There is also a chance that pupils considered the skills in terms of relative use, and felt that observation was only a minor element of their practice in that intervention.

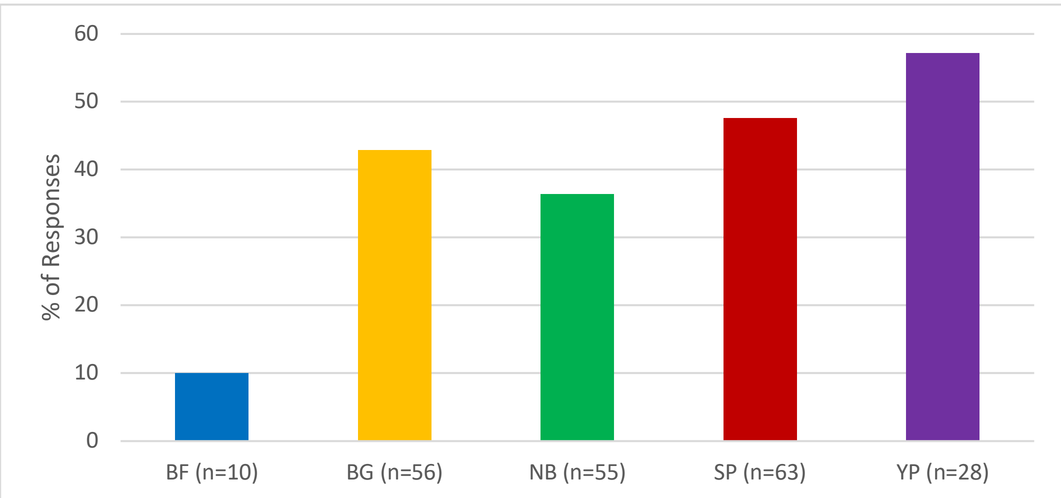
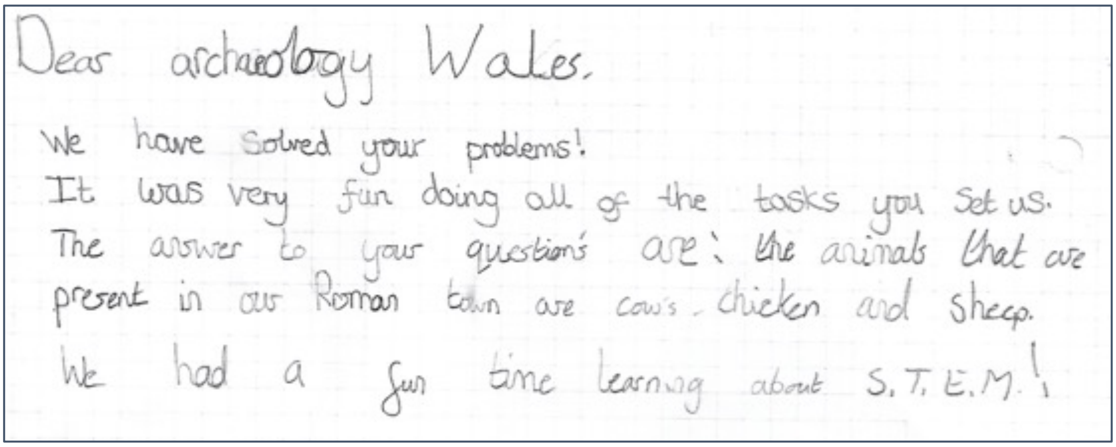


Figure 6.30: Relative percentage of pupils who circled 'observation' on their post-intervention 3 questionnaire.

Reported use of ‘communication’ was relatively consistent across all three interventions; over half of all participants indicated that they had used this skill in all three sessions. Inclusion of the ‘pupil voice’ was a key component of intervention design, with many tasks framed around discussions and interactions with peers. For example, the climate change intervention required pupils to consult multiple information sources simultaneously, and the aqueduct intervention assigned pupils individual but interlinking roles within their teams. The success of both tasks was dependent on pupils communicating effectively with each other.

‘Perseverance’ was also reported at similar levels across all three interventions; a likely reflection of the novel challenges presented in each session. Pupils were asked to engage with ideas that they were unlikely to have encountered before (e.g. animal bone/ pollen identification), and so may have persevered with unusual and complex tasks. The researcher also observed many pupils’ perseverance during the aqueduct intervention, as most designs required multiple construction attempts. While the percentage of pupils selecting this skill in the final intervention was lower than in the first (54% compared to 67%) and only marginally higher than in the second (53%), in terms of ranked frequency of skills within each session it is the highest (6 out of 12, as opposed to 8 out of 12 in Interventions 1 and 2). This may be the result of discussions in each class following their aqueduct tests, where participants reflected on areas for improvement in each design, and the researcher emphasised the role of perseverance within the working world of STEM.

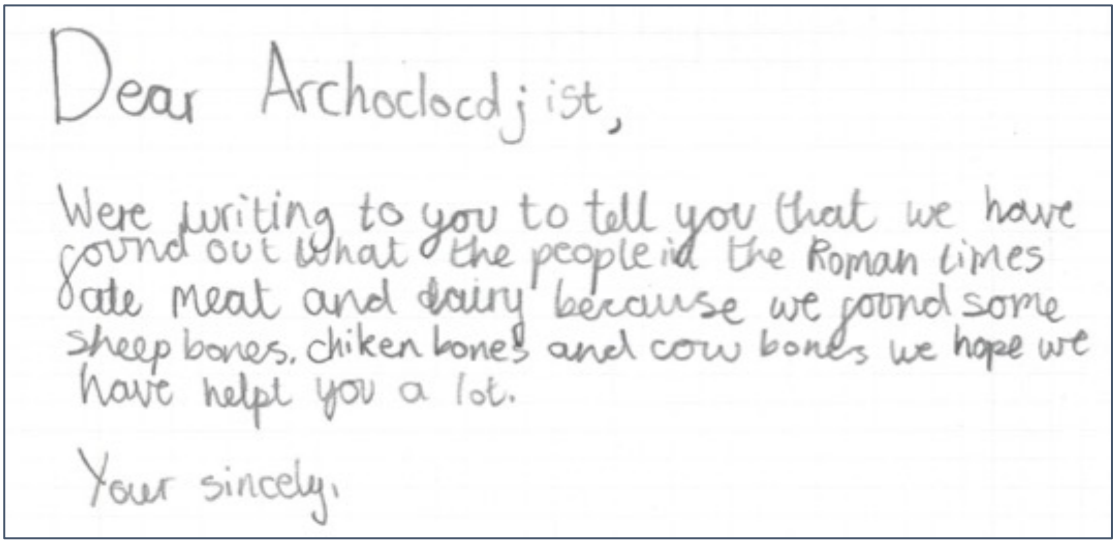
‘Creativity’ was one of the least frequently reported skills in the first and second interventions (fewer than 50% of pupils felt that they had used ‘creativity’ in their climate change session). The final activity of the faunal analysis intervention was a creative task, where pupils were asked to summarise the results of their analysis. It was anticipated that pupils would utilise creative writing and drawing to disseminate their research, which many of them did (Figure 6.31 to Figure 6.34). In addition to this task, pupils found other unexpected ways to express creativity in their work. Examples include the creation of ‘creatures’ out of animal bones (Figure 6.35), unusual ways of labelling a diagram of a human skeleton (Figure 6.36), and elaborately decorated graphs (Figure 6.37).



Dear archaeology Wales.

We have Solved your problems!
It was very fun doing all of the tasks you Set us.
The answer to your question's are: the animals that are present in our Roman town are cow's, chicken and sheep.
We had a fun time learning about S.T.E.M!

Figure 6.31: A letter from pupils at SP to Archaeology Wales, written as part of their faunal analysis intervention.



Dear Archoclocdjist,

Were writing to you to tell you that we have found out what the people in the Roman times ate meat and dairy because we found some sheep bones, chiken bones and cow bones we hope we have helpt you a lot.

Your sincely,

Figure 6.32: A letter from pupils at NB to archaeologists, written as part of their faunal analysis intervention.

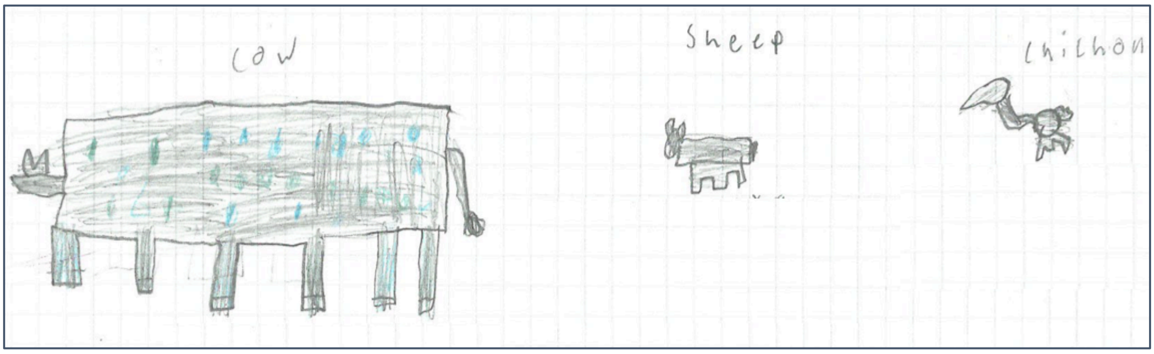


Figure 6.33: A drawing to show the types of animal present at a Roman town, drawn by a pupil at SP in their faunal analysis intervention.

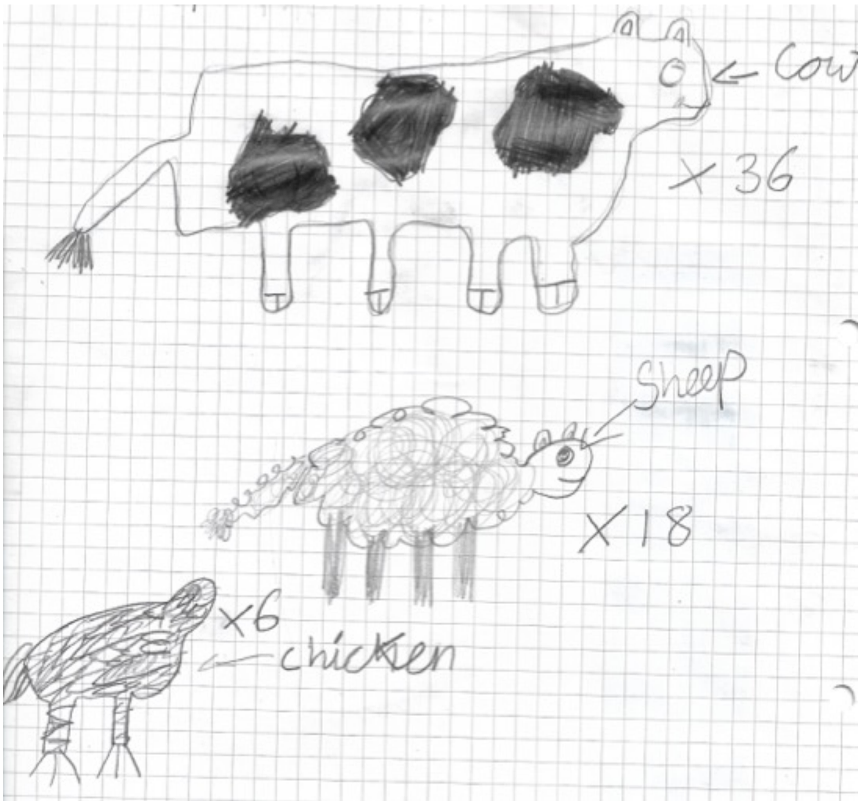


Figure 6.34: An infographic to show the number of specimens identified in a Roman town, drawn by a pupil at YP during their faunal analysis intervention.

Figure 6.35: A fantastical 'creature' made from animal bones, created by a pupil from BF in their faunal analysis intervention.

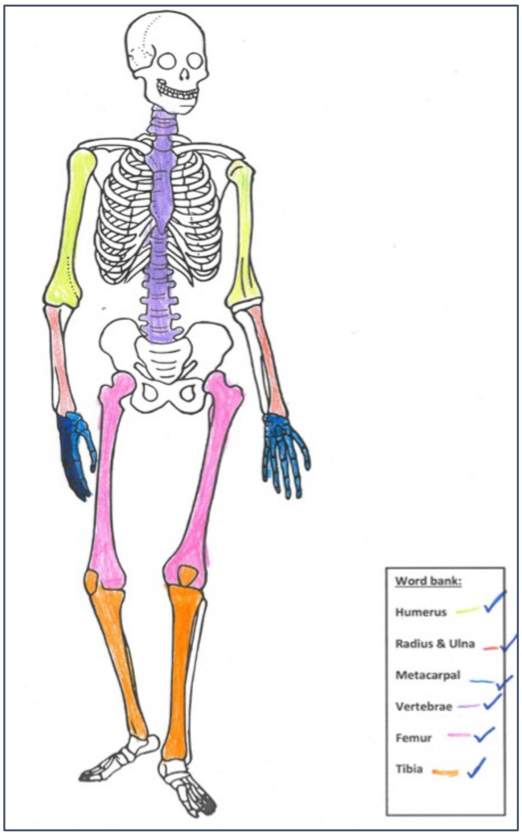


Figure 6.36: A creative way of labelling a skeleton diagram, done by a pupil from NB in their faunal analysis intervention.

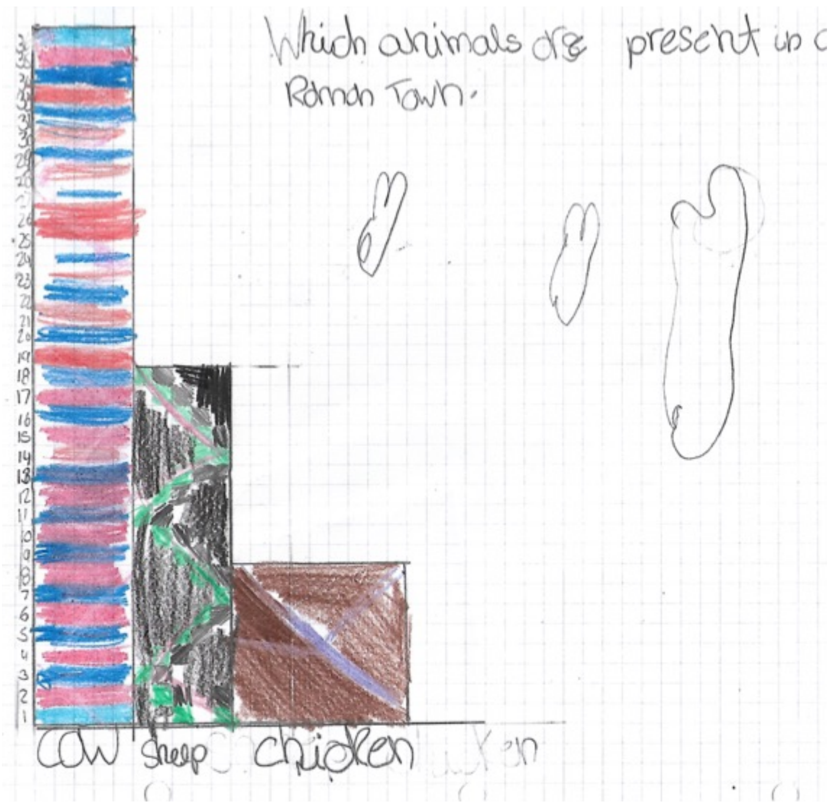


Figure 6.37: Highly decorated graph, drawn by a pupil at SP to show the representation of animals in a Roman town in their faunal analysis intervention.

So while the faunal analysis intervention had only one planned creative element, pupils still found ways to use creativity in their work. During the climate change intervention however, outlets for creative practice were limited to opportunities for 'creative thinking' (i.e. taking a novel approach to a task), or being creative presentation of information; there were no opportunities to physically 'create' something. Participants were not explicitly asked to engage in creative thinking or presentation skills, so children who identified this skill in their practice did so independently of adult direction. It is not surprising that fewer than 50% of pupils reported having used 'creativity' in this session. Following the third intervention, 'creativity' was the third most frequently selected skill (67%), which reflects the highly creative nature of the session: planning, contructing and testing 'Roman-style' aqueducts.

'Organisation' was one of the least frequently reported skills in all three interventions; the percentage of participants identifying this skill in their work decreased steadily across the whole research period (Int.1: 59%, Int.2: 45%, Int.3: 36%). This finding was unexpected, as a high level of organisation was required in all three interventions, particularly the aqueduct session. In Interventions 1 and 2, participants were presented with many resources for each activity: for faunal analysis pupils had images of bones, identification guides and recording sheets (Figure 6.38); in the climate change session they had pollen 'slides', plant 'Top Trumps', environment information cards, and a timeline (Figure 6.39).

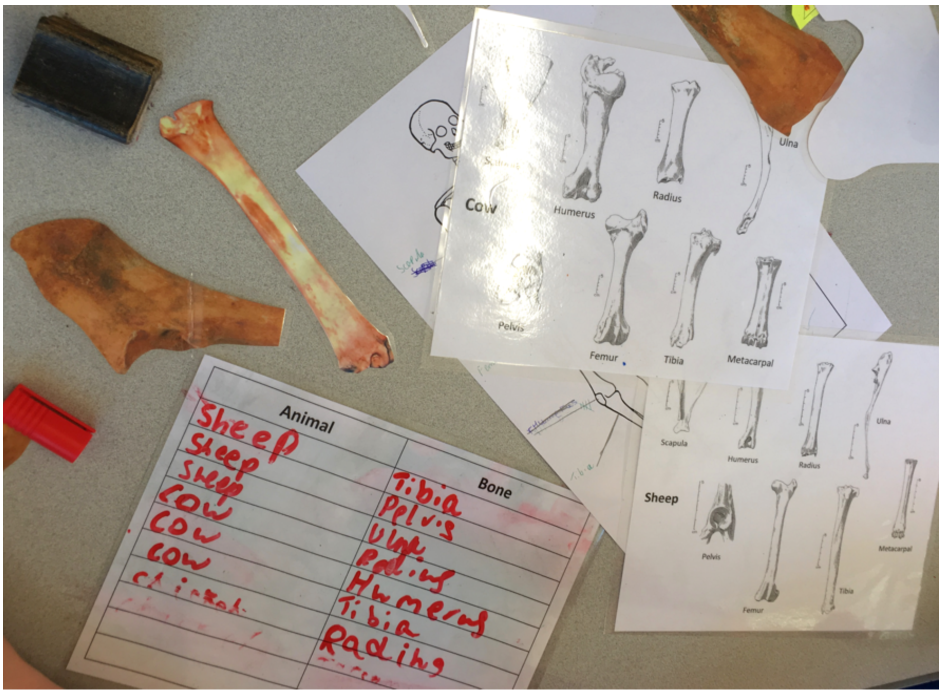


Figure 6.38: A photo of the resources used by BG pupils in their faunal analysis intervention. Items include: images of animal bone specimens, identification guides (adapted from Schmidt 1972) and recording sheets.

Figure 6.39: A photo of the resources used by YP pupils in their climate change intervention. Items include: pollen 'slides', plant 'Top Trumps', environment information cards and a timeline.

In addition to physically organising all of these resources, participants tracked their progress in tasks; for example separating faunal specimens which had been identified from those that had not. Organisation of data was also crucial in the faunal analysis intervention, where pupils had to use space appropriately to fit their graph on the page. Some pupils *did* organise their work effectively by using multiples of five to ensure that all their data was included (Figure 6.40), while others did not (Figure 6.41). ‘Organisation’ was crucial in the aqueduct intervention, where pupils were given a large degree of freedom to plan and experiment with materials when building their structures. Specific job roles were assigned within groups to help participants organise their time and contributions, though in practice these roles were not consistently adhered to. So despite the requirement for a high level of organisation within this intervention, it appears that many pupils found organising their time, workspace and materials challenging, which is reflected in post-intervention reflections.

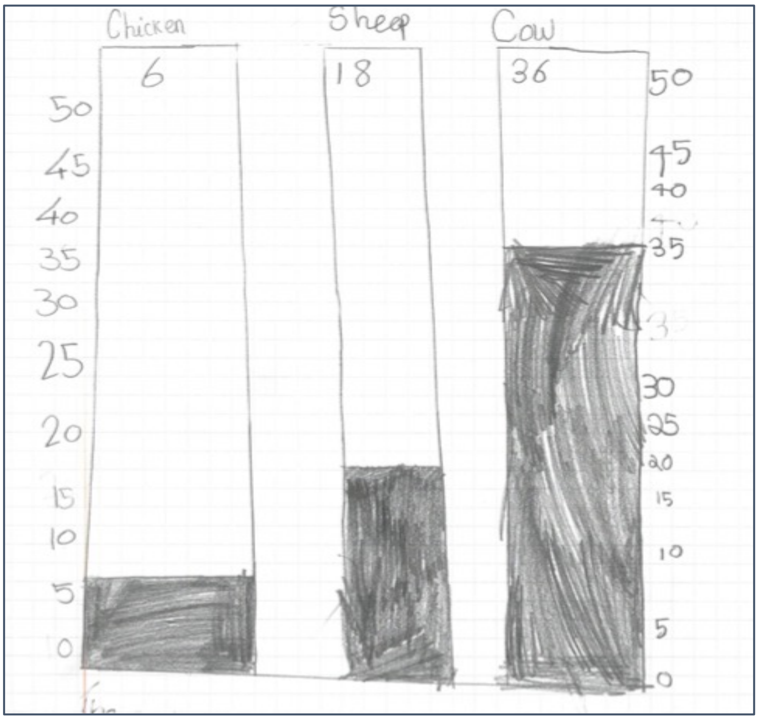


Figure 6.40: A graph drawn by pupils at NB in the faunal analysis intervention. These pupils used multiples of 5 on their axes to ensure that the graph would fit on the page.

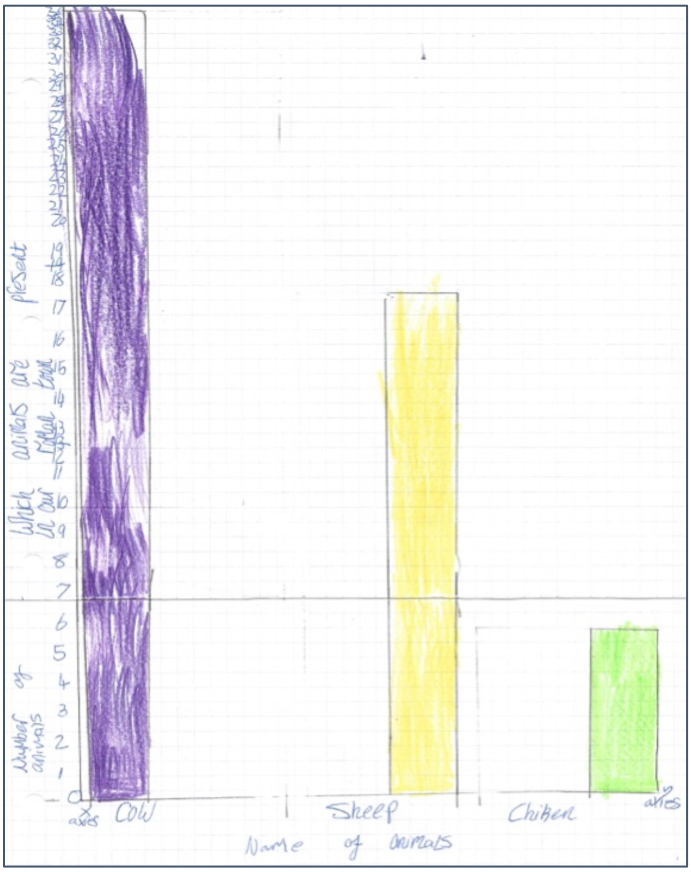


Figure 6.41: A graph drawn by pupils at BG in their faunal analysis intervention. These pupils found ran out of space to fit their graph at the top of the page.

‘Independent working’ was the least frequently reported skill in every single post-intervention questionnaire. This finding is reflective of how interventions were designed around pupil collaboration and discussion. Pupils were occasionally asked to think about a concept or question as an individual, and some pupils requested to complete certain tasks by themselves, but these were not substantial components of each session and questionnaire responses reflect this.

‘Imagination’ was also one of the least frequently selected skills in the first (56%) and second (45%) interventions. While it was not more widely reported in the final intervention by percentage of pupils (51%) reporting it, it was ranked more highly when compared to other skills (Int.1: 11 out of 12, Int.2: 10 out of 12, Int.3: 7 out of 12). This reported usage is consistent with opportunities for ‘imagination’ that were built into the intervention. Imagination is a key element of historical study (Lemisko 2004), and has also been identified as a way in which children bridge gaps in their historical understanding (VanSledright and Brophy 1992, 839-40). However, participants in these interventions were not explicitly asked to use their imagination; activities that required imagination (e.g. answering questions about archaeological artefacts, Figure 6.42) were not specifically signposted. Therefore it is possible that when reflecting upon the session students did not identify ‘imagination’ within their practice.

Figure 6.42: A slide from the Climate Change intervention asking students to consider artefacts that were placed on their tables.

6.1.3.3 Relationship between Q3 responses on pre and post-intervention questionnaires

As Q3 asked respondents to consider two separate (but similar) concepts on the pre and post-intervention surveys, it is not possible to directly compare them. To ascertain whether any relationship exists between them, this section will consider the results of each questionnaire alongside each other. The primary line of enquiry is to explore whether pupils' reflective practice influenced the skills they perceived to be 'most important' to someone working in a STEM career. The following discussion is presented with an acknowledgement of the time which passed between each intervention and the impact this may have had on participants' responses. As demonstrated by Figure 3.8 in Chapter 3, most pupils had gaps of many months between each intervention, making it impossible to directly compare post-intervention reflections and pre-intervention perceptions of 'important' skills. Additionally it is important to bear in mind that restrictions on how many skills pupils could circle in their pre-intervention 2 and 3 questionnaires may account for some of the difference in frequency of selection. However, it may be possible to observe broad patterns in how participants answer each question across the entire research period.

Each of the 12 skills were ranked according to the relative frequency at which they were circled; responses to all six questionnaires are displayed together in Figure 6.43 to demonstrate how each skill was regarded over time. Presenting the data like this reveals that the ranking and reported usage of skills is remarkably consistent amongst those that are the most and least frequently selected. The 'top three' skills (on both the pre and post-intervention surveys) were 'working as a team', 'problem solving' and 'logical thinking'; the exception to this is the final post-intervention questionnaire where 'creativity' replaced 'logical thinking' as the third most frequently reported skill. Pupils' perceptions of skills' importance were matched by how often they reported using them during interventions. It is possible that the level of importance respondents assigned to these skills influenced their reflections: someone who perceives certain skills to be important may be more likely to identify them within their own practice. A similar, though less uniform, picture is apparent for skills that were perceived as the least 'important' or least frequently used in each intervention. 'Independent working', 'organisation' and 'imagination' were consistently amongst the three lowest ranked skills, with 'curiosity' occasionally appearing throughout the research period. It is difficult to assign causality to this as students who feel certain skills are less valuable, may not readily identify them within their own work.

While perceptions and reported usage of the most and least highly regarded skills was reasonably consistent across the research period, those that fell in the middle present a more complex picture. No definitive trends or patterns are immediately obvious in this data, though there were a few points of interest that are outlined here. There appears to be a slight discrepancy between how 'important' participants considered particular skills to be, and how often they reported using those skills in an intervention. For example 'perseverance' is ranked 4th in perceived importance prior to interventions 2 and 3, but in terms of reported usage it was ranked 8th following interventions 1 and 2, and then 6th following intervention 3. This suggests that pupils' perception of the importance of this skill to a person working in STEM was independent of how frequently they felt that they had used it themselves. The inverse of this can be seen in the 'curiosity' skill, where its ranking in terms of perceived importance was lower than pupils' reported use of this skill, indicating that respondents' opinions of some skills were not influenced by how they were used. The exception to this is post-intervention 3, where 'curiosity' was the 11th most commonly reported skill out of the 12 options.

In the case of skills like 'creativity' and 'imagination' which were well reported following intervention 3 in comparison to previous interventions, it would have been interesting to follow up again a few months after the project ended to see whether this had an impact on perceived importance of these skills. As the data stands, it appears that participants were most consistent with their opinions and usage of high and low regarded skills, but less uniform in their perceptions of those skills that fell in the middle.

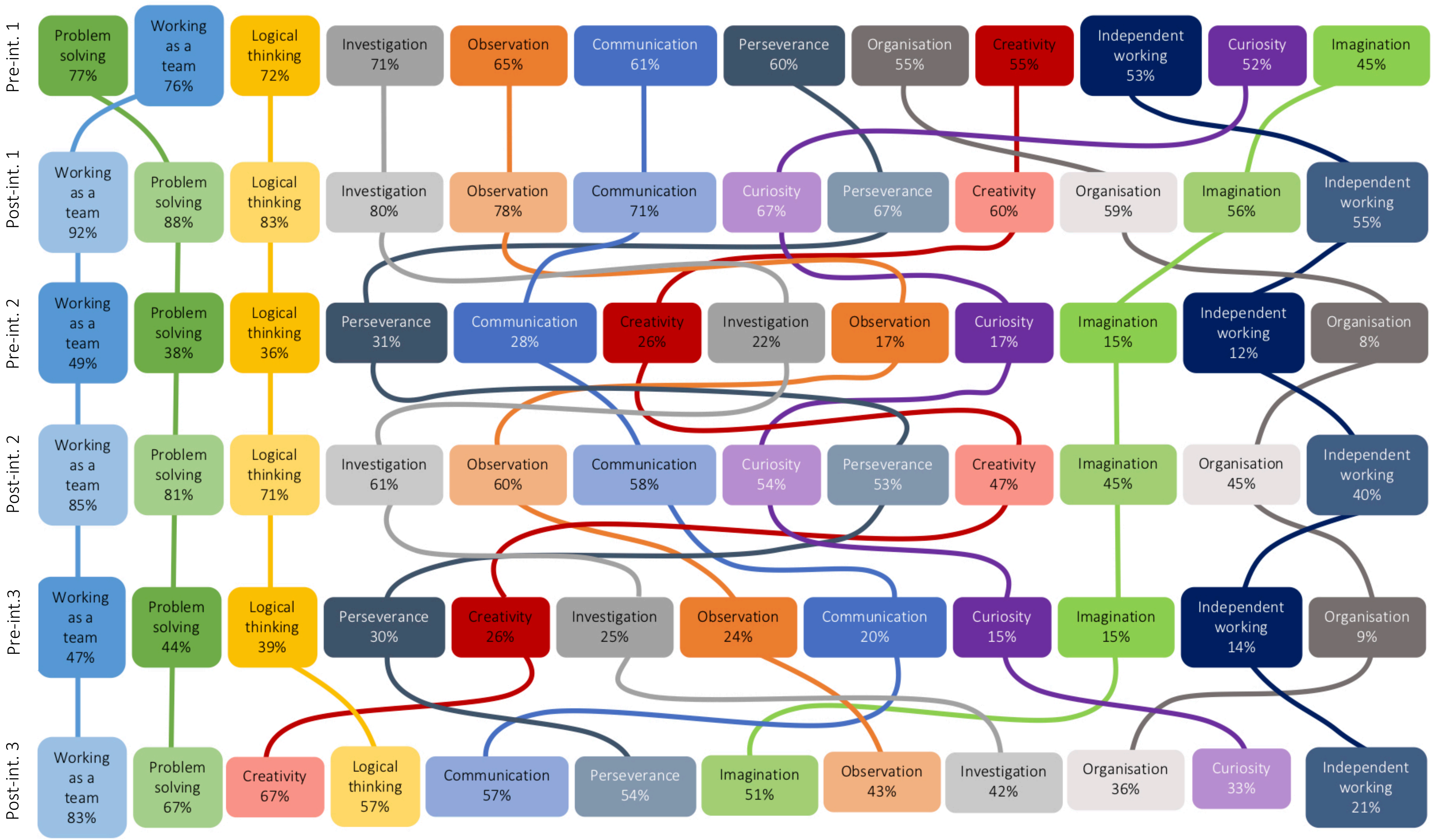


Figure 6.43: Skills ranked by relative frequency of selection on pre and post-intervention questionnaires. NB data included for pre and post-intervention 3.

6.2 Discussion of pupil questionnaire results

This series of questionnaires met the objective of observing potential changes to participants' STEM self-concepts in response to archaeological interventions. The results to questionnaires have been considered (where pertinent) alongside findings from interventions to meet the objective of attempting to understand the impact of archaeological engagement on participants' STEM concepts. The following will consider the extent to which pupils' perceptions changed, and attempt to situate these findings within the wider literature on STEM engagement.

6.2.1 Did participants distinguish between 'being a scientist' and other STEM professions?

As established by Archer *et al.* (2013, 12), very few children aspire to 'be a scientist'; a finding mirrored in the results of this project, where a consistently small proportion of pupils agreed with the statement 'I want to be a scientist when I grow up'. The same study demonstrated that while numbers of respondents wanting to become a 'scientist' were low, there was more interest expressed in other areas of STEM such as medicine and engineering (Archer *et al.* 2013, 10). Additionally, DeWitt *et al.* (2013, 1046) identified a slight differentiation in pupils who reported that they'd like to *use* science in their job and those who wanted to 'become a scientist' (DeWitt *et al.* 2013, 1046). As this project examines pupils' attitudes to all areas of STEM, the apparent difference in perceptions between science and other aspects of STEM was identified as an area of interest.

By asking participants about their desire to 'be a scientist' and also whether they'd like to 'use STEM in [their] job when [they're] older', this study sought to assess how far pupils' STEM aspirations might be tempered by the perception that STEM careers are limited to 'being a scientist'. When pupils' responses to these two statements are viewed side by side, it is clear that while there was more enthusiasm for a STEM career than 'being a scientist'. These differences are not substantial and in fact a greater number of pupils appeared unsure about their aspirations in both of these areas (Figure 6.44). Additionally, there was little observable change in pupil STEM and science career aspirations across the research period, and as recorded in sections 6.1.2.1 and 6.1.2.6, these minor changes are statistically insignificant. Therefore, it is difficult to draw many conclusions regarding how pupils distinguished between science and STEM careers other than to suggest that while some may aspire to a non-science specific STEM career, the majority of respondents did not have concrete ambitions for either area.

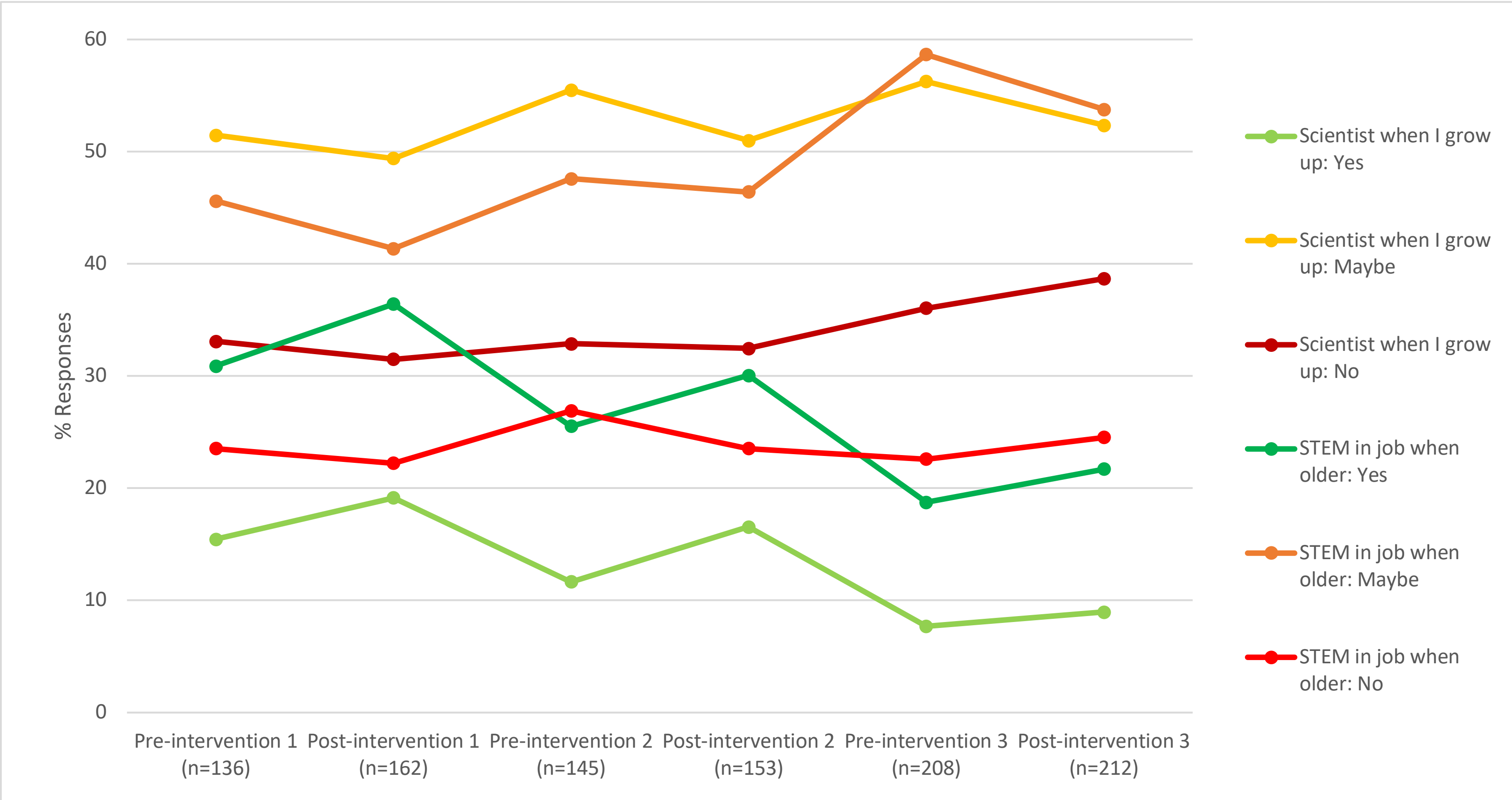


Figure 6.44: Relative percentage of responses to the statements 'I want to be a scientist when I grow up' and 'I would like to use STEM in my job when I'm older' from all questionnaires across research period. NB data included for pre/ post-intervention 3 only.

6.2.2 Participant enjoyment of maths and science lessons

Maths and science lessons are two ways that children frequently engage with STEM in a school context, as maths is taught every day (Welsh Office 1997, 16; DfES 2006, 8) and science at least once a week (Ofsted 2016, 5; Estyn 2017a, 5). Participants' enjoyment of these interactions were assessed to gain insight into their current relationships with school-based STEM, and see how these may have changed across the research period. The results were fairly conclusive; a majority of pupils indicated that they enjoyed both maths and science lessons across all six questionnaires. By comparing the results to each question side-by-side in
Figure 6.45 it appears that science lessons were marginally more popular amongst respondents than maths lessons. A (statistically insignificant) change to 'yes' responses to the question of enjoying science lessons across the research period resulted in science and maths lessons being much more similar in reported popularity by the final questionnaire.

It is clear that the archaeological interventions had little impact on how participants felt about maths and science lessons, but this is unsurprising and was never an aim of the project. Instead these questions reveal the complex ways in which STEM is regarded by pupils; while many of them had positive experiences of STEM in school lessons, very few respondents aspired to 'be a scientist' or use STEM in a future career (
Figure 6.46). This finding mirrors that of Archer *et al.* (2013, 12) who identified limited science aspirations even amongst pupils who enjoyed that subject, and widens the scope of that result to more broadly encompass all branches of STEM aspiration. It appears that amongst participants of this project, a child's desire to pursue STEM is not necessarily related to how much they enjoy school-based STEM engagement.

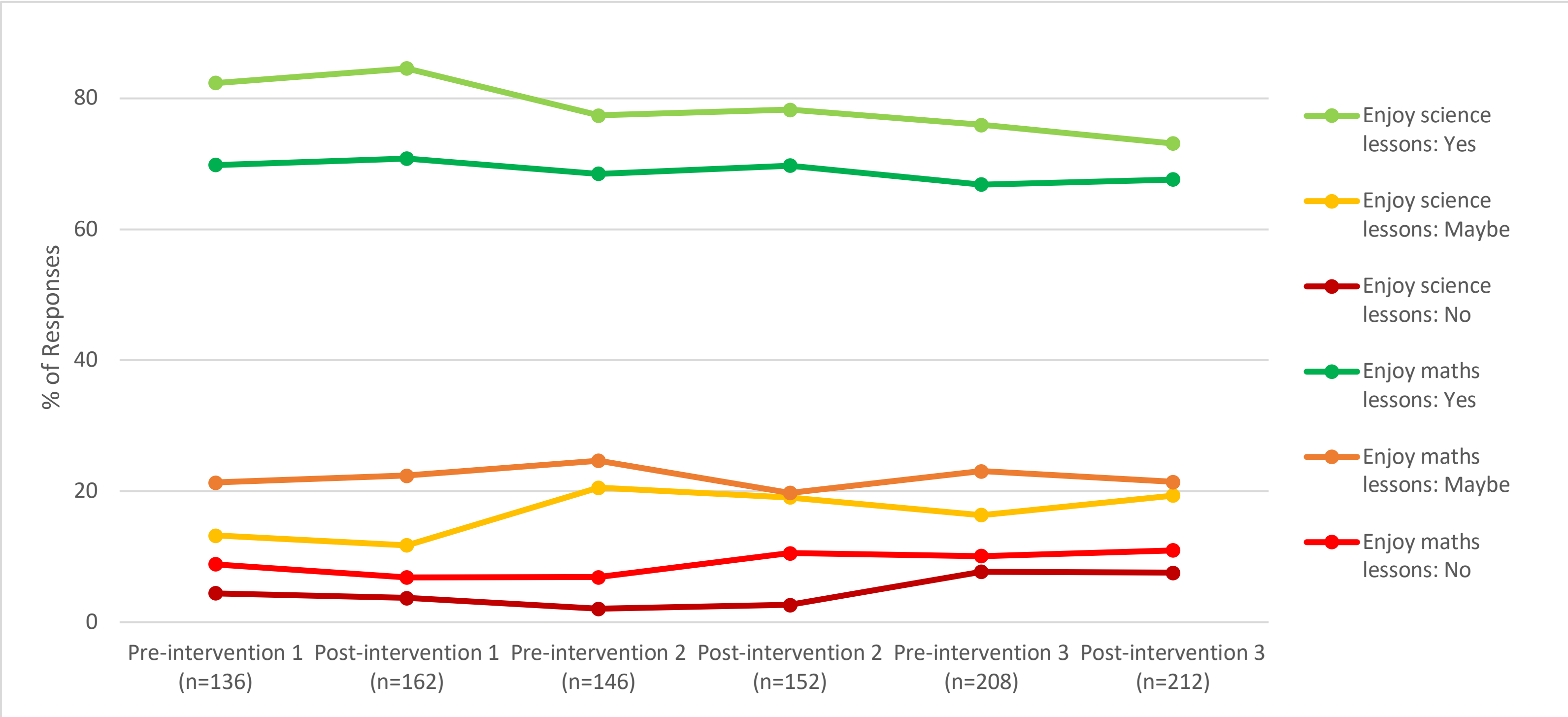


Figure 6.45: Relative percentage of responses to the statements 'I enjoy science lessons' and 'I enjoy maths lessons' from all questionnaires across research period. NB data included for pre/ post-intervention 3 only.

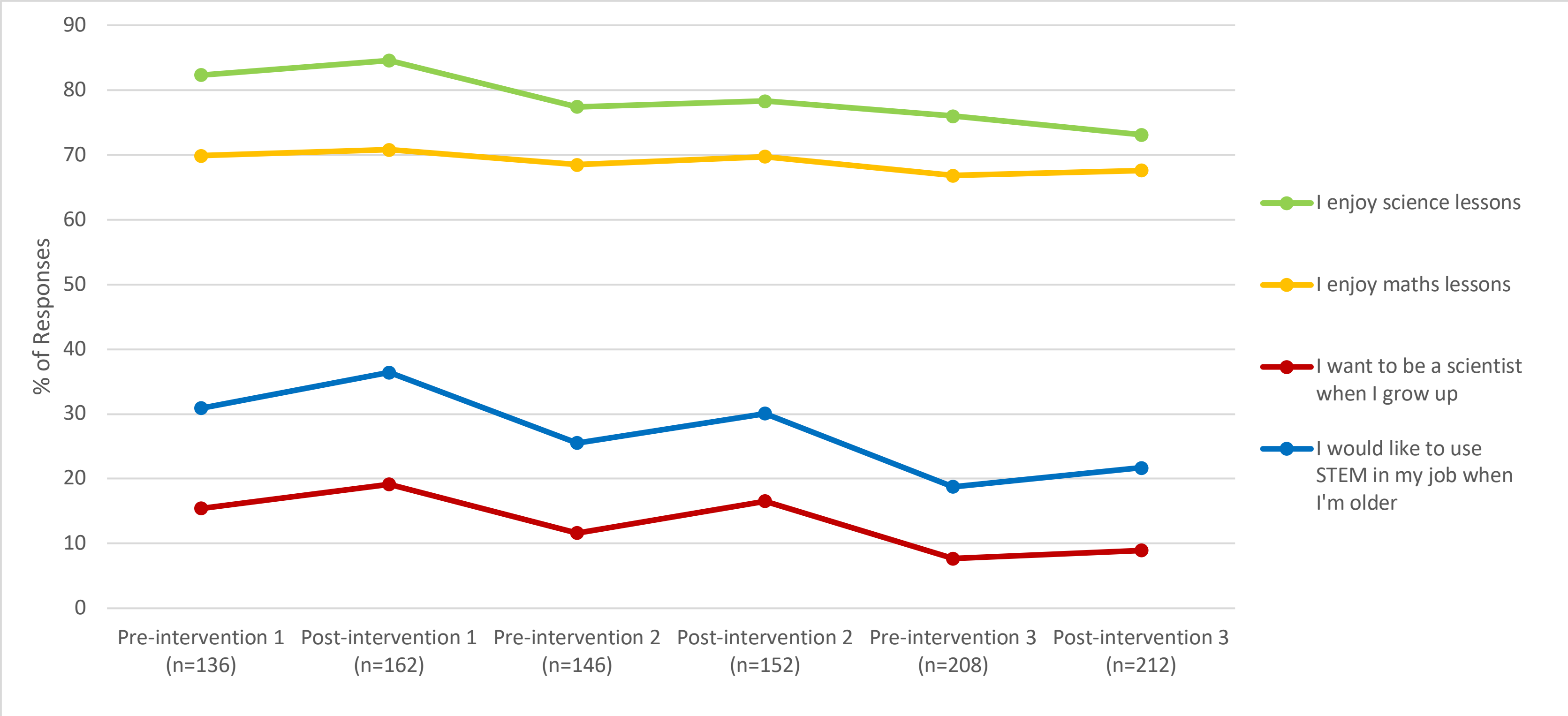


Figure 6.46: Relative percentage of agreement with the statements 'I enjoy science lessons', 'I enjoy maths lessons', 'I want to be a scientist when I grow up' and 'I would like to use STEM in my job when I'm older' from all questionnaires across research period. NB data included for pre/ post-intervention 3 only.

6.2.3 *Participant concept of the importance of STEM in their own lives*

The statement 'STEM is an important part of my life' is open to many interpretations, and so a few possibilities are outlined here. Pupils may have understood the statement through recognition of how STEM is woven into the fabric of modern society. One of the most obvious ways that a child might identify the role of STEM in their personal life is via technology; with the development of games consoles and other personal digital devices, children's play and social interactions are increasingly negotiated via technology (Silcock *et al.* 2014; OECD 2019). Technology is also prevalent throughout wider society, and large scale transformations in the modern world can be attributed to technological developments; such as politics (Bradshaw and Howard 2019), medical and surgical procedures (Nakayama 2018), labour practices (Casilli and Posada 2019), and food production (Mattick 2018). While participants may not be old enough to fully appreciate the impact of more recent advances – the first iPhone was released in 2007 (Goggin 2009, 231), 3 years before these children were born! – they may have encountered well-known technological innovations at home or in school which informed their responses. Participants may also have understood this statement in relation to a personal interest or feeling of affinity with an area of STEM. For example, a child with an interest in science that is supported in school and at home (e.g. visits to museums) may feel that science comprises a significant portion of their life.

The archaeological interventions appear to have had limited impact on participant responses to this statement. The only significant shift in response was observed following the first intervention, where the proportion of pupils agreeing with this statement doubled, although this change in opinion was primarily generated by the pupils from SP. The shift in response at BG was also significant, albeit much less substantial than that observed in the SP dataset. An explanation that might be offered for the apparently radical impact of the faunal analysis intervention on SP pupils is that these children had experienced fewer opportunities to engage with external educators than other participating schools. The novelty of the researcher's presence may have impacted the way they responded to the questionnaire. However, this explanation is not entirely convincing as the 2018 Estyn report carried out for this school specifically mentions a range of 'interesting visitors' to the school and opportunities for learning outside of the classroom (Excerpt 6.1). Instead it may be the content of the session that had such a great impact; pupils were presented with a highly unusual resource (animal bones), which the majority of them are unlikely to have encountered before. It may be that this novel and memorable experience generated such a positive response to the question of STEM's importance to their lives amongst the participants from SP. Whatever the reason for the change, it is clear that it was not long-lasting, and was not replicated by either of the other interventions.

> Teachers invite interesting visitors into the school, who broaden pupils' experiences and put their learning into a real-life context successfully. For example, a banker and a surgeon came to talk to pupils in key stage 2 about how they use mathematics in their daily lives, as part of the school's 'making maths real' event.

Excerpt 6.1: Excerpt from SP's 2018 Estyn report detailing the range of external activities and visitors offered to pupils across the school.

6.2.4 Participants' future STEM aspirations

Three of the Q2 statements explored this question, each from a slightly different angle: participants' desire to 'be a scientist', their intention to continue learning about STEM or to pursue a STEM-related career. The data for these responses does not indicate any significant changes in aspiration (which could result from improved STEM self-concepts) in response to the archaeological interventions (Figure 6.47). Despite the absence of statistical significance, there were minor increases in 'yes' responses to the question of being a scientist or using STEM in a future job following each of the three interventions. The sample size may be a factor here, and it is possible that a similar shift across a larger population may have been statistically significant. Although these changes are small, they are promising, and lessons from comparative research into maximising the efficacy of interventions will be explored further towards the end of this section. Responses to the question of learning more about STEM in the future did not follow this pattern; while a number of respondents felt favourably towards the prospect of learning more about STEM in the future, these feelings were not amplified by participation in the archaeological interventions.

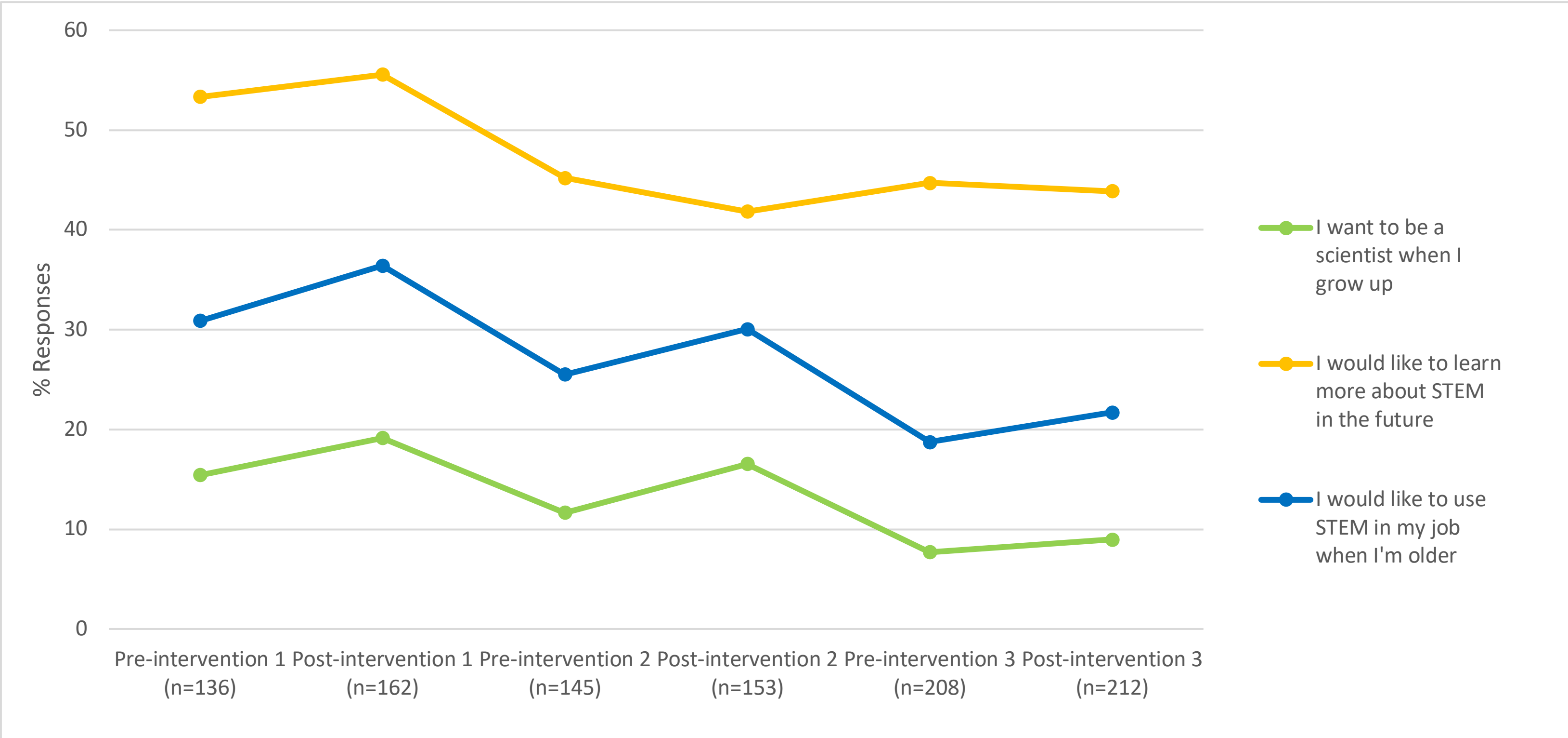


Figure 6.47: Relative percentage of agreement with the statements 'I want to be a scientist when I grow up', 'I would like to learn more about STEM in the future' and 'I would like to use STEM in my job when I'm older' from all questionnaires across the research period

There was a small (but statistically insignificant) change in positive response to all three statements across the research period. This mirrors the work of other researchers, who have documented a decline in pupil enjoyment of science towards the end of primary school (Pell and Jarvis 2001, 857; Murphy and Beggs 2003, 111; Turner and Ireson 2010, 129). Although the shift in response to these questions across the research period was statistically insignificant, the reduction in 'yes' responses occurred at a similar rate (Table 6.7). Responses to the question of 'being a scientist' do not quite fit this pattern, though aspirations for this were extremely low to begin with. It appears that the decline in enthusiasm for science (and STEM) may begin even earlier than identified by other researchers, in lower Key Stage 2 rather than the final years of primary school.

Statement	Pre-int.1	Post-int.3	% Difference	p value	MWU
I enjoy science lessons	82%	73%	- 9%	.836	20485
I want to be a scientist when I grow up	15%	9%	- 6%	.067	19458
I'd like to learn more about STEM in the future	53%	44%	- 9%	.166	18956
I'd like to use STEM in my job when I'm older	31%	22%	- 9%	.528	19609

Table 6.7: Difference between percentage of 'yes' responses to Q2 statements at the beginning and end of the research period.

It is also possible that participants' decreased enthusiasm was in response to the presence of the researcher and the prospect of undertaking another archaeological intervention, or filling out another questionnaire. The enthusiasm observed by the researcher in each classroom prior to interventions indicated that pupils looked forward to sessions. Research into the effects of administering multiple surveys to adults has demonstrated a decline in response rates when participants were asked to complete many surveys over a period of time (Porter *et al.* 2004, 72). Other researchers have also highlighted the occurrence of 'satisfying', where a child may respond to questions without fully considering them if they find the content difficult or uninteresting (Borgers *et al.* 2000, 66). It may the case that pupils' enthusiasm and patience for filling out questionnaires declined over the research period, resulting in less positive responses.

Comparative research into the impact of interventions on STEM aspirations has produced equally ambiguous results. While many studies have collected positive feedback from students immediately following an intervention, they do not demonstrate whether these findings resulted in long term aspirational change (Archer *et al.* 2014b, 36; Sadler *et al.* 2018, 588). For example, Fernández-Cézar *et al.* (2018, 285; 2020, 10) identified small positive impacts on Spanish primary pupils' perceptions of maths and science, though both studies examined a stand-alone intervention and participants were only re-interviewed a few weeks after the intervention. Where attempts have been made to research long term effects, the results and context of each study are extremely varied. One project followed a US high school teacher over three years to identify whether his integration of engineering into science lessons would impact pupil outcomes and interest in STEM (Guzey *et al.* 2019, 24). Researchers identified an improvement in both student attainment and interest in science and engineering, however the changes in interest were not statistically significant (Guzey *et al.* 2019, 38). Blustein *et al.* (2012) interviewed high school students following a STEM-based summer school and then once again 12/18 months later. They found that student interest in STEM was maintained in this time (Blustein *et al.* 2012, 57), though the study lacked 'pre-intervention' data, meaning that students' interest in STEM prior to the intervention is unknown. Banerjee (2017a, 12) compared the GCSE results of secondary school pupils in England and found no significant difference between those who had experienced long term STEM engagements to those who hadn't. In addition to this, Banerjee (2017b, 220) identified no difference in uptake of post-compulsory STEM in these pupils either.

Other studies have focused less on providing specific educational experiences, and more on training pupils in cognitive methods to change their STEM mindset. For example, Blackwell *et al.* (2007, 256) targeted pupils' notions of the rigidity of intelligence, and found that those who underwent training on the malleability of intelligence became more motivated in maths lessons. Rosenzweig and Wigfield's (2016) systematic literature review of studies into improving students' motivational constructs revealed that the majority of studies under review were successful in this. Another systematic review conducted by van den Hurk *et al.* (2019, 161) concluded that '*programmes focusing on knowledge, ability, motivation and feelings of belonging could increase the interest and persistence in STEM education*'.

6.2.5 Impact of reflecting on STEM skills

This section explores the efficacy of interventions in impacting participants' STEM identities and associated aspirations. Question 3 was intended to influence two areas: broaden participants' understanding of the necessary skills to produce a happy and successful future within STEM, and self-concepts of their own suitability for STEM.

6.2.5.1 Impact of reflections on perceptions of how skills are valuable in a STEM career

By identifying skills in personal STEM practice, it was anticipated that participants would develop insight into how those skills are applicable to a STEM career. Additionally, by using skills less commonly associated with STEM, such as creativity (Kind and Kind 2007, 6) in a STEM-specific context, participants would more readily recognise their relevance and value in STEM. Despite these hypotheses, there was little shift in how participants perceived STEM skills throughout the research period. This was particularly notable for skills that were most and least highly regarded or reported as being used in each session. The same three skills were consistently identified as being 'most important' within a STEM career and the most widely used in interventions. Less consistency was observed in the ranking of the least frequently used/regarded as important skills, though there was a clear (absence of) preference for 'independent working', 'organisation' and 'imagination'. While it is clear that participating in the interventions did not alter the specific choices of important and less important skills, this does not indicate a complete absence of impact. Instead it may be the case that the archaeological interventions reinforced the skills that pupils believed to be of most and least importance within a STEM career.

There was no apparent link between participants' skill usage and their perceptions of those skills' value in a STEM career. Although the three most and least frequently reported skills remained fairly consistent, there was much more observable change in skills that ranked in the middle. The ranking of these skills does not seem to be influenced by how often they were reportedly used during interventions. This suggests that pupils did not necessarily link their practice to that of a 'real person working in STEM', or that their experience of the interventions did not align with their understanding of that of a STEM practitioner. For example, a child may imagine a person working in STEM to encounter difficulties which require perseverance, but did not feel that they had encountered such a situation in the interventions.

The school-based context of interventions may have been a factor, as well as the alignment of the researcher within a 'teacher' role rather than that of 'a person working in STEM'. Despite efforts to occupy a 'non-teacher' role, such as encouraging pupil use of her first name, many pupils addressed the researcher as 'miss' throughout the project. While the researcher represented a less stereotypical (e.g. young and female, albeit still white and middle class) view of what a STEM practitioner might look like, this may have actually positioned her closer to pupils' expectations of how a teacher 'should' look (Thornton and Bricheno 2000, 191; Carrington 2002, 288; Skelton 2003, 203). In addition to this, leading a session within a classroom rather than an 'authentic' STEM setting may have led many participants to see their interventions as an extension of school, rather than a separate STEM-specific experience.

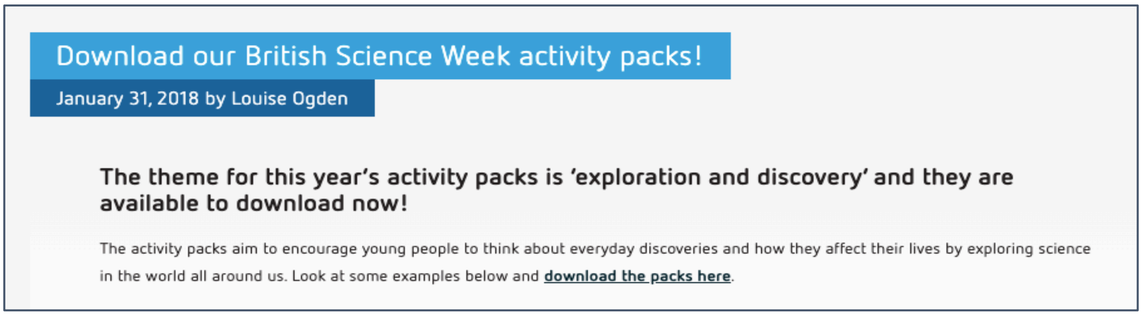
6.2.5.2 *Impact of reflections on pupils' STEM self-concepts*

It was hoped that by connecting personal STEM practice with that of 'real' STEM practitioners through the reflective element of question 3, participants' would develop positive STEM self-concepts. Reflecting on the overlap between your own actions and those of a person active in STEM is likely to result in greater awareness of how you might be happy and successful in future pursuit of STEM. However, the limited overall changes in response to these reflective sections of the questionnaire allow for few robust conclusions. Instead, responses highlight a rigidity in participants' perceptions, and reported skill usage during sessions was largely unchanged by the format of each intervention. The inclusion of 'creativity' as a frequently used skill after the aqueduct intervention is an exception which demonstrates that where intervention content was overtly related to a skill, pupils were flexible in their recognition of using that skill.

There is limited comparative literature on the subject of children's perceptions of their own skills and personality traits in relation to STEM. Most studies outline their impact on participants' STEM aspirations, rather than examining their identification of specific skills that might indicate an aptitude for STEM. While focusing on self-concepts of ability has been proven effective in other studies (Herman *et al.* 2018; Falco and Summers 2019, 70), it seems that self-reflection must take a more central role within interventions to effect change. The positioning of self-reflection and self-concepts within the data collection section of this project failed to place the required emphasis on these issues, resulting in a negligible impact on participants' understanding of STEM skills in relation to themselves. In addition to this, the interventions only took place three times throughout the year and may not have been frequent enough to impact pupils' perceptions of their abilities in STEM. Instead ongoing explorations of STEM in terms of how people are happy and successful in STEM careers, combined with self-concept affirming exercises may be necessary in order to achieve the greatest impact (Macdonald 2014, 24; Zecharia *et al.* 2014, 35-38; Macdonald 2015; Godec *et al.* 2017; Archer *et al.* 2018, 7).

6.2.6 Impact of British Science Week on STEM aspirations at NB

The second NB intervention took place at the end of their school-wide celebration of British Science Week (BSW). BSW is an annual event organised by the British Science Association; each year, they publish activity packs for schools and other organisations to use (Figure 6.48). Although it was not possible to use the data collected from NB pupils following the first and second interventions in the overall analysis, that data did illustrate the potential impact of the school's celebration of BSW. This was done by comparing the post-intervention 1 questionnaire data (collected at the end of January 2018), and the pre-intervention 2 questionnaire data (collected at the beginning of March 2018).


Download our British Science Week activity packs!

January 31, 2018 by Louise Ogden

The theme for this year's activity packs is 'exploration and discovery' and they are available to download now!

The activity packs aim to encourage young people to think about everyday discoveries and how they affect their lives by exploring science in the world all around us. Look at some examples below and **download the packs here**.

Figure 6.48: A screenshot from the British Science Week activity pack webpage (Ogden 2018).

These datasets represent two snapshots of opinion, less than two months apart and may have inadvertently captured the effect that participating in BSW had on the children (Figure 6.49). While shifts in opinion could also be explained by other changes at NB (e.g. teaching methods), there is little indication of this in the rest of the data. Something as influential and persistent as an institution-wide change in teaching policy should produce a long-term effect on pupils' answers to these questions. However, aside from the (statistically insignificant) change in reported enjoyment of maths lessons, there is no indication of such a change in the data. Instead the short-term impact of a stand-alone event is a more likely explanation here, once again highlighting the importance of taking consistent and sustainable approaches to STEM engagement.

There is an interesting pattern in which statements saw an increase in 'yes' responses at the end of BSW. Reported enjoyment of maths and science lessons increased in this period, which is consistent with the fact that pupils engaged in activities specifically designed to '*spark enthusiasm'* for STEM (British Science Association n.d.). Pupils agreeing that STEM was an important part of their lives increased significantly, which may also reflect the BSA activity pack's aim '*to encourage young people to think about everyday discoveries and how they affect their lives'* (Figure 6.48). The number of respondents agreeing with the statement 'I'd like to use STEM in my job when I'm older' almost doubled, suggesting that a week of engaging with STEM concepts improved children's enthusiasm and understanding of how they might pursue STEM in the future.

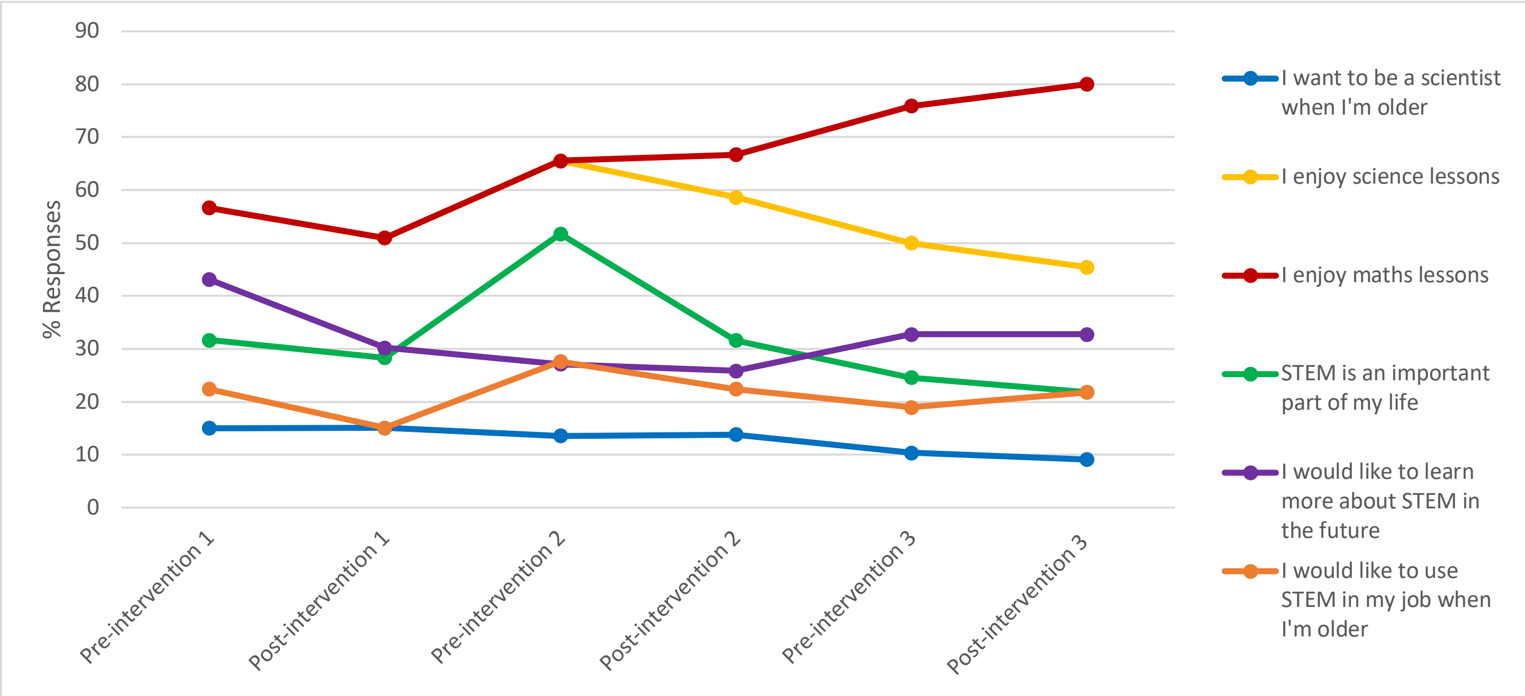


Figure 6.49: Relative percentage of 'yes' responses to each of the six statements in Q2 from NB pupils across the entire research period.

Statements which did *not* see an increase in positive response were: 'I'd like to be a scientist when I am older' and 'I'd like to learn more about STEM in the future' (Figure 6.49). It is notable that although the science week celebrations saw an increase in enjoyment of science lessons, it did not raise science specific aspirations, a finding that dovetails with Archer *et al.*'s (2010) examination of the discrepancy between children's interest in 'doing science' vs. 'being a scientist'. The finding that pupils did not report increased interest in 'learning more about STEM in the future' is inconsistent with the increased enthusiasm for other statements, and may reflect a difference in how the statement was interpreted. This statement did see an increase in 'maybe' responses, indicating a level of uncertainty on the part of respondents which might be a result of the broadness of the statement. 'Learning more about STEM in the future' might refer to specific areas of interest, or it could be understood as simply 'learning more about the concept of STEM as a whole', which may be less attractive to pupils.

Overall it appears that engaging in BSW did bring about more positive perceptions of school-based STEM to the pupils of NB, as well as a more positive opinion of the relevance of STEM within their current and future lives. However, this change was not long lasting as most post-intervention 2 responses returned to the same level as had been recorded before the BSW intervention. This finding demonstrates a need for a consistent approach to addressing STEM engagement and perceptions, though this may be incompatible with contemporary education systems where schools and teachers are often constrained by performance indicators, curriculum requirements and economic considerations (Murphy and Beggs 2005, 9; Dobbins 2009, 101).

6.3 Chapter 6 summary

This chapter presented and discussed the results of a series of questionnaires that were completed by pupils from the five participating schools. Results indicate a limited impact of the interventions on the STEM perceptions and self-concepts of participants. Aspirations to pursue science or STEM in the future remained low throughout the course of the project, a finding that contrasts with the high level of enjoyment reported for science and maths lessons. This result builds upon the findings of other researchers (Archer *et al.* 2013), and supports the assertion that STEM enjoyment does not automatically translate into STEM aspiration. Although a rise in science and STEM aspiration was captured following each archaeological intervention, these changes were small, statistically insignificant, and short-lived. In addition to this, a small (but statistically insignificant) change in reported enjoyment of science lessons was recorded over the course of the project. Other researchers have observed a decline in enthusiasm for science towards the end of primary school (Pell and Jarvis 2001, 857; Murphy and Beggs 2003, 111; Turner and Ireson 2010, 129), but this finding suggests that for some pupils the decline may begin even earlier, in lower Key Stage 2.

Pupil enthusiasm for using STEM in future careers increased following each of the three interventions, and though these increases were statistically insignificant, they hint at the potential impact of a long-term, consistent and sustainable approach to STEM engagement. Interventions also had a minor effect on perceptions of the importance of STEM within participants' lives across the entire research period. While the faunal analysis intervention produced a significant change in response to this question, it was largely driven by participants from one school and was not long-lasting. Neither of the following interventions elicited such a substantial change, and it is possible that the novelty of interacting with skeletal specimens is what generated this (short-lived) change. However, novelty alone is not enough to effect change in STEM engagement; many researchers have highlighted the importance of fostering an identity that is aligned with STEM (Kyriacou and Goulding 2006, 18; Mendick 2006, 63; Wong 2012; Macdonald 2015; Hernandez-Martinez 2016, 232; Godec *et al.* 2017; Falco and Summers 2019; van den Hurk *et al.* 2019, 161). The reflective element of these questionnaires (Q3) was devised in recognition of this.

Data for question 3 indicates that archaeological interventions did not affect which skills were perceived to be the most or least important for a person working in a STEM role. Participants' ranking of the most and least important skills was remarkably consistent, as was their reported use of these skills in each intervention. However, outside of the most and least highly ranked skills, there was no clear relationship between how frequently participants used a skill and how likely it was to be considered 'important'. This suggests that participants' understanding of skill usage requires a greater level of attention during engagements; reflecting on skills as they are used may have a greater impact on learners. Alternatively it is possible that the interventions *did* influence perceptions, but only so far as to confirm participants preconceptions about skills that are valued in STEM. There is also a question of perceived authenticity of the interventions; participants may not have linked their actions with that of a STEM practitioner if they did not believe their experience to accurately reflect that of someone in a STEM career. This is a crucial consideration for those wishing to conduct similar engagement endeavours in the future, as the many logistical benefits to approaching young people within a school environment may come at the cost of reproducing an 'authentic' STEM intervention.

Questionnaire results have underlined the complexity of impacting young peoples' STEM self-concepts, identity and subsequent aspirations. Comparative research into STEM engagement has produced mixed results (Blustein *et al.* 2012; Baran *et al.* 2016; Banerjee 2017a; Banerjee 2017b), and even where positive impacts have been identified they are often very small or statistically insignificant (Vennix *et al.* 2018; Fernández-Cézar *et al.* 2018; Fernández-Cézar *et al.* 2020). Programmes that placed self-concepts, STEM capital and identity at the centre of their practice produced a positive impact on STEM aspirations (Archer *et al.* 2018; Herman *et al.* 2018; Falco and Summers 2019), and these findings further contribute to that corpus of knowledge. While this research attempted to integrate elements of self-concepts and identity with straightforward STEM content delivery, its limited success in influencing STEM aspirations highlights the need for reflections to take a greater role within interventions. These two approaches might have been more effectively combined by integrating reflective practice more explicitly into the intervention content, ensuring that pupils are engaged in constant metacognition rather than positioning it at the end of each session.

These results also demonstrate the need for a sustained, long term approach to STEM engagement. The oscillation in STEM aspirations throughout the research period suggests that more frequent interventions may be required to sustain them. In addition to this, evidence from other researchers indicates that programmes which develop relationships with participants via a high volume of sessions, spanning many months/years achieve a high level of success in maintaining STEM participation (Archer *et al.* 2021). The cumulative knowledge of this project and other comparative research presents some key lessons for those embarking on STEM engagement in the future.

In summary, the efforts to observe impact of interventions on participants revealed how novel content can elevate the impact of an experience on learners, but must also be perceived as authentically reflective of STEM practice. In addition to this, self-reflection and metacognition must represent a central component of learning to ensure participants habitually reassess their own skills and competencies as their understanding of STEM aptitude develops. Finally, interventions must be frequent and consistent in order to sustain aspirations. This chapter outlined and discussed the results of a quantitative data collection method, the following chapters will explore the results of qualitative data collection undertaken as interview sessions with a sample of participants from each school.

7 Chapter 7: Word sort exercise results

This chapter presents the results of a word sort exercise which was carried out in small-group, task-based interviews with pupils from all participating schools. This exercise facilitated observation of participants' perceptions of STEM skills and aptitudes by asking them to consider what they believed to be important for people working in STEM roles. Exploring STEM from the perspective of skills and aptitudes gives participants insight into how they might be happy and successful in STEM (Macdonald 2015), and emphasises the value of skills which might be less commonly associated with STEM. Participants were presented with a selection of cards (see Chapter 3 section 3.4.4.1), each with a skill or aptitude, and asked to discuss those which they felt were most and least important for a person working in STEM. The word sort exercise was one of three qualitative data collection methods undertaken with small-group interview participants. It established general perceptions of skills and aptitudes in relation to hypothetical STEM practitioners to provide a baseline from which their self-concepts were explored. Self-concepts were examined through self-reflections (see Chapter 8) and a final survey (see Chapter 9). The word sort also complements quantitative data collection (see Chapter 6) by examining the nuance of participants' STEM perceptions. The word sort was repeated throughout the main research period to observe potential impact of the archaeological interventions (see Chapter 5) on participants' understanding of how skills and aptitudes are relevant within STEM practice. A full outline of the methods used in this exercise and their rationale may be found in Chapter 3 (section 3.4.4.1). This chapter outlines the results of the word sort and situates findings in the wider context of STEM engagement research.

7.1 Results

Due to the volume of words presented to participants for discussion in this exercise, the resulting datasets were vast, and cannot be presented in full here. Instead, this section covers skills/aptitudes that generated data across other qualitative and quantitative collection methods. Prioritising those results here allows for a more comprehensive consideration of them across the entire thesis, and ensures that the data presented throughout all four results chapters is broadly comparable. Word sort results for all other skills/aptitudes may be found in Appendix 37. Participant responses to each skill or aptitude are presented here, with specific consideration of how participants' understanding changed in response to the archaeological interventions.

7.1.1 Can use computers

In their initial interview most groups discussed the importance of being able to use computers in a STEM role (Excerpt 7.1), with specific suggestions that they could be used for programming, scanning bones and in a bank. This continued in the second interview, where groups highlighted how people from the STEM profiles would need to work with computers in their jobs (Excerpt 7.2). They suggested computers could be used as a research tool, for medical diagnosis, and to disseminate research. Some participants also discussed how an IT technician might work with computers as a physical object. Two groups discussed this card in their final interview (Excerpt 7.3), and both touched upon the idea that as computers are a form of technology, using them is inherently useful in STEM. Each group also briefly discussed how computers might be useful to archaeologists; Jelly's specification of '*certain equipment'* which is similar to a computer is reference to forms of computing outside of desktop and laptop machines.

Bumble: *I think it's quite important, you can't really do anything without computers*

NJ: *you would fix computers – because mathematics, programming and…*
Cupcake: *I would go to the bank – work in a bank because it's technology with computers*

Pepperoni: *can use computers, because you might have to – if you work in STEM club, you might have to scan the bones and stuff to see what bone it is?*
Cleo: *if you could use a computer, it won't help everything but if you worked with computers you would have to know that*
Apple: *science and stuff, you can use computers for most things… they use it for zooming in on stuff, they use it they can zoom in and then examine it*

Videogame Guy: t*he T is technology, and technology is computers, to be able to use technology, one of those things* [is] *to be able to use computers*

Excerpt 7.1: Participants' comments on the importance of using computers in STEM careers from the first interview sessions.

Black Cat: [Rhodri] *needs to know the right wires, which hole to go in, how to connect them, how to charge them? What's the right size socket*

Pasta: [Ali] *needs to know the bodies and she needs to see the illness, and that's why she* [uses] *computers… so she can see all what's happening with the body*

Barry: [Ali] *has to scan*
Stanley: *they scan the broken bone, they want to know so she scans it then she looks at them*
Barry: *she can scan how many degrees it twisted*

Skull Trooper: *scientists, they need to use computers because if they've made something new, they might want to show it to the world, so they need computers to tell other people about it?... Archaeologists might want to search up some bones, if they don't know what bones there is*
Cupcake: *maybe they could use it to scan, to look closer at things*
Skull Trooper: *and you could search up the DNA of the animals if you get them off the bone*

Excerpt 7.2: Participants' comments on using computers from the second interview sessions.

Videogame Guy: *it would be good to be able to use computers, because computers are technology and you'd need to know how to use them*
Interviewer: *does* everyone *in STEM need to know how to use them?*
Videogame Guy: *no, not everyone*
…
Blackjack: *maybe someone who studies bones to see what type it is?*

Apple: *computers are tech and tech is part of the STEM*
…
Apple: *if you can use computers it would be helpful for DNA and things like that… so if you went out and found something, you could bring it back and see what is was*
Jelly: *you use certain equipment for that… I know what I'm thinking of, I just don't know what the name is*
Interviewer: *okay – and is that equipment related to using computers?*
Jelly: *yeah a bit because it is technology, it's similar to a computer*

Excerpt 7.3: Participants' discussion about computer use in STEM from the third interview.

Two major themes emerged from these discussions: the equivalence between computers and technology and the use of computers to 'scan' objects or study DNA. Computers were understood as an inherently useful form of technology, though discussions did not explore this any further. This mirrors findings from other studies which demonstrate the limited understanding children have of computing and computer science (Grover *et al.* 2016; Hansen *et al.* 2017; Henry and Dumas 2018). Examples of how computers are used in STEM became more specific in response to the profile prompts in the second interview, though this was not replicated in the third interview when the prompts were not present. Two frequent suggestions across multiple groups were the use of computers in 'scanning' objects and studying DNA. Participant descriptions were vague, as might be expected for children their age, and may have been informed by popular culture portrayals, which play a significant role in informing the public about these technologies (Harris and Willoughby 2009; Brewer and Ley 2010; Ley *et al.* 2012). It might be assumed that modern children, whose lives are increasingly accompanied by technology (Ibbetson 2020; Ofcom 2020), would hold relative confidence to explore potential applications of computers in STEM careers. However, confidence does not guarantee accurate knowledge, and it was clear that participants maintained a limited understanding of computing throughout.

7.1.2 Can work in a team

Conversation surrounding this card in the first interview placed an emphasis on working together to avoid negative outcomes (Excerpt 7.4). Pasta noted that '*when you're doing science, you can work as a team'*, although it is unclear whether he was referring to science lessons or career-based science. Black Cat provided a caveat to her group's discussion of teamwork: '*if you want to work on your own…you don't always have to work as a team*'. In the second interview, teamwork was regarded as something that improves outcomes of projects, and provides an opportunity to advance learning (Excerpt 7.5). The concept of 'help' was also apparent, where a key element of teamwork was 'helping' others on your team, and benefitting from their help in return. Discussions in the final interview revisited concepts that teamwork would make tasks easier, though opinion was divided on how essential teamwork is for success in STEM (Excerpt 7.6).

Barry: *can work like a team… because then everybody does everything right*

Apple: *if you're told to work in a team, and you're not very good at it, then everything's going to go wrong*

Excerpt 7.4: Participants' comments about teamwork in the first interview session.

Videogame Guy: *I just think they might need to work as a team to answer a question, or do a task that they need to do*

Bluebell: [Chloe] *might need a team to build this big thing*

Black Cat: *because if she hasn't got it, somebody else has – who's a friend – she'll get that friend*

Skull Trooper: *if you work in a team then you can improve stuff better?*

…

Blossom: *then you can help everyone else out… and people can help you and you'll learn new things*

Excerpt 7.5: Participants' discussions about teamwork in the second interview.

Skull Trooper: *if you work in a team, you can figure stuff out easily… you don't want to just be too independent because if you are, people might want to learn from you, and you don't really say anything because you're too independent*

Blackjack: *you might need to work in a team to find out something… like what type of bones and what animal… if you're not very good at working with other people well then* [you] *wouldn't be doing your job*

Videogame Guy: *you might need to work in a team – say you were making a computer for technology, you probably wouldn't be able to do it on your own, so you would work as a team because you'd need some help*

Cupcake: *you don't always have to work in a team, you can work by yourself. You don't just have to work in a team… maybe when you're looking at bones. You may not need a team, you may just look at them by yourself*

Excerpt 7.6: Participant discussions about teamwork in the third interview.

The positive perception of teamwork and STEM displayed by participants contrasts with popular culture depictions of STEM practitioners, where they are often presented as socially awkward, solitary workers (Mendick *et al.* 2008, 15; Boston and Cimpian 2018, 201). Instead, the ability to work well in a team was consistently well-regarded across all groups and interviews; a likely reflection of the emphasis on groupwork in each archaeological intervention, and more generally throughout primary education (Glancy and Moore 2013, 6; Blatchford and Russell 2019). Perceptions of teamwork did not appear to change throughout interviews, though the way participants spoke about it did; pupils drew upon a range of specific examples to illustrate their opinions as the interviews progressed and they became more familiar and more informed about the working world of STEM. It is notable that two of the examples in Excerpt 7.6 make reference to 'bones'. These comments indicate two things: participants recalled content from an intervention eight months prior *and* they recognised the value of teamwork in STEM via an archaeological example. The impact of interventions are twofold in this case, as they instilled participants with an understanding of how teamwork is valuable in STEM *and* presented them with a memorable archaeological experience to demonstrate that.

7.1.3 Can work independently

This card generated very limited discussion following the first interview, making it hard to thoroughly assess participant perceptions throughout the research period. While participants agreed independent work might occasionally be useful, they favoured collaborative work over it (Excerpt 7.7). Independent work was primarily perceived as interfering with, or inferior to group work, though some participants highlighted the need for independent work in the context of a test. Though people are subject to testing and exams outside of primary education, it is likely that the reference to testing here is the result of pupils' experience of tests in school. Some of the discussion about this card in the second interview suggested that independent work is most relevant in situations where it is not possible to work in a team (Excerpt 7.8). The emphasis placed on the value of teamwork by participants throughout interviews is consistent with the perception that independent work is secondary to team work. No participants opted to discuss this card in the final interview.

Black Cat: *very important because if you don't have a team with you, then you can find it out on your own*

…

Olivia: *if you're working independently and you find something* [and] *you don't really know what it is… if you're not so good on that subject, about that animal or something, you might need some help*

Black Cat: *if you find something like a bone, and you don't know which type of animal it is, I think it's better to work in a team*

Pepperoni: *I think you need, if you're a scientist you need to be independent… because you can't always ask for help, you need to do stuff yourself. Because one day you might have to do a test on your own without anyone else and then you might not learn anything because you've been copying people*

…

Cleo: *you need to work independently, but sometimes you need to actually – you can't always be by yourself, just doing everything by yourself because sometimes you have to work as a team… so if you're not good at team work, you're not going to get very far in life*

Blossom: *well if you're doing a test, you have to work independently, because then if someone's copying you, you might have them wrong and then they've just got the same answers*

Excerpt 7.7: Participants' conversations regarding working independently in the first interview.

Olivia: *so say there was* [pause] *ten of you, and then nine of them leave, you might need to work independently*

Buster: *I think it might be important because if you weren't in a group, or there's not much people that work in a certain part, and you want to work on your own, then you have to be good at working on your own*

Excerpt 7.8: Participants' comments about independent working in the second interview.

Lemley (2012) argues that independence in STEM is largely romanticised and there are other countless pop-culture references to the isolation of people working in STEM, often due to poor social skills (Epstein *et al.* 2010; Kendall 2011; Haynes 2016). These stereotypes did not appear to be a consideration for participants in this study, and instead their opinions were largely dictated by a regard for teamwork over independence. Once again, participant perspectives are a likely reflection of the groupwork in each intervention and more broadly throughout primary education. Black Cat's reference to 'a bone' in Excerpt 7.7 is interesting as this interview took place prior to the first intervention. It is likely that this comment was a response to the researcher's introduction earlier in the day, which included animal bones. It appears that interacting with animal bones, even briefly, left an impression on this participant.

7.1.4 Clever

This card revealed dramatically different opinions amongst groups in the first interview: YP felt that cleverness was of high importance in STEM, whereas BG participants decided that it was not (Excerpt 7.9). In the second interview, 'clever' was used to describe both skills and knowledge of individuals (Excerpt 7.11). Discussion of clever-related skills focused on 'fixing things' and using multiple methods to complete a task. Knowledge retention was also considered a signifier of cleverness, as was putting knowledge into action. In contrast to this, BG group felt that cleverness could be useful, but did not think it was essential to succeed in STEM (Excerpt 7.10). Perceptions of cleverness remained divided amongst groups in their final interview. SP and YP groups considered it important (Excerpt 7.13), while BF participants could not agree on its relative importance (Excerpt 7.12). Most discussions of cleverness in third interviews appear to regard it as the extent of an individual's knowledge. During the YP conversation about cleverness, the subject of 'nerds' was highlighted by Stanley's assertion that '*nerds are very clever*'. In the resulting discussion about 'nerds', participants struggled to define them, for example Molly suggested that '*no one's* really *a nerd, it's just some people look geeky*'. Some of the conversation was contradictory, appearing to come from a desire to embrace cleverness, but reject the 'nerd' label. Stanley described nerds as '*very clever'*, but then asserted that '*my dad's very clever, he's not a nerd'* and Pippin also stated that someone in their class '*is very clever, but he's not a* nerd'.

Barry: *I think you have to be clever to design*

…

Barry & Stanley: *yeah, you have to be clever*

Barry: *clever and sensible are a little bit of the same thing… if you're sensible, that means you're quite clever*

Pasta: *it's about clever of science and maths… you don't have to be clever*

Excerpt 7.9: Comments from YP and BG groups about cleverness, from the first interview.

Bluebell: *you need to be clever to make… to fix*

Apple: [my grandad is] *clever because he – if I ask him to fix an iPad or something, he'll just do it. It will take him like five days or something, but he'll do it*

Skull Trooper: *Rhodri, he helps other people with computers so he has to be clever to fix them*
NJ: *you need to be clever to be able to do things*
Skull Trooper: *you need to be clever to use a computer*
NJ: *to be able to fix things and to be able to tell what temperature different objects need to be in*

Barry: *yeah I think science, you can be clever because if you get two bones and try to stick them together – you try and stick it together and "oh, that doesn't go there – I'm clever so I can do the other way"*
…
Barry: *I think Ali could be clever. Clever what to do because if it's a baby born – she can be clever what to do with the – you know you need to clean the baby? She could be clever what step to do after the other*

Black Cat: *if you did something wrong, and you'd learnt it already – you need to also memorise it, so if it was two weeks ago that you learnt it and you forgot about it, you need to be clever to remember it*

Excerpt 7.11: Groups discussed cleverness in their second interviews.

Buster: *you don't need to be clever if you're working in STEM… you can be clever but you don't need to be to be in STEM*
Videogame Guy: *although clever you don't* ***need*** *it, it would be good to have it*

Excerpt 7.10: BG group felt that cleverness is not essential for STEM success in the second interview.

Skull Trooper: *if you're an archaeologist and you're looking at all those bones, you have to be clever to figure out which bones are which*

Interviewer: *can you think of any other examples where you might need to be clever in STEM?*

NJ: *in all of them, you've got to be clever in all of them*

Stanley: *you don't need to be clever –*

Barry: *but it would be good*

Stanley: *it's good to be clever because you know –*

Molly: *a lot of stuff*

Stanley: *you know more than ten stuff. You know about 100 stuff, which is very important*

Excerpt 7.13: SP and YP groups explored the perceived importance of cleverness in the final interview.

Black Cat: *you don't always need to be clever if you're working with STEM, because you might find things difficult. You might be doing a test, so you might be a bit resilient or a bit independent because you're not allowed to ask other people for help in the test*

Olivia: *I don't think it's that important because you don't really need to be clever to be a scientist*

Black Cat: *it's not about how smart you are, it's about your thinking… I'm going to need to think "what do I know already?"*

Bumble: *I think you need to be clever to be a scientist because you need to know what things mean, and what they are, and how they work, and stuff like that*

Bluebell: *so you need to be clever in parts of it, but not in other parts maybe*

Bumble: *you need to be good at maths. You don't need to be clever in all of it*

Olivia: *I'm mostly saying you don't need to be clever, some things you do need to be clever about. Like how to use some of the technology… and the rest I think you don't need to be clever*

Excerpt 7.12: BF participants disagreed on the relevance of cleverness in STEM in their final interview.

Discussions about cleverness became more detailed and nuanced as interviews progressed, likely a reflection of increased participant confidence and comfort in an interview context. BG participants consistently identified cleverness as being unimportant to pursue STEM, though other participants demonstrated more flexible attitudes. For example, Barry explored how cleverness might be comprised of other skills/aptitudes, such as being sensible, however, this perception was not sustained in YP's final interview, where participants emphasised the role of knowledge acquisition instead. Black Cat initially linked cleverness with knowledge retention, but highlighted different 'types' of cleverness and their associated skills in her final interview. Outside of these interviews, cleverness is frequently perceived as essential to STEM (Bian *et al.* 2017), with negative effects on people's STEM self-concepts (Brown *et al.* 2008; Archer *et al.* 2013b, 183). Therefore, it was notable that even where participants stated that cleverness is unnecessary, many then caveated that it could still be useful in STEM pursuit. This raises the question of how these participants have embedded cultural ideas about cleverness and STEM, and whether this has impacted their own self-concepts (see Chapter 8 for an examination of how participants relate to cleverness in their self-reflections).

The archaeological interventions made no explicit reference to 'cleverness' or its necessity to pursue archaeology. However, one participant did link 'cleverness' with faunal analysis, suggesting that this experience resulted in them associating 'cleverness' with archaeology. Their assumption that 'cleverness' is defined by 'knowing things' may be related to this, as pupils encountered a great deal of new knowledge in each intervention. Therefore, interventions may have inadvertently reinforced the perception that 'cleverness' is vital to succeed in STEM. To counter this, educators could highlight alternative skills/aptitudes as they are used during learning opportunities to draw attention to broader practice than simple knowledge acquisition.

7.1.5 Creative

Creativity did not generate much discussion in the first interview (Excerpt 7.14): what was said was generally positive, though Cleo explored potential drawbacks of creativity when following instructions. In the second interview, NB participants drew upon personal experiences of STEM and creativity from their school's Science Week, while BF pupils discussed it in terms of the people presented in the STEM profiles (Excerpt 7.15). Only BF and YP discussed this skill/attribute in their final interview. Bumble and Olivia discussed the way in which archaeologists might use creativity (although it is possible that 'archaeologist' was confused with 'architect'), and YP made suggestions for creative STEM inventions (Excerpt 7.17). BF participants also discussed ways creativity is used outside art and design, though not all pupils agreed that this was the case (Excerpt 7.16).

Jelly: *I think you need to be very creative, to help about science. Because you need to be creative to learn about new things*

Stanley: *if you're creative, you could make something up and it can be very clever to use. You could make anything, you could make up a new science thing*

Cleo: *you can't be over creative because maybe you have to stick to something and if you're too creative, you might not stick to it*

Excerpt 7.14: Participant comments about creativity in the first interviews.

Pepperoni: *so you have to be creative to do something? We're making* [an] *invention and you have to be creative – you don't have to be, but you can be as creative as you like*

Jelly: *I've been very creative with my invention. It's basically a really fancy windmill that can stop a tornado*

Pepperoni: *mine is a bin which has electric arms to pick up trash on the floor*

Olivia: [Ali] *might need to maybe mix some medicines*

Black Cat: *or maybe that's also like taking risks. Because it could be wrong. Because in medicine, if you try it and it goes wrong, something could happen to you and then they won't know what medicine to use to help you get better*

…

Black Cat: *I think* [Rhodri] *needs to maybe make something for the equipment*

Bluebell: *if he's making something, he might not have a piece that he needs for the thing, so he doesn't have enough money to make it*

…

Black Cat: *Chloe might need it because if she needs to build something, she might need to use her imagination, so that also goes with imagination*

Excerpt 7.15: NB and BF pupils discuss uses of creativity in STEM in their second interview.

Olivia: *you have to be creative*

Bluebell: *you don't have to be creative in maths though*

Olivia: *in art, you've got to. You've got to be creative thinking about what the bone is. Because sometimes creative can mean –*

Black Cat: *– other things. Not just "oh I'm just going to make something"*

Olivia: *you can also have creative thinking*

Interviewer: *okay – would you use creative thinking in maths?*

Olivia: *yeah*

Black Cat: *a bit yeah, because would you just have to make a sum up, but it's not right –*

Bumble: *I don't think you can just imagine and make a sum up*

Olivia: *you have to be creative to pick the right numbers – say you got a sum, you have to be creative to find out what the answers is. You can't just be silly, you have to be creative and think creatively*

Excerpt 7.16: BF participants discussed how creativity is used outside of art and design.

Bumble: *archaeologists are sometimes creative*

Olivia: *they need to build stuff*

Bumble: *they imagine it, then they draw it and they work out if they can build it or not*

Stanley: *because you could design lots of stuff which are very creative, and things which are not useless, but they're useful, they might be useful in the future*

…

Barry: *you could invent a cupboard which is automatic*

…

Molly: *I have a good idea about an electric wardrobe… you could have this little thing on the wall with what style you want, so like jazzy, denim so you just click on that design you want and this thing would turn around: denim ding ding!*

Excerpt 7.17: BF and YP participants made suggestions about how creativity might be useful in STEM in their final interview.

Participants' understanding of creativity developed in a similar way: while almost all children thought it was important to a person working in STEM, their initial explorations appeared vague and based in hypothetical or theoretical examples. Statements and phrases, such as '*science is creative*', '*make up a new science thing*' are very generalised and were not followed up by specific examples. However, the second interview generated more concrete ideas about creativity and STEM in response to personal experiences and the STEM profiles. Though the STEM profiles were not part of an archaeological intervention, they still appear to have had an impact on how participants discussed creativity in STEM. There may be value in developing such resources so participants can further explore concepts of skill and aptitude as part of their STEM learning.

Nuanced perceptions of creativity were also demonstrated in the final interview; most participants understood creativity to be applicable beyond arts and crafts, though it was primarily associated with 'making' things rather than a way of thinking. The creative content of interventions (e.g. aqueduct construction) may have further embedded this perception, and future iterations could emphasise broader types of creativity more effectively through signposting and 'creative thinking' exercises. Bumble and Olivia's comments on the creativity of archaeologists following the aqueduct session may reflect confusion between two similar sounding words (archaeologist and architect) or a perception of archaeologists as creators. Experimental archaeology is an extremely creative branch of the discipline, and though not explicitly discussed during interventions, it may be an area of future potential in engaging creatively aligned people in STEM via archaeology.

7.1.6 Curious

Discussion of curiosity was extremely limited in both interview sessions, though where it was considered, it was consistently discussed as a way for a person to increase their knowledge. Black Cat , Cleo and Jelly expressed their thoughts about curiosity in the first interview, which Black Cat making further reference to animal bones (Excerpt 7.18). Only Buster and Black Cat chose to talk about this card in the second interview session, and both highlighted the role of curiosity in learning and knowledge acquisition (Excerpt 7.19). None of the participants elected to speak about curiosity in their final interview. Participants' understanding of curiosity was that it could help them 'learn new things', but discussions rarely explored examples of how this might apply to STEM practice.

Black Cat: *I think that's actually important. If you found a bone of this animal, and you haven't found the last bone, then you're curious to find it*

Cleo: *you can't be over curious, because you can't just be nosey looking at what other people are doing*
Jelly: *yeah, like if you have someone next to you and you're being really nosey*
Cleo: *and it's like if you were doing a test, you can't really look over and ask people questions… so you can't be that curious, but it's still important to learn new things. It helps learning new things*

Excerpt 7.18: Black Cat, Cleo and Jelly discussed 'curious' in the first interview.

Buster: *if you have new things and you don't want to learn about them then you're not curious. But if you did want to learn about them, then you'll know about more things*

Black Cat: *you might want to find out more things, not just stay to the ones which you already know because you need to have a growth mind set if you want to be curious*
Interviewer: *so which people do you think need to be curious? Is there anyone in particular?*
Black Cat: *I think maybe Johanna because she – well she's curious about history and she wants to learn more about it*

Excerpt 7.19: Buster and Black Cat explored curiosity in the second interview.

While curiosity *is* a key component of learning (Pluck and Johnson 2011, 24), it is argued by some that the current curriculum (Craft *et al.* 2014, 18) and system of SATs testing (Ward and

Quennerstedt 2019, 274) restricts teachers and pupils in their pursuit of curiosity in the classroom. This is not to imply that participating teachers do not foster a 'culture of inquiry' (Uiterwijk-Luijk *et al.* 2019, 2) in their lessons, just that those who feel most constrained by time pressures and performance indicators (experienced by a number of teachers in this study, see Chapter 4) may be less able to give pupils completely free reign in investigative lessons. It was noted in the first intervention that some pupils lacked confidence when challenged to direct their learning via research questions (see Chapter 5, section 5.2.1), which may be related to this. It was interesting that Jelly, who consistently demonstrated academic curiosity by speaking about a range of interests (learning German, the periodic table, Roman history) throughout each interview, did not speak more about the 'curiosity' trait. Although this aptitude might describe him well it appears that the interventions did not support him (and others) to recognise how it might be valued in a STEM career.

7.1.7 Enjoys dancing

The majority of participants laughed when this card was raised: the implied comedy of dancing having relevance in STEM, demonstrates the strong perception of participants that it does not. Exceptions to this were Cleo, who suggested ways that dance and science might overlap, and Bumble, who highlighted potential benefits of agility attained by dancing (Excerpt 7.20). The second interview revealed more nuanced opinions of dancing and STEM; while Buster continued to argue that dancing was irrelevant to STEM, SP and BF participants observed that an interest in STEM did not preclude a person from enjoyment of dancing (Excerpt 7.21). In the final interview, enjoyment of dancing was largely understood as something that is not particularly relevant to STEM, but does not impact a person's ability to succeed in it (Excerpt 7.22).

Despite the overwhelming perception that enjoyment of dancing is not important to a person with a STEM career, all groups agreed that having an interest in dancing and STEM were not mutually exclusive. Olivia's examples were particularly powerful, as she drew upon an existing relationship as evidence that STEM and dancing are compatible interests. Most responses to this card focused on whether dance would be 'used' in STEM, rather than considering how dancers use STEM knowledge to maintain their fitness as athletes (Mehta and Choi 2017; Redding 2019). The relationship between dance and sport was recognised only by Cleo: '*it's a type of sport'*. As Cleo was the only participant to consider how the physiology of dance is relevant to STEM, this suggests an opportunity for children to explore STEM from a new angle. 'Bones' were also mentioned as an example of STEM-based work by Blossom, indicating her understanding of faunal analysis as a legitimate STEM activity. The faunal analysis intervention was successful in presenting this perception to her.

Videogame Guy: *not at all important*

Blackjack: *you're not going to be doing it*

NJ: *not important at all*

Jelly: *if you're good at dancing, it doesn't really help you do science*

Cleo: *I disagree because maybe if you're a scientist, maybe you're looking at what happens to your heartbeat or maybe to your oxygen levels when someone's dancing*

Bumble: *you need to be clever to do the footwork… if you have strings around where you're working, you can jump over*

Excerpt 7.20: Participants discussed dancing in the first interview.

Buster: *enjoys dancing isn't relevant*

Interviewer: *okay – can you tell us more about that?*

Buster: *because in science technology engineering and mathematics, you don't do any dancing in that*

NJ: *if you find something important you might want to have a little boogie*

Cupcake: *well you could enjoy dancing, because you wouldn't use it in your work, but you could still enjoy it*

Olivia: *she's my baby sitter and she teaches me in dance – but I think she's working in science… I'm not quite sure, because she's in university but I don't know exactly*

Excerpt 7.21: BG, SP and BF participants discussed dancing in their second interview.

Blackjack: *you don't need to enjoy dancing for your job because you don't do any dancing in STEM*
Videogame Guy: *the only way it would be good to enjoy dancing in any type of job is if you were a dancer*
Buster: *you can still like dancing just –*
Videogame Guy: *you just don't need to*
Buster: *not in your job*
Videogame Guy: *well you can, but you don't need to because it wouldn't make any difference*

Olivia: *you don't really need to enjoy dancing to do* [STEM]*… because that's not really in the job*
Black Cat: *your hobby might be dancing but then your job can be a scientist. So you can still enjoy it – but you might just have a different job than your hobby*
Olivia: *like my mum's friend, who's a scientist, she still does dancing*

Blossom: *you don't dance when you're looking at bones and you don't need it in STEM. It doesn't help you with STEM*

Pippin: *in science, technology, engineering and maths, I don't really need dancing*

Jelly: *if you were very obsessed with it, you'd just spend all day* [dancing]
Apple: *yeah because when you're working, you might be dancing and you might get something wrong*

Excerpt 7.22: BG, BF, SP and YP participants discussed dancing in their final interview.

7.1.8 Enjoys maths

Throughout all three interviews participants observed that the 'M' in STEM represents 'mathematics', and reasoned that enjoying maths would facilitate success in STEM. Buster countered this in the first interview, arguing that being 'good' at maths is not essential to its use (Excerpt 7.23). General examples of 'counting' or 'adding' were common amongst participants in the second interview (Excerpt 7.25), indicating that these are skills they could most easily conceive in a 'STEM career'. A range of mathematical skills are covered in the KS2 curriculum (DfE 2013a, 113-141; DfES 2016a, 2-11), and were also present in the archaeological interventions, including graph making and interpretation, and calculating variations in temperature over time (see Chapter 5). Skull Trooper was the only child to reference maths skills from a workshop, indicating that interventions were largely not recalled by participants when asked to consider the use of maths in a STEM profession.

Black Cat: *it's very important because then if you have tricky sums to do, you can find them out in different methods*

Bumble: *I think it's important because in STEM there's maths*

Blackjack: *if they don't, they basically won't enjoy STEM because there's maths in STEM*

…

Buster: *you don't need to be good at maths to do it*

Jelly: *if you're a scientist, you do need to be good at maths*

…

Apple: *you might need to enjoy maths because then you would know what to do*

Excerpt 7.23: Participants examined how maths might be used in STEM in the first interview.

Videogame Guy: *to enjoy STEM you need to enjoy maths*

Interviewer: *how come?*

Videogame Guy: *because maths is a part of STEM, so to enjoy it all then you need to enjoy maths because that's a part of it*

Apple: [speaking about his grandad] *he enjoys maths because he's really good at adding up bills*

Pepperoni: *oh my dad does maths in BT Sport because sometimes he has to maybe – I don't know – count up stuff?*

Skull Trooper: *if it's 8000 BC and all the other stuff that you're talking* [about] *in the class, you could add up the years?*

Stanley: *you have to count their heartbeat*

Barry: *their heart pressure, if the electronic thing doesn't work*

Black Cat: *maybe Johanna because she might need to count how many* [artefacts] *she has from that day and then figure out how many need that place*

Olivia: *I also think Ali because she needs to count how many medicines are left in case there's no more medicine left*

Excerpt 7.25: Participant conversations about the use of maths in STEM in the second interviews.

Blackjack: *maths is an important thing of your job – of STEM – and it's part of STEM, so you need to know about it*

Cupcake: *maths is in the STEM. You use it in your job, so if you want to enjoy your job, you need to enjoys maths, science, stuff about technology because that's the stuff that you're using in your job*

Pippin: *because STEM, the M stands for maths. And if you don't enjoy maths or don't really know anything about maths, you can't really join in with STEM*

Excerpt 7.24: BG, SP and YP participants highlighted the placement of maths within the STEM acronym in their final interview.

Participants continued to highlight the placement of maths in the STEM acronym in their third interview, with the majority assuming that this denoted its relative importance (Excerpt 7.24). Some participants did consider it more broadly (Excerpt 7.26): Buster discussed the possibility of STEM jobs that are unrelated to maths, and Molly considered the word 'enjoy', suggesting that enjoyment was not necessary to use maths effectively. Throughout interviews, many participants spoke about STEM as if it were a single homogenous thing, despite previous discussion indicating that they understand the different strands within STEM. Some children did explicitly acknowledge how elements of maths are used across the whole spectrum of STEM: Jelly spoke about scientists' use of maths, while Stanley and Olivia explored its use in healthcare. Sustained engagement with broader applications of maths, such as that encountered in archaeology, engineering or sociology, combined with an explicit focus by educators on the maths skills in use may produce more effective outcomes in children's understanding of this.

Buster: *you don't have to enjoy maths… you* [can] *work in a job that is in STEM, but that doesn't really have that much about maths*

Molly: *you don't have to enjoy it, it's just you have to know how to multiply*

Excerpt 7.26: Buster and Molly discussed maths enjoyment in STEM in their final interview.

7.1.9 Enjoys science

In the first interview, some groups highlighted the link between 'enjoying science' and the 'science' branch of the STEM acronym, though not all were confident in their response (Excerpt 7.27). Pasta suggested a relationship between science, creativity and teamwork, but when pressed was uncertain of his rationale. In their second interview, participants described ways enjoying science might be relevant to a specifically scientific career (Excerpt 7.28). An exception to this was Stanley, who highlighted science in engineering. Almost all groups highlighted the positioning of science in the STEM acronym in their final interviews (Excerpt 7.30). Some discussions further explored the need to enjoy science if its constitutes a large part of your job (Excerpt 7.29), and others examined the interplay of science and technology (Excerpt 7.31).

Blackjack: *that's mostly what you're going to be doing… and* [pause] *yeah I don't know*

Pasta: *science is creative… when you're doing science, you can work as a team?*

Black Cat: *I think it's very important because that's in STEM. And if you do science, you will know a lot of things and then you can answer your friend's questions*

Bumble: *I think that's quite important because that's your job*

NJ: *you need to enjoy science though to do it*

Cupcake: *but it's not the* most *important thing is it?*

NJ: *technically yes*

Cupcake: *yeah but -*

NJ: *enjoy maths*

…

Cupcake: *in STEM you usually mostly use maths probably*

NJ: *but then you need to know science as well*

Excerpt 7.27: BG, BF and SP participants explore enjoying science in the first interview.

Videogame Guy: *well this one's quite like the maths one because science is a part of STEM and to enjoy STEM fully, you also need to enjoy science*

Black Cat: *science is in STEM… you find out new things all the time and it's really useful because if somebody else comes across that same thing, and they need a little bit of help with it, then you can help them*

Pepperoni: *enjoy science because if you don't enjoy science and you work for a STEM company, one day you might have to do STEM and you might – well you don't have to enjoy science, but it would be better if you enjoy science to do science*

Barry: *you can be a scientist if you enjoy it*

Stanley: *be a scientist, you* can *use science in engineering*

Interviewer: *yep?*

Stanley: *when you* [unclear] *a big plane: that's science*

Interviewer: *yeah?*

Stanley: *and then, with the actual plane – that's science*

Excerpt 7.28: Participants discussed enjoying science in the second interview.

Olivia: *you need to enjoy science to be a scientist, because if you don't enjoy science –*

Bluebell: *what's the point of being a scientist?*

Olivia: *yeah, what's the point? Because you don't even want to do science, but you're doing a science job. So I think you need to be able to like it to be able to do your job*

Cupcake: *if you're working in STEM it's to do with science. And if you want to do the job, you have to like what you're doing*

Excerpt 7.29: Olivia, Bluebell and Cupcake discussed the implications of enjoying science for a science career in the third interview.

Videogame Guy: *I think it would be good – the S is for science – so it would probably be good to enjoy science*

Bumble: *science is actually one of the STEM things*

Skull Trooper: *when you have STEM you might think you do science a lot, because it's even in the STEM name*

Barry: *science is like STEM because it's in the word: science, technology, engineering, maths*

Excerpt 7.30: BG, BF, SP and YP participants all highlighted 'science' in the STEM acronym in the final interview.

Bumble: *science is also part of technology… because you need to know how stuff works, and that's science isn't it? If you know how things work, you need to know how technology works – if you can do science, you can do technology*

Bluebell: *I think science is partly technology because there might be something that you actually need technology to work out*

Interviewer: *okay, like what?*

Bluebell: [pause] *I'm not sure*

Black Cat: *you might need to work out – your friend might have sent you this bone on the computer… and then you work it out with them, but then you're not near each other, so you could send texts or stuff like that for what you've worked out so far*

Interviewer: *okay, so the technology would help with your communication?*

Bumble: *I also think that technology's with science because scientists probably actually do use technology quite a lot. I think they also make technology*

Excerpt 7.31: BF participants explored how science and technology are used together in the third

Discussion of enjoying science primarily focused on pupils' identification that science makes up part of the STEM acronym. Many subsequently reasoned that enjoyment of science must be important to a person working in it to ensure enjoyment of their job. Some children refined their opinions as the interviews unfolded, developing from simply stating that enjoying science might be *'quite important'* to thinking about how an enjoyment of science might be applied within a career. This was best demonstrated by Bumble, Bluebell and Black Cat, who drew links between the skills used in science and technology, and explored how scientists might use technology in their work, whilst also being responsible for developing it. In this example, Black Cat mentioned faunal analysis; another indication of the longevity of the intervention experience in her mind. Black Cat's comment is the only example of a participant drawing upon their experience of scientific practice in the interventions, suggesting their limited impact on participants' understanding of scientific practice.

7.1.10 Enjoys sport

This card was initially perceived to be of limited importance for someone working in STEM. SP group built upon this by examining the role of stamina in physical work, but Black Cat remained sceptical of the value sport might have in a STEM career (Excerpt 7.32). Olivia's appeared to suggest ways sport and STEM might be interlinked; though her comment was not fully captured in the recording. In the second interview participants made similar suggestions about the benefits of being fit in physical work, but also explored sports knowledge in a medical setting (Excerpt 7.33). Barry and Stanley suggested a scenario where medical staff with knowledge of sport could advise patients on how to engage with sport following an injury. Videogame Guy caveated his example with the acknowledgement that 'enjoyment' does not preclude action, and that a person does not have to 'enjoy' sport to be physically fit.

Blossom: *because when it's sports, it can help you with things and then you won't have run out of energy to do anything*
NJ: *stamina*
Cupcake: *it can help you*

Black Cat: *enjoys sport? Then you won't be able to do your job – you have a job and then every day you're off doing sport, then you won't be able to do your job*
Olivia: *unless you're someone who works for sport… I think some people* [unclear] *because all you can do is time how fast you go and see how fast the other things go*

Excerpt 7.32: SP and BF participants comments on sport in STEM in the first interview.

Stanley: *you might have really hurt yourself by doing sports, and go to a nurse or a doctor. The nurse could help you then she says "you can do a little bit of sport"*

Barry: *but not too much*

Interviewer: *ah okay*

Barry: *like go to training*

Stanley: *when you finish it, you could be all back all on sport*

Videogame Guy: *you might need to be fit, but you don't need to enjoy doing that*

Interviewer: *why might you need to be fit if you work in STEM?*

Videogame Guy: *maybe you would be* [pause] *looking for something, maybe and you'll be outside. Or doing a task outside and then you might be running around to see if you could find it. And to be able to run good you need to be fit*

Excerpt 7.33: YP and BG participants describe sports and STEM in the second interview.

Most participants discussing this card in their final interview asserted that sport is irrelevant to STEM, and though some still suggested ways that it might be useful, these suggestions were largely related to fitness (Excerpt 7.34). Cleo's comments were the most realistic example of links between STEM and sport, whereas Jelly's concerns appeared more fantastical. The absence of change to participant perceptions of sport and STEM are unsurprising, as this project did little to address the many ways in which STEM informs sporting practice (Burkett 2016; Paul and Ellapen 2016; Mamrack 2017; Kellman *et al.* 2018; Subic 2019). While these participants did not consider an interest in sport to be an impediment to STEM, there is clear scope to broaden their understanding with particular implications for individuals who identify with sport but not STEM.

Jelly: *if you were learning about science or engineering or mathematics, sport wouldn't really be involved in any of those things… when you're a scientist it wouldn't really help, it would distract you… if you were just playing with a football, you could cause a whole station to explode. Because what if you hit a powerline and it causes it to malfunction and hit multiple things?*

Skull Trooper: *I don't think sports would be good for STEM because it's not really anything like science, technology, engineering or mathematical*

Videogame Guy: *sports isn't anything to do with science, nothing to do with technology, nothing to do with engineering or mathematics, so I just think it isn't important at all… it would be okay if you do, but it doesn't matter if you do or you don't*

Stanley: *it keeps you fit, but too much sport makes you really tired and stressed*

Black Cat: *you could celebrate by doing sport, like if you got the job?*

Buster: *maybe if you found animal bones and you found the animal* [but] *it was running away from you, you would be have to be able to chase it*

Cleo: *you could experiment with sport. Because if you like sport you could check your heartrate in exercise and you could see before and after… so if you enjoy sport you could do stuff like more research about it using STEM*

Excerpt 7.34: Participants discussed the pros and cons of sport in STEM in their final interviews.

7.1.11 Honest

This card was deemed important in initial interviews, although participants' comments were less focused towards a STEM context, and more towards honesty in general (Excerpt 7.35). An emphasis was also placed on not getting into trouble and owning up to mistakes, with only Barry and Stanley considering a specifically job-based context. These perspectives are likely based in the way that honesty is perceived in wider society. Children are discouraged from lying by adults (Wagland and Bussey 2005, 640) and through religious or secular stories (e.g. Aesop's fables; Talwar and Crossman 2011, 140-1). Participants' concerns about getting 'into trouble' are reflected in wider research which reveals that children favour honesty to avoid punishment (Wagman and Bussey 2005, 649; Talwar and Crossman 2011, 144; Talwar *et al.* 2015, 215). The theme of honesty in terms of admitting fault was continued in the second round of interviews, though participants made use of the STEM profiles to explore how honesty might be important in medicine, IT and civil engineering (Excerpt 7.36). Participants demonstrated an understanding of how dishonesty in a STEM career has repercussions beyond the individual.

NJ: *that's really important, because you should always be honest*
Cupcake: *always be honest*

Buster: *if you're not honest, then you might get into trouble*

Stanley: *you have to be honest to do the right thing, when you're doing your job*
Barry: *because if you broke one of the tools, you have to be honest you broke them*

Excerpt 7.35: Participants discussed the importance of honesty in the first interview.

Cupcake: *because if* [Ali is] *not honest with what she's saying to a patient, a patient could get really ill*
Skull Trooper: *Rhodri could be honest because if he's not honest and it broke again, if the computer's not fixed… he could have damaged it even more*

Bluebell: [Rhodri] *might need to be honest, to say to somebody that he cannot actually fix it*
…
Bluebell: [Ali] *might not have the right medicine, for the patients?*
Black Cat: [if Chloe] *was building something with somebody and she told them that she has the material, but she doesn't, then she needs to be honest about it. Because then the other person who's planning it will go ahead, and it's too late because the material could be in a different country*

Excerpt 7.36: Participants used STEM profiles to explore honesty in the second interview.

Honesty was discussed by two groups in the final interview. Participants gave examples where honesty might be important which covered a range of contexts: professional, personal and interpersonal (Excerpt 7.37). Bumble, Molly and Pippin's suggestions reflect design and collaborative themes of the third intervention, suggesting potential impact of the session on their perspectives. Molly also described an archaeologist finding money (assumed modern) whilst excavating, which does not reflect workshop content, but does demonstrate that she considers archaeology to be a STEM-related profession. This highlights the success of the interventions in instilling participants with the understanding that archaeology is a STEM-based discipline.

Bumble: *if you said the design has gone perfectly, and it hasn't, they will think it has and they'll build it like you said, and then it will go wrong*

Molly: *or you could have an honest opinion, so if someone gives you an opinion, you have to give them an honest opinion back*
Pippin: *yeah like if you didn't like their idea, you have to be honest because it might not work. So you could go "we could try your idea out first, but I don't think it's going to work". So we could try it out first*
Molly: *then change something that's wrong*
…
Molly: *so if you're an archaeologist… and you found something, if you found five pounds under the ground and you kept it, but then you felt like really bad*

Bluebell: *you could say you know how to do it, and they say "do it", and then you don't actually know how to do it*
Olivia: *so basically, say you can do football and they said "can you teach me?", and you actually have nothing to do with football, and you can't actually show them, and you just make up silly things*
Bluebell: *and then you're making big lies*
…
Black Cat: *if you say to your teacher "I've done my homework, it's on the computer" and then they check it, and then it's not there, but that was the deadline, you might get told off. But then you should be honest, so you could say to your teacher "Sorry I didn't have time" or "I didn't have the right things or anything like that to do my project so that's why I haven't brought it in, am I allowed a bit extra time?"*

Excerpt 7.37: YP and BF participants discussed honesty in a range of contexts in the third interview.

7.1.12 Imaginative

In the first interview a general consensus emerged about imagination's role in planning or preparation (Excerpt 7.38). No groups elected to discuss this card in the second interview although many participants chose to describe themselves with it (see Chapter 8). Only Cleo and Pepperoni discussed this card in their third interview, with Cleo asserting that imagination in scientific predictions is inappropriate (Excerpt 7.39). Throughout imagination was primarily perceived as a method for planning, or a diversion from work. Only Buster made specific links to STEM with her brief comment on imagination in engineering. Cleo favoured logic over imagination in STEM, framing imagination as a poor way to predict STEM outcomes. Ideas about the separation of skills like logic and imagination are based in (now discredited) neuroscience, where assumptions that they belonged to different hemispheres of our brains (Kitchens *et al.* 1991, 3) were disseminated into educational practice (Goswami 2006, 2; van Dijk & Lane 2018). This widespread assumption is likely to have impacted participants' perception of the relationship between imagination and STEM.

> **Black Cat:** *important because then you can get somewhere and then you can get the stuff and you can just build and make something really nice*
> **Bumble:** *instead of doing it on bits of paper you can have it in your mind*
>
> **Buster:** *if you're an engineer, you have to be quite imaginative about what you make*
>
> **NJ:** *it's quite important because you could think of something before you go there, or do something, you could plan something, or you can just have good thoughts of something that might happen*

Excerpt 7.38: Participants discussed imagination in STEM in the first interview.

> **Cleo:** *you need to be logical in your predictions because if you're just imagining, you're like* [impression of day dream] *rainbows, clouds – and stuff like that, it won't help and it's not useful*
> **Pepperoni:** [the experiment] *will probably blow up if you've done that*

Excerpt 7.39: Cleo and Pepperoni discussed imagination in the final interview.

Though imagination was subject to limited discussion in word sort exercises, participants described their own imaginative practice it in terms of making up stories, daydreams or actual dreams (see Chapter 8). This implies an association of imagination with things outside of reality, which may be at odds with STEM in these children's minds. Despite participants' limited interaction with this card in interviews, the interventions required substantial imaginative skills. Archaeology requires learners to picture past lives and events based on artefacts and data, something that was particularly important in the first and second interventions. Imagination also plays a role in the kind of creative design and construction of the third intervention. Highlighting imaginative skills as they are used will support learners to recognise its value in STEM and wider education.

7.1.13 Likes being outdoors

In the first interview, Blackjack suggested that being outside might be part of an engineer's job, while other participants thought that being outdoors might provide inspiration to someone in a STEM career (Excerpt 7.40). Discussion in second interviews examined the work archaeologists do outside (Excerpt 7.41). Bluebell and Black Cat also made reference to the STEM profiles and to personal experiences. Participants' thoughts were largely consistent throughout interviews; they considered outdoors to be a place of inspiration, but also a location to carry out work. Outdoor learning has been emphasised in schools with the rise of initiatives like Forest Schools (Maynard 2007), though not all schools have adequate access to outdoor spaces (Estyn 2017b, 70; Prince 2019, 338). This disparity in access to quality outdoor space often relates to children and school's positioning within rural vs urban environments (Thomas and Thompson 2004, 9). It was notable that the three participants who described outdoor spaces as sources of inspiration and discovery had access to a great deal of outdoor space at their schools and were based in rural environments. The third intervention made some use of outdoor space as a testing location for aqueduct structures, however there is much more scope to locate future archaeological engagements outdoors.

Blackjack: *like being outdoors: they might be building a house, when they're an engineer*

Black Cat: *being outdoors is good for science because you can look for things that might be interesting*

Bumble: *I think being outdoors is quite important because* [you might see] *how a bird* [flies], *you can use that to make an aeroplane fly better*

Apple: *you could discover new things like go exploring and discovering*

Excerpt 7.40: Participants describe ways being outdoors might be relevant to STEM in the first interview.

Black Cat: *because if you're digging up bones or something, then basically, you like being outdoors to find things?*
Olivia: *if you like to be outside, so say that I was digging up bones, I would basically need to go* ***into*** *the ground to get the bones… so I would need to get the bones, so I would need to like the outdoors*
Black Cat: *because my brother he also sometimes doesn't want to be outside, he wants to play the PS4, and I'm outside, so I get him out because I need a bit of help getting this thing out of the ground… getting somebody out of their place where they're on the computer or something like that – because being outside is good*
…
Bluebell: [Scott] *might go to a place, and he might need to be outdoors for it? So a job that he might need to do that's outdoors*

Cleo: *for STEM overall, you need to like being outdoors because sometimes you have to do experiments, if you're a scientist or if you're doing archaeology and you're excavating places, you need to be outside to do it*

Excerpt 7.41: BF and NB participants spoke about being outdoors in the second interview.

7.1.14 Likes computer games

This card elicited laughter from participants, their amusement indicating that they did not consider this to be important for a STEM career. This impression was supported by their accompanying statements (Excerpt 7.42). NJ was an exception to this; he encouraged his group to consider ways that computer games have value as a form of technology, and they subsequently agreed that educational games might be important learning tools. Apple suggested that playing computer games is a male pastime: *'boys are the ones that like the computer games'*. Though it is interesting to note that Apple held this view, the issue of gender and computer games was not explored any further in the initial interview as the conversation was moved on by another participant. While YP participants argued that board games were 'better' in the second interview, BG and SP participants' explored the value of computer games in STEM in more depth (Excerpt 7.43). Videogame Guy and Skull Trooper were initially sceptical, but identified links between computer games and technology. NJ's example demonstrated his familiarity with computer technology; an interest he had spoken about in the previous interview.

By the third interview participant conversations became more nuanced, with groups considering multiple viewpoints. Some pupils continued to argue that liking computer games is of low value in STEM, these reasons included: assumptions of gaming's irrelevance to a STEM career, and potential negative impacts of playing games (Excerpt 7.44). Participants also explored how playing computer games might have transferrable skills and other educational value (Excerpt 7.45). NJ went even further and used his computing expertise to discuss the role of game developers: *'if you make a computer game and you want to test it out… what if you want to make it better? Improve it'*.

Pippin: *this one is definitely not what you should do!*

Pasta: *you do **not** need to do that!*

Apple: *if you're doing the computer… and you play computer games, it might make your eyes bad so you can't see the computer properly*

Skull Trooper: *I've got a really not important one*
Cupcake: *that's the least important!*
NJ: *that's really important… if it's technology, you should be like*
Cupcake: *it could be a game that helps you - helps you learn some more stuff*
Skull Trooper: *that's true*

Excerpt 7.42: Participants' perception of liking computer games in their first interview.

Stanley: *because* [computer] *games are not the **best** thing, but some games like monopoly, you could learn –*
Barry: *you can learn to bank*
Stanley: *yeah you could learn how to use the bank… board games are a lot better… chess, you have to have the mind to check mate*

Videogame Guy: *you definitely don't need to because it's not relevant at all – well it's an intsy wintsy bit relevant for the technology bit … because computer games are technology, but you don't **need** to like them*

Skull Trooper: *like computer games* [laugh] *it might be a little bit for* [Rhodri and Scott]
NJ: *because they both use – Rhodri fixes computers so he might need to know how to make a computer game – like computer games, maybe it's got a virus on it and then it gives the whole thing a virus, he needs to be able to get the virus off that disk to then carry on using it. Then Scott needs to be able to make a device that if when he plays a game, to stop anyone hacking it or something?*

Excerpt 7.43: Participants explored the value of computer games in STEM in the second interview.

Jelly: *computer games can be very distracting*

Cleo: *or you could get addicted to it and miss work*

Jelly: *you get addicted to it and play it on your work computer*

Blossom: *when you play computer games all the time, you won't really learn anything*

Stanley: *enjoys computer games? That's really silly… you can spend too much time on it… and sometimes you can get a little bit addicted*

…

Barry: *say you were addicted to computer games and you worked in STEM, you would just think of computer games*

Blackjack: *you might go on the computer, but I don't think you'll play games*

Buster: *you don't have to like computer games. You can, but it's not very important for your job*

Videogame Guy: *so it's* ***okay*** *to do it, but you don't have to*

Olivia: *you don't have to like computer games to be able to do STEM*

Bumble: *it's technology isn't it?*

Black Cat: *yeah, but computer* ***games***

Excerpt 7.44: Participants discussed why liking computer games may be irrelevant to a STEM career in the third interview.

Black Cat: *when you're young, you might have heard this game and you played it, but then when you're older, you might need to use some of that skills which you used*

Apple: *if you like computer games it might help you with all the keyboard, keys and things like that… it might help you type really fast as well*

Bumble: *there is some computer games where it's questions and you answer the questions*
Black Cat: *there might be a game where you have to answer questions, to get to the next level and then you might have to answer question in your work*
Bluebell: *one of the questions could be, maybe a very important question: a thing you must know when you're older*

Molly: *it can make a computer game on STEM? Like a computer game so it's educational*
Stanley: *so you could have a game to find bones and learn about them*
Molly: *yeah!*
Stanley: *so there could be episodes of finding a bone and learning about it… BUT you won't really get money for that would you?*
Barry: *that's technology, that could fit in technology… but I don't think it's that important*

Excerpt 7.45: Participants described potential benefits of computer games for a STEM career in the third interview.

This skill/aptitude was notable for the development in discussions throughout each interview. As participants became more confident discussing STEM, their conversations became more nuanced and insightful. In wider cultural discourse, playing computer games is often presented in a negative light, with some suggestion that it might even be harmful to children (Wartella and Jennings, 2000, 38-39; Ng and Wiemer-Hastings 2005, 110; Billieux *et al.* 2015). Some of the conversations outlined here subscribed to the belief that games can have a negative impact, though others acknowledged benefits of games as learning and skill development tools. There was limited consideration of the gaming industry – a rapidly growing area of STEM (Cabras *et al.* 2017, 306) – indicating that these individuals had not considered how computer games are created. Only NJ recognised this, likely due to his background in computing and the experience of making his own computer game. Despite negative discussions around computer games in STEM careers, numerous participants highlighted a personal interest in them for the self-reflective exercise (see Chapter 8), revealing another way in which STEM engagement could be approached with this group. Stanley's example of 'finding bones' in an educational game is a further example of the long-term impact and memorability of the first intervention.

7.1.15 Likes helping others

Discussion about this card in the first interview emphasised its relevance when helping peers and colleagues with work or research (Excerpt 7.46). The context of helping colleagues was explored further in the second round of interviews, though responses were more specific via use of STEM profiles (Excerpt 7.47). Skull Trooper's comments were made in response to the 'listens to other people' card, but are more relevant to the issue of helping others. Skull Trooper had previously spoken about helping peers in IT lessons, and his words here may reflect that experience; he has not considered that Rhodri helps people with IT issues as part of paid employment.

Barry: *likes helping others… because if they're stuck, you can help them*
Stanley: *because tell your friend you can do something, and they can't – but they* can *– but*
Molly: *they don't believe in themselves*
Barry: *I think if you're working together, you could help someone else in your team*
Stanley: *then you might do something different to your* [gestures at another participant] *work then you could do something a little bit different and then when the boss comes in and he checks the work, his might be better, but you've helped!*

Cupcake: *if somebody needs help, you could go over and help them if they're struggling to research something, you could help them*

Excerpt 7.46: YP and SP participants discussed helping others in the first interview.

Videogame Guy: *I don't know why – I just think so. Say you're working together, then say the other person couldn't do something, but you needed to do it. Then you could help them and then you would end up doing it*

Pepperoni: *if you're a – how do you say it?*
Cleo: *Archaeologist*
Pepperoni: *yes! There you go. You have to help each other to figure out what bones it is*

Bluebell: [indicates Ali] *because she's a doctor… so she needs to give them medicine and stuff so she must like helping others… I think* [Rhodri] *helps other people because he fixes stuff for them?*

Skull Trooper: [Rhodri] *helps other people for nothing – they don't do anything for him and he just does it for them without them doing anything for him*

Excerpt 7.47: Participants described ways STEM workers may help people in the second interview.

In their third interview, participants discussed this card exclusively in terms of helping someone with a piece of work (Excerpt 7.48). Some of these comments appear to have a clear basis in the experience of a school child, though others are more ambiguous and could refer to a workplace, or a school setting. Some groups also outlined scenarios where a person might not choose to help others (Excerpt 7.49). Skull Trooper spoke about teaching peers (which may be a further reflection of his own experiences), and Bluebell and Bumble discussed whether helping others may hinder personal development. In the same interview, Black Cat and Blossom outlined similar rationales for the importance of helping people; describing it as '*kind* and *'nice'*. Contrastingly Bluebell and Bumble were concerned that helping a peer might result in them getting unfair recognition for your ideas. It may be significant that the participants who regarded helping people as kind or nice were female, while the two who perceive a potential competitive threat were male. Male and female children are frequently socialized differently, with strongly gendered expectations of behaviour where boys are encouraged to be assertive and competitive, and girls to be compliant and accommodating (Orr 2011, 273; Verniers *et al.* 2016, 376-377).

Black Cat: *it's quite important because* [someone] *might be really stuck and you might be almost finished so you could help them because you might have a certain amount of time so you could just help them because it would be kind. And kind is one of our citizenship values*
Olivia: *I think it's actually quite good, because say you're finished and somebody's really stuck, and they're only on the second or first question – when there's about five questions – you have to help them because time's nearly out. So you could – not give them the answer – but just give them some solutions… but you can't just not help them because if you don't help them –*
Black Cat: *they might lose their break or something*
Olivia: *yeah they might lose some of their break and they're your friends and you wanted to play with them*

Blossom: *it's nice to be helpful*
Interviewer: *how might you help others if you worked in STEM?*
NJ: *give them an answer*
Interviewer: *giving some answers maybe? Anything else?*
Blossom: *helping them work out things?*

Excerpt 7.48: BF and SP participants spoke about helping a peer or colleague with work in the third

Skull Trooper: *I don't think it's that important – I think it should go in the middle – it's important if others want you to teach you stuff, sometimes you don't want to teach them stuff*

Bluebell: *I don't think like helping others is very important… maybe because it will be them who's improving, not you who's improving?*
Bumble: *you might have one of your best ideas ever and you might tell them and they'll use them, and it will be like you're the second person to use your actual idea*
Bluebell: *and you come up with the idea, and you want to maybe build it, but they build it and they get the reward. When the person who figured what it should do, should get the reward*

Excerpt 7.49: Skull Trooper, Bluebell and Bumble explored reasons to not help others in the third

Interviews revealed few instances where pupils examined how people working in STEM help those outside a circle of co-workers or personal relationships. Bluebell and Skull Trooper outlined examples of helping strangers: a doctor helping a patient, or an IT technician solving a clients' problem. The majority of participants did not discuss how a desire to help people translates into a career choice, or the potential for STEM careers to help others via research, development, or output. This finding is consistent with other studies, where pupils citing a desire to help others as a factor in career choice were in the minority (Schultheiss *et al.* 2005, 251). It is possible that the pupils were unaware of (or did not articulate at the time) the huge impact STEM has had on improving lives, most notably in terms of health and technological advances. The age of participants may be a factor here, as they have grown up at a time when many of these advances are already embedded in everyday life (e.g. smart phones, Haddon and Vincent 2015), and may be less aware of their impact.

7.1.16 Logical

While participants suggested that this card might be important to a person working in STEM, they did not elaborate much during the first interview. The glossary definition provided in each session ('is able to think clearly about facts and information'), led some children to focus on acquisition of knowledge, rather than the process of 'thinking clearly' (Excerpt 7.50). Cleo was the only child in this interview to distinguish between *learning* 'facts and information' and thinking logically *with* that information. Only Buster and Black Cat discussed this skill/aptitude in the second interview (Excerpt 7.51). Buster's comments suggested that while she did not consider 'logical' as a way of thinking, she did believe that people in STEM ought to be knowledgeable about their field. Black Cat spoke about logic as a tool to plan for the future and touched upon logistical considerations of travel. This card was not discussed in the third interview.

While the conversation surrounding 'logical' did not reflect much on logic, the emphasis placed on knowledge acquisition by participants indicates that pupils believed people working in STEM should have a great deal of knowledge about their chosen field. According to developmental psychology, young children are unable to think logically (Babakr *et al.* 2019), though theorists are undecided upon the age at which logical thought emerges (Comer and Gould 2010, 78; Maksimenko and Mirzakhanyan 2019). While the Welsh and English primary maths curricula cover a broad range of logical processes, 'logic' is not specifically alluded to[21] (DfE 2013a; Welsh Government 2016), resulting in pupil unfamiliarity with the concept. It is possible that the limited discussion reflects this.

Cleo: *if you don't understand facts and information, you can't really transfer it to anything. If you have a question in school, it might be like a comprehension or something. So you have to read the text and you have to find out the answers and*

…

Pepperoni: *knowing facts and information helps you be a better science person*

Apple: *yeah but if you understand everything that means you don't have anything else to learn*

Jelly: *if you know everything there's no point of being alive because you need to learn new things to have fun*

Cleo: *but if you are logical, it means to be able to think clearly about facts and information you're given, not like facts and information* [that] *you already have*

Pippin: *you've got to know a lot of information about what you may be teaching, or what you're doing*

Cupcake: *I don't know but it seems like a good one to have if you're going to work in STEM*

Excerpt 7.50: Participants discussed logic in the first interview.

[21] Logic is mentioned in the English computing curriculum only (DfE 2013, 179).

Buster: *I think you need to be logical if you're in STEM because you have to be able to know about the facts and know about the information and if you have historical artefacts then you have to be able to know things about what – what kind of things they're from and what year they're from*

Black Cat: *then you can think clearly what you're going to do in the future and what you've already done… then that could help with something that is happening, or is going to happen in the future… if* [Scott is] *going to Japan, he needs to think "what's the quickest way to get there?" because if there's something which has gone wrong with the technology then he has to get there*

Excerpt 7.51: Buster and Black Cat considered logic in the second interview.

7.1.17 Methodical

Participant discussion about this skill/aptitude in the first interview was largely moulded by the glossary definition. Based on the definition 'able to follow a set of instructions carefully' children focussed on the ability to follow instructions, rather than completing a process step by step. Conversations emphasised avoidance of harm (Excerpt 7.52), perhaps prompted by the inclusion of 'carefully'. Jelly suggested that methodical might mean 'good at maths', though his rationale was unclear. The glossary definition was amended for participants' second interview, to read 'works through each stage of a task carefully'. The resulting discussions outlined being methodical in educational and professional contexts (Excerpt 7.54). This card was not selected for discussion in the final interview. Participant responses to this skill/aptitude did change throughout the research period, though this was in response to an alteration of the glossary definition. Discussions were mostly limited, though pupils were able to make some suggestions of how methodical practice might be useful in a professional STEM context. Some of these suggestions were vague, but indicative that participants believed a methodical approach is taken in order to ensure that work is complete and correct. Unfamiliarity with the concept may also have been a factor in these responses.

Interviewer: *what does methodical mean?*

Jelly: *good at maths, because if you're a scientist, you do need to be good at maths*

Apple: [reading from glossary] *follows a set of instructions carefully*

Jelly: *yeah because if you don't do something correctly, you can end up getting hurt*

Cupcake: *that's really important I would say because if you don't follow the instructions, it could go wrong*

Bumble: *follows instructions carefully, you don't **actually** have to do that*

Excerpt 7.52: NB, SP and BF participants discussed methodical in the first interview.

Interviewer: *what does methodical mean?*

Jelly: *good at maths, because if you're a scientist, you do need to be good at maths*

Interviewer: *methodical, part of that might be being good at maths – what does it say on* [the glossary]*?*

Apple: *follows a set of instructions carefully*

Interviewer: *yeah, so you can follow sets of instructions carefully, you can work through something in a careful way*

Jelly: *yeah because if you don't do something correctly, you can end up getting hurt*

Cupcake: *that's really important I would say because if you don't follow the instructions, it could go wrong*

Bumble: *follows instructions carefully, you don't **actually** have to do that, so I think* [less important]

Excerpt 7.53: NB, SP and BF participants discussed methodical in the first interview.

Cupcake: *when you're doing your research and you're helping somebody maybe you have to do it carefully and in steps, so you don't go all rush into it and you forget to do something*

Stanley: *methodical: works through each stage carefully… instead of rushing it and going like this* [scribble] *"finished" – might have all of the answers wrong*
Barry: *so you work through and you have loads of time – you have two hours and it only takes an hour and a half and you have two hours you just go slowly*
Stanley: *then you say to your teacher "finished" … and your teacher looks at it and she's like "F"*
Interviewer: *is that important for people who work in STEM as well as when you're doing a test?*
Stanley: *yeah because you have to learn the bones… if you find one you'll be like "oh… I forgot to check which one it was"*

Olivia: *I think Ali needs to do that one because she needs to think things through before, like which medicine they should take*
Interviewer: *okay, is there anyone else who needs to be methodical?*
Bluebell: *maybe* [Rhodri] *because he needs to think things through – what he needs to do with that thing*

Excerpt 7.54: Participants discussed methodical in the second interview.

7.1.18 Organised

Discussion of this skill/aptitude in the first interview was vague and brief; NJ and Buster's comments did not convey any particular importance on this card (Excerpt 7.55). In the second interview, organisation was described as a tool to keep objects in order and its application in time keeping (Excerpt 7.56). The two groups who discussed this card in their final interview (NB and SP), focused on the concept of tidiness (Excerpt 7.56). Participants considered organisation in terms of physical objects, rather than time or task management, and believed that a lack of organisation can result in damaged or lost equipment.

NJ: *you need to be quite* [organised]

Buster: *you can be organised, but you don't need to be organised all the time*

Excerpt 7.55: NJ and Busters discussed organisation in their first interview.

Buster: *you have to be organised because if you have two bones that look exactly the same… if they mix together, you can't really put them back into the other groups… you have to make sure you've organised which things are which*

…

Videogame Guy: *about what she said about the bones being the same – to organise them you could write down the names of the people who were using it on them… so they don't get mixed up*

Olivia: *I think Ali might be organised, because she might need to get the medicine out before the patient comes to pick it up*

…

Interviewer: *so why might you need to be organised if you're a doctor in a hospital?*

Black Cat: *because if you can't remember where a medicine is, and your patient is coming, then you need to be organised where your medicines are*

Excerpt 7.57: BG and BF pupils discussed organisation in the second interview.

Jelly: *if your desk was just* [messy], *you'd find it very hard to find something. Say if you were trying to find a very special piece of equipment, and you find out it's snapped in half, I don't think that would be much help*

Cupcake: *in STEM, you need to be organised about what you're doing. If you're not organised you'll have bones everywhere, you won't know where your pencil is to write, you won't know where stuff is. It's gonna be everywhere, and it's gonna be very messy*

Blossom: *and you need to be tidy*

Cupcake: *yeah, you need to be all tidy and when you finish, you need to clean it all up so it's all nice and tidy*

Excerpt 7.56: NB and SP pupils discussed organisation in the final interview.

Organisation was mostly considered in terms of ordering physical objects, but with reference to specific STEM careers, including archaeology via mentions of 'bones'. Participants' discussion of organisation became more extended as they progressed through each interview, indicating a higher degree of comfort with the interview context, and a greater degree of knowledge about STEM careers. Participants made suggestions that were related to areas of STEM, but did not necessarily reflect the reality of those careers. However, the accuracy of statements is a secondary concern to pupils' exploration of organisation's relevance in a STEM career.

Emphasis on organisation of objects rather than time may reflect pupils' experiences in school, where they have limited control over daily timetables but are encouraged to keep workspaces and classrooms tidy. Cupcake and Blossom's assertions about being 'tidy' are of particular interest here: their class teacher noted that these pupils often volunteer to help, which Cupcake also highlighted in her self-reflections (see Chapter 8). It is likely that these girls' perceptions of organisation are connected to their own experiences of 'tidying up' their classroom. Gendered child socialisation is relevant here as female children are more likely to undertake domestic work within the home (Etaugh and Liss 1992, 141; Wikle 2014), and anecdotally are more likely to do so in the classroom (Reay 1995, 363, Skelton *et al.* 2009, 198).

7.1.19 Resourceful

Only Black Cat and Olivia spoke about this card in their first interview (Excerpt 7.58). Black Cat defined resourcefulness in terms of obtaining resources, while Olivia outlined a method pupils might use to solve theoretical problems. In the second interview, discussion surrounding this card was heavily framed by the glossary definition ('finds quick clever ways to get things done or make things easier'), particularly the idea of doing something quickly (Excerpt 7.59). Resourceful was not discussed in the final interview. Participant discussion of this skill/aptitude was limited, but did appear to change in response to the STEM profiles in the second session. 'Resourceful' is another skill/aptitude that children may be less familiar with; at their age resources may be more frequently provided by parents and other adults. It was notable that participants did not opt to speak about this trait following their third workshop, where one of the roles had been 'resource manager'. This decision emphasises participants' ambivalence towards resourcefulness as a useful STEM skill.

Olivia: *quite important*

Black Cat: *because then you get equipment to help you, then if you can't do it maybe your friend could be equipment – because if you can't do it on your own then you can ask them to help*

Olivia: *and also our teacher went on a course and she said we could work things out by 'brain, buddy, boss'… and brain is our brain, buddy is our friend, and boss is the teacher*

Excerpt 7.58: Olivia and Black Cat discussed resourcefulness in the first interview.

Buster: *Ali works as a doctor and she has to think quickly because then she has to work out what the cure could be*

Black Cat: *because if the patient has chosen a time when to be there… then* [Ali] *needs to get a quick and easy way how to get it done so that they can be back home*

Excerpt 7.59: Buster and Black Cat discussed resourcefulness in the second interview.

7.1.20 Sensible

In the first interview, much of the conversation surrounding this card focused on accident prevention (Excerpt 7.60). Barry and Stanley also highlighted links between being sensible and being clever and Cleo discussed drawbacks of being '*too sensible'* (Excerpt 7.61). Examples in the second interview also focused on potential negative outcomes of not being sensible (Excerpt 7.62). The link between safety and being sensible was explored further in participants' final interview (Excerpt 7.63). Buster's comment was made in response to the 'reliable' card, but has been included due to its pertinence here.

Blackjack: *because if you* [are] *silly, something could go wrong*

Pepperoni: *if you don't be sensible, you might go too far and it might go all wrong because you didn't be sensible. And if you're sensible, you wouldn't have messed it up*

Molly: *I think it's important so you don't mess around*

Black Cat: *you need to be sensible so you can hold a bone and not drop it*

Excerpt 7.60: Participants spoke about being sensible and accident prevention in the first interview.

Barry: *clever and sensible are a little bit of the same thing*
Stanley: *if you're sensible, that means you're quite clever*

Cleo: *you can't be over sensible, because then it will be boring if you're too sensible, so you need to have at least fun with your job*

Excerpt 7.61: Barry, Stanley and Cleo made suggestions for being sensible that did not focus on accident prevention in the first interview.

Jelly: *you have to be sensible because you can't just be playing catch with random bones. You can't be throwing bones all over the place – what if you hit someone in the head?*
Cleo: *don't you mean if you hit someone anywhere?*

Buster: *if you're working in a lab, then if you're making explosions when you're not supposed to, that's not being sensible*
Videogame Guy: *you don't want the lab to explode!* [laugh]

Black Cat: *if you mess around with something and it was really expensive, and it was from a different country, then it's going to be really hard to get it back*
…
Bluebell: *if* [Rhodri] *was fixing something… he might have dropped it and broken it even more*
…
Olivia: *you need to make sensible answers instead of just messing around… like saying the wrong thing to make you sound funny*

Excerpt 7.62: Participants described potential outcomes of not being sensible in the second interview.

Buster: *if you were left on your own to do a job then you have to* [pause] *be sensible and not mess things up*

Black Cat: *if you're going to have this big job, and your boss is counting on you to do it right, then you should do it sensible. If you don't do it sensible, you might not get the job done*
…
Bluebell: *you might break the bone, or break the thing you've got to be careful with*
Interviewer: *okay, and what would happen if you broke something?*
Bluebell: *you might get told off by your boss, and you might get fired*

Excerpt 7.63: Participants explored the value of being sensible and potential outcomes if this is not met in their final interview.

Much of the discussion surrounding the 'sensible' card outlined the importance of not engaging in dangerous behaviour and considered potential negative outcomes. Discussions of 'sensible' developed over each interview, from vague ideas about 'being silly' and 'messing around' to specific examples of how being sensible might be of value in a STEM job role. Some references were made to sensible behaviour in school contexts throughout, though these were increasingly made alongside multiple examples of being sensible in a STEM workplace. The need for sensible behaviour was examined in a range of contexts: as an archaeologist, working in a laboratory or with computers, and when using expensive resources. Some of these examples, such as Buster and Videogame Guy's comments about explosions, fall into the 'unrealistic' category of science perception identified by Tan *et al.* (2017, 523), where a pupil depicts or describes 'a mad scientist or scientist engaging in non-scientific work'. A shortcoming of replicating 'real world' STEM experiences in schools is demonstrated here: despite having engaged with work that might ordinarily be carried out in a lab (such as faunal and palynological analysis or testing models), participants retained an unrealistic perception of lab-based work. Classroom-based interventions may inhibit pupils' appreciation of the 'real' nature of their experience, meaning educators must ensure that pupils are aware how their work mirrors that of STEM professionals.

7.2 Discussion of word sort exercise results

7.2.1 Impact of intervention content

The word sort exercise revealed varying influence of interventions on the way that participants spoke about STEM and the people working in it. Some elements appeared highly influential, such as the use of animal bone in the first session. The experience of handling a completely novel material, combined with participant knowledge of the interviewer's zooarchaeology expertise clearly impacted interview-based conversations. In the examples of 'someone working in STEM' presented in this chapter, 'bones' were referenced 17 times by ten individuals[22]. This demonstrates the influence of the faunal analysis intervention in instilling participants with an understanding of zooarchaeology as a STEM discipline, and also highlights the value of presenting learners with novel and unusual experiences. Establishing impact beyond the interview context would require a longitudinal approach that is outside the scope of a PhD thesis, but would provide interesting insight into how participants embedded their experiences without the interviewer's presence to prompt them.

Other responses demonstrated a small impact on how participants discussed skills/aptitudes in STEM. Following the third intervention, participant discussions about honesty explored themes of collaboration, design and construction, mirroring intervention content. Participants also used archaeological examples to illustrate their arguments throughout; these primarily focused on 'the bones', such as comments made in favour of educational computer games, being sensible and helping others, though more general examples of archaeology also featured in conversations about 'being outdoors' and honesty. In some cases, the archaeological interventions appear to have confirmed participants' preconceptions about how particular skills/aptitudes are relevant to STEM. For example, favouring teamwork over independent work,

[22] Not counting the times they were mentioned in an obviously medical context.

practicing creativity in terms of ‘making’ things, and perceived lack of need for dance-related skills were a feature of both interventions and interview discussions.

There were multiple instances where participants did not relate key skills/aptitudes from interventions to their interview discussions. This was particularly notable for the maths and science cards, where only one participant referenced intervention content despite consistent archaeological applications of maths/science skills and knowledge throughout. Minimal discussion of the ‘resourceful’ card following the third intervention was also notable, as ‘resource manager’ was one of the key roles in that session. Other intervention-based skills/aptitudes were less explicit, but still intended to feature in pupils’ practice. Though each intervention had scope for pupils to engage in logical thinking, methodical working, and organisation, it is possible that these skills were not recognised due to age-related factors. Organisation and approaching a task logically or methodically are advanced skills, which these participants may still be developing, meaning they may be less likely to understand their actions and practice in this way. Although during interviews participants demonstrated an understanding that people use their imagination when designing and creating, they did not link this with their own intervention practice. It appears that interventions did not effectively communicate the use of these skills/aptitudes, and that despite participants’ intended experience of these things, they were not embedded into future STEM perceptions. These examples highlight the need for intervention content and educators to be more explicit in signposting how and when skills/aptitudes are used in learning engagements.

7.2.2 Development of responses

The word sort exercise was designed to see how participant STEM perceptions and conversations developed in response to archaeological interventions. The most prominent change to participant discussions was a clear shift from vague and generalised comments to industry specific examples of STEM skills/aptitudes. These examples were not always accurate *but* demonstrated increased participant confidence: both in in their knowledge of STEM, and experience of an interview setting. Participants responded particularly well to the STEM profiles, which allowed them to move away from examples based in a primary education context, to suggestions for how real people might interact with each skill/aptitude in their STEM roles.

The power of peer discussion on influencing individual perspectives was apparent throughout. The best example of this was SP group’s conversation about computer games: NJ’s expert insight was shared with peers to expand their understanding of computer games’ relevance to

STEM. Encouraging young people to share expertise with peers validates their experience and contributions; a key step in broadening STEM participation (Godec *et al.* 2017). Other research has demonstrated the benefits of differing participant views in collaborative work on content knowledge and argumentation skills (Howe *et al.* 2005; Iourdano *et al.* 2019; Larrain *et al.* 2019; Larrain *et al.* 2021, 747). It was clear that these conversations have similar value in allowing peers to challenge each other's perceptions in a constructive way, and broaden each other's understanding through shared expertise. Though interventions appear to have had limited impact on participant's STEM perceptions, it was clear that the interview process was a valuable experience in itself. Supporting young people to explore these themes, with appropriate resources and discussion facilitation, clearly has the power to inform individuals whilst increasing their confidence and competence in thinking and talking about STEM.

7.2.3 Perceived importance of acronym specific skills/aptitudes

Though participants placed high importance on cards that were specific to the STEM acronym, their rationales were often brief, comprising the simple reflection: 'that's part of STEM'. Enjoying maths and science, and using computers were all discussed in relation to the STEM acronym. Participants demonstrated some recognition of variation across STEM branches, and the relationships between them, but largely relied on the STEM acronym as justification for their choices. These conversations demonstrate a shortcoming of using simple acronyms and 'buzzwords' to discuss complex themes, as referencing 'STEM' requires no deeper reflection on the experience of people working in those industries. A key aim of this exercise was to encourage participants to consider STEM skills/aptitudes rather than STEM job specifications (Macdonald 2014, 28), however these discussions focused more on what STEM practitioners 'do' than what they are 'like', suggesting that the exercise did not fully meet its aim. Future investigators could prepare follow up questions to encourage participants to think beyond the acronym: e.g. 'what do you think they enjoy about science/ maths? Why might this impact their STEM role?'.

Encouraging young people to consider skills and aptitudes beyond the STEM acronym is essential to provide novel access points to STEM participation. Interdisciplinary subjects like archaeology are of great benefit here, as they facilitate a wide range of skills/aptitudes across multiple contexts. Young people who consistently engage with interdisciplinary subjects have increased opportunities to observe skill/aptitude usage across the curriculum and to understand the value that skills/aptitudes have in a broad range of contexts (e.g. creativity in maths or imagination in science).

7.2.4 Impact of personal experience

Individual experiences were a common discussion theme, both in terms of specific personal examples and those more generally experienced by primary aged pupils. Discussion of helping peers, teamwork, and being sensible were all frequently located in pupil experiences, such as 'giving answers to a friend' and 'not being silly'. Pepperoni and Jelly's personal example of a recent British Science Week challenge was relayed when discussing creativity; their experience enabled them to consider STEM-based creativity via non-imaginary information. However, neither participant discussed creativity in their final interview; it is unclear whether this was a deliberate choice or simply the result of having such a large range of cards presented in the exercise. 'One off' interventions have been criticised for their limited impact (Zecharia *et al.* 2014, 42; Macdonald 2015, 25; Prieto-Rodriguez *et al.* 2020, 1157), and it would have been valuable to explore the potential cumulative impact of the British Science Week activity and third archaeological intervention on these individuals' perceptions of creativity in STEM.

Other participants drew upon examples of family/friends to illustrate their arguments; Olivia's assertion that dancers may also like STEM, based upon someone who dances and is enrolled on a STEM degree, was an excellent example of this. The importance of 'who you know' in science capital is well established (Archer *et al*. 2012; Dewitt and Archer 2015), and some conversations outlined above demonstrate individual advantage in ability to discuss STEM for participants with STEM-based family members. However, this was somewhat negated by the introduction of STEM profiles, suggesting that this disadvantage between young people can be addressed. Frequent participation in realistic STEM experiences such as those of the archaeological interventions may also address this by ensuring young people have more equitable access to STEM capital. Individuals' personal interests also impacted responses; for example, NJ's recognition of the role programming plays in computer games was derived from the experience of designing his own game. Capitalising on pupil experiences is key to creating compelling and relatable learning opportunities (Glancy and Moore 2013, 9; Godec *et al.* 2017, 27), and other areas for potential STEM-related development on experience and interests were apparent. Individual interests are discussed in further depth in Chapter 8, though it was clear from these word sort-based conversations that areas such as sport, dance, computer gaming and creative practice represent key areas in which to explore STEM engagement with primary aged pupils.

7.3 Chapter 7 summary

The word sort exercise presented in this chapter was designed to provide insight into participants' perceptions of skills and aptitudes necessary for STEM participation. Repeating the exercise throughout the main research period met the objective of observing changes to perceptions over time, in response to intervention experiences. A major finding of this exercise was the impact of the word sort itself; as participants became more familiar with the process, and more confident in discussing STEM skills/aptitudes their rationales became more detailed, nuanced, and specific to STEM. Conversations shifted from vague or imaginary ideas to specific – if not always accurate – examples of skill/aptitude use in STEM. Some participants even demonstrated perception change based on the arguments of their peers, highlighting the value of being exposed to alternative viewpoints and experiences in individuals' understanding of STEM. Having the opportunity to occupy the position of 'expert' is also valuable for the child in that role, as being 'recognised' as having expertise in an area of STEM is a key factor in the development of STEM identity (Dou *et al.* 2019; Godec *et al.* 2017). Though the changes recounted in this chapter are small, they are the result of only a few discussions, and providing consistent opportunities for young people to hold similar conversations may have a greater impact. Incorporating such discussions more broadly into STEM education would provide space for pupils to share experience and knowledge and to challenge cultural misconceptions about who can participate in STEM.

The impact of interventions on participants was less straightforward: though they undertook a range of skills/aptitudes throughout interventions, not all recognised or recalled this during word sort exercises. The most memorable experience appears to have been handling faunal specimens in the first intervention. Participants were left with the long-term understanding of archaeology as a STEM discipline and zooarchaeology as a direct example to illustrate their rationales. Though handling faunal remains was memorable, participants did not reflect on the skills/aptitudes used during bone identification, and focused solely upon the experience itself. There was a further disconnect between multiple skills/aptitudes that featured in interventions (e.g. logical, methodical, imaginative) and how participants regarded those cards in interview discussions, where they generated very few comments. In addition to this, limited intervention content was revisited in conversations about relevant skills/aptitudes (e.g. enjoyment of maths and science).

Overall it was apparent that a greater focus on skills/aptitudes during intervention sessions was needed to influence the way participants understood skill/aptitude's relevance in STEM. Educators could achieve this by explaining which skills/aptitudes will be used in a session, highlighting their usage as it occurs, and reflecting on how expectations of those skills/aptitudes were met (or otherwise) with learners afterwards. This would benefit learners' personal insight (linked to their self-concepts) and their ability to consider STEM beyond the acronym. Consistent engagement with interdisciplinary subjects like archaeology will also empower learners to recognise the relevance of their skills/aptitudes across a range of contexts, and provide a novel access point to STEM for young people who have not identified with it via traditional routes.

This chapter considered the results of a word sort exercise undertaken by interview participants. It established participants' perspectives on general skill/aptitude use in STEM, and provided insight into how far these perceptions were influenced by archaeological interventions. The following chapter will examine how participants reflect on skills/aptitudes in relation to themselves, and how these self-concepts may influence their development of a STEM identity.

8 Chapter 8: Self-reflection results

Chapter 2 outlined how individual identity is crucial to pursuit and persistence with STEM. A person's perception of how they 'fit' into STEM is a key factor in their uptake and continued engagement (Kyriacou and Goulding 2006, 17; Mendick 2006, 63; Stevens *et al.* 2008, 358; Archer *et al.* 2010; Macdonald 2014, 12; Dou *et al.* 2019). Macdonald (2015, 14) argues that reflecting on '*personality and aptitudes'* makes it possible for an individual to see how they might be happy and successful in a STEM career. Reflecting on skills/aptitudes and interests enables young people to incorporate 'fit for STEM' into their identity. This chapter outlines and analyses the results of an exercise carried out during pupil interview sessions, following the word sort activity. The exercise comprised a self-reflection and was intended to observe how participants' understanding of themselves may have developed in response to the archaeological interventions. See Chapter 3 for an outline of the methods used in this exercise. Participants' reflections provided vital insight into individual self-concepts, making it possible to observe whether individuals prioritised STEM interest within their identity.

This exercise was conducted three times during the research, to meet the objective of observing potential changes to participants' STEM self-concepts over time in response to archaeological interventions. Analysis of responses revealed that while some participants did highlight STEM affinity in their self-reflections, these identities were fixed prior to the beginning of research. This exercise provided insight into the nuance of family STEM influence. It demonstrated the level of confidence that young people have in describing themselves, as well as the limitations of those descriptions. Popular skills, aptitudes and interests were identified and compared with wide-scale research into the young people of Wales and England, to reveal potential avenues for future STEM education. Finally, the complex relationship of participants with the concept of 'cleverness' is explored to assess its impact on their relationship with STEM.

8.1 Results

The following considers participant responses to the self-reflection exercise, and assesses them for trends and changes in how pupils described themselves. Results are divided into sections according to participants' relative alignment with STEM. 'STEM aligned participants' are those who expressed a clear and consistent interest in one or more aspects of STEM throughout the main research period. Participants who explicitly expressed an interest in pursuing a future in STEM during this exercise (such as Jelly) were also considered to be 'aligned with STEM'. 'STEM ambivalent' participants did not express an overt interest in STEM during this exercise, choosing to prioritise other interests and skills instead. Three participants' responses were either too inconsistent or not detailed enough to confidently state their alignment with STEM and were grouped into 'inconsistent or limited responses'. The term 'personality' was used in discussion with participants as an accessible and age appropriate term for 'identity'. It is beyond the scope of this chapter to interrogate differences between 'personality' and 'identity', however, this usage was based on the understanding that personality traits inform individual identity. 'Self-concept' is used more broadly throughout this chapter to reference how an individual perceives their personality, skillsets, ability, and identity.

8.1.1 STEM aligned participants

A number of responses reflected considerable assimilation of STEM skills and interests into participants' identity. These children consistently highlighted STEM aligned skills, aptitudes and interests in their self-reflections. Participants' alignment with STEM was largely expressed through the subjects or activities they enjoyed, such as maths and science lessons, or using computers (Table 8.1).

NJ	Int. 1	Enjoys maths	Can use computers	Likes being outdoors	Enjoys sports	Enjoys dancing
	Int. 2	Enjoys maths	Can use computers	Likes computer games	Likes helping others	Honest
	Int. 3	Enjoys maths	Can use computers	Likes computer games	Enjoys sports	Listens to other people's opinions
Skull Trooper	Int. 1	Likes computer games	Likes helping others	Honest	Learns from their mistakes	Curious
	Int. 2	Likes computer games	Likes helping others	Honest	Can use computers	Enjoys maths
	Int. 3	Likes computer games	Listens to other people's opinions	Enjoys sport	Can use computers	Enjoys maths

Table 8.1: Self-reflections of 'STEM aligned' participants in all three interview sessions.

Videogame Guy	Int. 1	Likes computer games	Enjoys maths	Sensible	Likes being outdoors	Enjoys drawing
	Int. 2	Likes computer games	Enjoys maths	Can use computers	Enjoys dancing	Can work in a team
	Int. 3	Likes computer games	Enjoys maths	Sensible	Likes visiting other countries	Determined
Black Cat	Int. 1	Enjoys science	Enjoys maths	Enjoys reading	Imaginative	Enjoys building things
	Int. 2	Determined	Curious	Creative	Artistic	Likes being outdoors
	Int. 3	Enjoys science	Enjoys maths	Enjoys reading	Likes to learn new things	Likes being outdoors
Apple	Int. 1	Likes computer games	Imaginative	Likes visiting other countries	Practical	Likes being outdoors
	Int. 2	Likes computer games	Imaginative	Likes helping others	Enjoys building things	Enjoys sports
	Int. 3	Likes computer games	Inventive	Can use computers	Practical	Can take risks
Pepperoni	Int. 1	Can use computers	Enjoy maths	Learn from their mistakes	Likes learning languages	Enjoys science
	Int. 2	Can use computers	Enjoy maths	Likes visiting other countries	Creative	Enjoys dancing
	Int. 3	Likes computer games	Can take risks	Enjoys sport		
Jelly	Int. 1	Enjoy history	Likes helping others	Hardworking	Can take risks	Likes learning new things
	Int. 2	Enjoy history	Likes learning languages	Hardworking	Likes computer games	Reliable
	Int. 3	Enjoy history	Likes learning languages	Enjoys maths	Enjoys science	Clever

Table 8.1 continued.

Barry	Int. 1	Enjoys maths	Enjoys sport	Clever	Can work in a team	Can use computers	Likes to try new things
		Likes computer games					
	Int. 2	Enjoys maths	Enjoys sport	Clever	Likes helping others	Creative	Enjoys reading
	Int. 3	Enjoys maths	Enjoys sport	Hardworking	Enjoys science	Likes visiting other countries	

Table 8.1 continued.

Skull Trooper and Apple[23] consistently discussed playing computer games (Excerpt 8.1), and both children described how their computer-based knowledge could be used to help or educate others (Excerpt 8.2). NJ also demonstrated a clear affinity with computers and computer games through his experience in coding apps and games (Excerpt 8.3). NJ's father appeared to play a key role in facilitating and encouraging these skills and interests. Being 'recognised' by others as skilled or interested in an element of STEM is key to developing a STEM identity (Dou *et al.* 2019), though this experience may not always be enjoyable for Skull Trooper; the phrase '*they're just all around me*' suggests a feeling of being overwhelmed by demand.

Skull Trooper: *I like computer games because they're fun to play with your friends... we can all have fun together, even when we're not together*

Apple: *this one is the best one to describe me ever: likes computer games... you know boys – the boys are the ones that like the computer games*

Apple: *likes computer games* ***obviously***

Apple: *I like computer games – I just do... because I'm a boy*

Excerpt 8.1: Skull Trooper's (int. 2) and Apples' (int. 1,2,3) comments about computers and computer

[23] Both pupils' pseudonyms appear to reflect their interests in technology and computer games. 'Skull Trooper' is an outfit that players can use in the popular computer game Fortnite (Skull Trooper pers. comm) and Apple is a well-known technology company. Apple did not confirm that this was the inspiration for his pseudonym, but he did refer to Apple products during interview conversations.

Skull Trooper: *I can fix computers really well. All my class – say if we're doing computer work – they just all ask me to do it, they're just all around me*

Skull Trooper: *I'm really good at computers, everyone in my class comes to me*

Apple: *can use computers because if someone asks me – if you've got one of them new laptops – if they wanted to know how to put their fingerprint in, I know how to do it*

Excerpt 8.2: Skull Trooper (int. 2 & 3) and Apple (int. 3) highlighted their ability to educate and help peers with computers.

NJ: *I can use computers because my dad taught me how to code last year*

NJ: *I can use computers because I code and I'm making an app*

Interviewer: *what app are you making?*

NJ: *I'm making one that's meant to be like a game sort of thing, similar to Fortnite*

NJ: *I like computer games because I've made a few*

Interviewer: *how do you make a computer game?*

NJ: *I code them and then my dad just checks that I've coded them right and then he does the rest*

…

NJ: *I can use computers because I can code*

Interviewer: *is there anything you code apart from games?*

NJ: *I've coded a computer… it's called a Kano. You get this thing and you have to code it, and then you can make your own, like Minecraft and YouTube on it*

Excerpt 8.3: NJ highlighted his interest in computer programming in all three interview sessions.

Videogame Guy and Apple explicitly linked their use of computers and computer games with creative practice[24] (Excerpt 8.4). Apple described the role of 'invention' in engineering and his creation of computer animations as 'inventing', and Videogame Guy stated that he enjoys drawing plans for Minecraft. Both children appear to use their artistic (enjoys drawing) and creative (inventive) skills to support their other interests, however Videogame Guy did not consistently prioritise this in his self-reflections (Table 8.1). Apple believed that enjoying computer games was inherent to his male identity (Excerpt 8.1), and highlighted the influence of his father in one of his game preferences (Excerpt 8.4). The gaming role models in his home

[24] NJ's experience of coding can also be understood as creative practice, however, he did not highlight this himself.

may have reinforced his perception that computer games are a ‘male’ pursuit. Apple and Videogame Guy previously established their perceived association between computers and technology (Chapter 7), and it is likely that they felt aligned with STEM in that respect. Apple’s belief that computer games can enhance computer skills and NJ’s recognition of the programming skills necessary to develop a computer game (see Chapter 7) indicate that they understood the interplay between these skillsets and interests; their identities as gamers may also reinforce their self-concepts as someone who is suited to technology. However, these parts of Apple, Videogame Guy and NJ’s identity appear to have been developed prior to and sustained outside of the research project.

Apple: *inventive because I like being engineers, and stuff like that*

Interviewer: *what kind of stuff do you like to invent?*

Apple: *I like inventing – my dad’s got this computer game on his PC, that I like. And it’s got a book that goes with and I like using his book on the computer game to make some animation things on there*

…

Videogame Guy: *Likes computer games… I really like playing Roblox and Minecraft, and when I said about drawing plans I was talking about plans for things I was going to build in Minecraft, so I just really like it*

Interviewer: *okay, so you like to draw out plans before you build it on the computer?*

Videogame Guy: *yes, but there are some times where I just draw a plan, but I don’t actually make it*

Excerpt 8.4: Apple (int. 3) and Videogame Guy (int. 3) discuss creative skills in relation to computer use.

Enjoyment of STEM-based subjects was another key factor in many of these participants’ self-concepts, with many describing a love of maths and science. Some of these interests were clearly rooted in school-based experiences, such as NJ, Barry and Videogame Guy’s rationales for enjoying maths (Excerpt 8.5). Pepperoni, Jelly and Barry presented their interest in science as exploratory, and not necessarily grounded in a school context, with Jelly’s statements in particular appearing to reflect imagined science experiences (Excerpt 8.6). Science was perceived by these participants as an opportunity to discover and learn new things. Pepperoni described skills that she associates with science (experimenting, problem solving, predicting), which has implications for how she could be supported to recognise her aptitude for alternative learning contexts via skills she already feels confident in. Jelly’s description of scientific experimentation touched on similar themes of pop-culture science depictions as in Chapter 7, where scientific practice results in ‘things blowing up’. Interestingly Jelly’s concept of science featured both fantastical and realistic elements: he envisioned explosive and ‘stinky’ outcomes, but also understood that the role of scientist is to record findings accurately.

NJ: *I enjoy maths because I just find it the funnest bit of… school*

NJ: *I really enjoy maths, it's the funnest subject I think*

NJ: *I enjoy maths because I like my maths lessons at school*

Barry: *sometimes I get all of* [the work] *right or one wrong in maths because I've been hardworking*

Videogame Guy: *in school maths is my favourite subject. I enjoy it – I don't know if it's because it's easy to me or for another reason*

Excerpt 8.5: NJ (int. 1,2,3, Barry (int. 3) and Videogame Guy (int. 3) all spoke about their enjoyment of school-based maths.

Barry: *science because I like to see what other stuff is out in the world you can make*

Pepperoni: *I like science because learning new things… experimenting with stuff and problem solving, like bones and stuff… I love finding out new things and I like predicting stuff because I like working out new things.*

Jelly: *I enjoy science because I like to experiment with different things, so mixing uranium with titanium, carbon dioxide mixed with oxygen and all of that… I just like seeing the outcome – I don't care if it blows up in my face – I don't care if I get something really stinky, I'll just write down what I get*

Excerpt 8.6: Barry (int. 3), Pepperoni (int. 2) and Jelly (int. 3) described their rationales for enjoying

Pepperoni's statement that science comprises 'bones and stuff' is a likely reflection of the zooarchaeological intervention she had participated in a few weeks prior. This indicates that the intervention was memorable *and* that Pepperoni understood her actions during it as 'science'. A key aim of this project was to widen young people's understanding of STEM to include non-traditional elements like archaeology, so this represents an important moment of success for the project. Both Jelly and Pepperoni highlighted the role that maths plays in scientific practice (Excerpt 8.7) and had incorporated it accordingly into their identities as someone with an interest in pursuing science. This demonstrated their knowledge of the interconnectedness of STEM branches, albeit with room for refinement and development. Jelly's assertion that he aspired to be a scientist in his final self-reflection was interesting as he had not identified ‘enjoys science’ as a key part of his identity before in this exercise. However, Jelly’s description of scientific practice (Excerpt 8.6) did not reflect the science content of the archaeological interventions, and may instead represent an interest he developed independently of this project.

Pepperoni: *I put enjoy maths because if I want to be a scientist I need to learn maths*

Jelly: *I want to be able to get really good at maths because I want to be a scientist and in some points you need to be really good at maths to sometimes do science*

Interviewer: *what kind of science do you need to be good at maths for?*

Jelly: [pause] *mathematics?*

Excerpt 8.7: Pepperoni (int. 1) and Jelly (int. 3) explained how their interest in maths related to their desire to be a scientist.

Black Cat’s examples of times that she has particularly enjoyed science both related to experimental and practical work that she carried out with her family: both at home and in school (Excerpt 8.8). It appears that Black Cat’s interest in science is supported and encouraged in both her home and school environments. Black Cat’s comments about maths focused on the methods and strategies she could employ to solve sums and challenges, and suggested confidence in her ability to choose effective methods to work through problems. Black Cat described other home-based engagements with STEM, such as practical projects and exploration of nature, largely facilitated through family members (Excerpt 8.9). Although Black Cat’s interest in STEM appeared to exist prior to participation in the project, her focus on skillsets/aptitudes and interests (creativity, curiosity, being outdoors) in her previous STEM engagements reflects a key objective of this research. However, it was unclear how far she considered these actions to represent STEM practice. Pepperoni also described previous STEM engagements as creative, though her example was an explicit reference to creative practice she had undertaken as part of British Science Week: ‘*we’re making* [an] *invention and you have to be creative… you can be as creative as you like*’.

Black Cat: *I enjoyed science because we do at home, we do these experiments and I really enjoy doing them… I always enjoy maths because I like all the different strategies, which you can do sums in*

Black Cat: *I enjoy science because once we did this really fun science lesson, where our parents came in and we had to pour all these liquids down this ramp… I also enjoy maths because it's quite challenging for me. And some of the ones – like column method – I like that because I can do big numbers and it's a quick way for me to do my maths*

Excerpt 8.8: Black Cat's comments (int. 1 & 3) about enjoying maths and science in school and home contexts.

Black Cat: *enjoys building things because* [my brother] *and me right now are building this little cart and I'm really enjoying it*

Black Cat: *I like being outdoors because I usually find these things which I haven't found before in the woods… we once found this cow shoulder bone then we told our mum, and she told us what it was*

…

Black Cat: *I think I'm creative because, sometimes at home with my brother – I made this wood shelf … I think I'm curious because I sometimes want to get another bone, but if we don't have it, I go somewhere else. Because we have loads of fields at our house, so I go into one of the fields*

Black Cat: *I like being outdoors because my mum does work at* [local garden centre] *and then I like being outdoors because in our garden, we have three baby kestrels – birds of prey – and then we always go down and visit them, and every year we have a group of them… my mum teaches me how to recognise some plants from their fruits and stuff like that*

Excerpt 8.9: Black Cat described multiple home-based STEM engagements in interviews 1, 2, and 3.

The children whose self-reflections indicated an alignment with STEM in their identities, also held a range of other interests, and skills though these were not often linked to STEM by participants (Excerpt 8.10). Participants demonstrated confidence in their abilities in these skillsets and areas of interest, though there was a notable absence of discussion around how those things might relate to STEM.

Black Cat: *I think I'm artistic because I like doing art, and I'm really good at doing art*

Apple: *imaginative because sometimes I just go wild with imagination – I imagine there's a massive T-rex, pterodactyl, evil thing outside*

Jelly: *I love German, I can already count from 0 to 9,999 – I can have a full conversation*

NJ: *I enjoy sports because I play rugby, football and tennis, and I do swimming three times a week, and I did a running competition for our school and we came fourth in the relay*

Skull Trooper: *I like listening to other people's opinions because sometimes people have a different opinions to me and I would like to hear what they say*

Barry: *I enjoy sport because I do a lot of sport in the weeks: I do rugby, I do football… I do a lot of stuff sporty, and I do it in school*

Videogame Guy: *sensible because well I just am* [I*] just get on with stuff when I'm supposed to especially in school*

Pepperoni: *I can take risks because yesterday night dad cooked some brownies and I kept on sneaking into the kitchen to try and get some*

Excerpt 8.10: Participants whose self-reflections demonstrated an alignment with STEM also discussed other self-concepts. Black Cat, Apple, Jelly (int.2), NJ, Skull Trooper, Barry, Videogame Guy, Pepperoni (int. 3).

8.1.2 *STEM ambivalent participants*

These participants did not highlight any specific affinity with STEM in their self-reflections. They did not necessarily reject STEM from their identity, but instead chose to prioritise other skills and aptitudes which they did not associate with STEM practice (Table 8.2).

Blossom	Int. 1	Enjoys drawing	Can work independently	Wants to understand how things work	Hardworking	Likes to try new things	
	Int. 2	Artistic	Enjoys dancing	Imaginative	Can work as a team		
	Int. 3	Creative	Enjoys dancing	Can use computers	Likes helping others	Enjoys sport	
Cupcake	Int. 1	Enjoys dancing	Creative	Comes up with lots of new ideas	Shares information with others	Enjoys history	
	Int. 2	Enjoys dancing	Creative	Clever	Hardworking	Sensible	
	Int. 3	Enjoys dancing	Creative	Can use computers	Likes helping others	Enjoys sport	
Stanley	Int. 1	Enjoys sport	Likes visiting other countries	Likes computer games	Comes up with new ideas	Enjoys maths	Likes to learn new things
	Int. 2	Enjoys sport	Likes visiting other countries	Enjoys history	Enjoys building things	Enjoys science	
	Int. 3	Enjoys sport	Likes visiting other countries	Enjoys history	Creative	Enjoys reading	
Pippin	Int. 1	Enjoys dancing	Enjoys drawing	Enjoys history	Enjoys science	Likes to learn new things	
		Imaginative	Hardworking				
	Int. 2						
	Int. 3	Enjoys dancing	Artistic	Enjoys history	Can work in a team	Gets all of the answers right	
Blackjack	Int. 1	Imaginative	Artistic	Clever	Likes helping others	Enjoys dancing	
	Int. 2						
	Int. 3	Imaginative	Creative	Likes being outdoors	Can use computers	Honest	

Table 8.2: Self-reflections of 'STEM ambivalent' participants in all three interview sessions.

Buster	Int. 1	Enjoys reading	Inventive	Creative	Organised	Reliable
	Int. 2	Enjoys reading	Likes being outdoors	Creative	Artistic	Imaginative
	Int. 3	Enjoys reading	Likes being outdoors	Enjoys sport	Artistic	Hardworking
Olivia	Int. 1	Enjoys dancing	Can work in a team	Reflective	Enjoys history	Likes to learn new things
	Int. 2	Enjoys dancing	Can work in a team	Creative	Artistic	Hardworking
	Int. 3	Enjoys dancing	Reliable	Creative	Artistic	Imaginative
Bluebell	Int. 1					
	Int. 2	Organised	Can work independently	Enjoys maths	Enjoys building things	Likes to learn new things
	Int. 3	Organised	Creative	Artistic	Enjoys history	Enjoys sport
Cleo	Int. 1	Enjoy sports	Clever	Competitive	Can work independently	Sensible
	Int. 2	Enjoy sports	Clever	Competitive	Gets all of the answers right	Enjoys reading
	Int. 3	Enjoy sports	Clever	Likes being outdoors	Can work independently	Sensible

Table 8.2 continued.

Two of the most commonly prioritised skills and interests were sport and dance; Cleo and Stanley (sport) and Cupcake, Pippin and Olivia (dance) highlighted this in every self-reflection. The examples given by these participants demonstrated how strongly they identified with sport and dance (Excerpt 8.11).

Pippin: *I enjoy dancing, I'm a dancer*

Pippin: *most people know that I **love** dancing*

Olivia: *I'm in a dancing family – down my family we've been doing all different types of dancing and I actually go to dance lessons, and I really enjoy it*

Olivia: *I dance at school because we do a talent show*

Olivia: *I enjoy dancing because the people there feel a bit like my family… all of them feel like my sisters and we always have sleepovers and playdates*

Cupcake: *I love dancing… we do a competition every month so it's really fun to do competitions because I never really get to do them apart from in dance… I got through to the semi-finals with one of my solos*

Cleo: *I do sports every day, and I **love** it… I do gymnastics three times a week because I do squad training, I do football on Fridays, I do swimming on Monday and also on Wednesdays I sometimes go out and play football with my dad*

Stanley: *I absolutely love sport I will never ever stop playing it*

Stanley: *I just like* [sport] *because whenever I have time to do something, I just play sport. I go athletics club… and in* [place name] *there's a track, it's 100m and I really like it. I like running around it and we do it as a team*

Excerpt 8.11: Pippin (int. 1 & 3), Olivia (int. 1,2,3), Cupcake (int. 3), Cleo (int. 1) and Stanley (int. 1 & 2) explained their relationships with dance and sport.

Pippin described herself as a 'dancer', emphasising that dance is not simply something she enjoys, but something that she defines herself by (Excerpt 8.11). She also stated that '*most people know'* about her love of dance, suggesting that she is recognised as having an aptitude for dance by those around her: a crucial factor in identity development (Dou *et al.* 2019). Pippin described dance as being the 'least important' skill for a person working in STEM elsewhere in the interview sessions (Chapter 7), demonstrating that she does not associate her experiences with STEM. Pippin expressed an interest in science once: '*I love science because me and my dad are always doing small experiments at home'*, but did not discuss it again.

Olivia highlighted her participation in a school talent show (Excerpt 8.11), something which is likely to have strengthened her confidence and 'recognised' status among peers as a dancer. Olivia's relationship with dance is largely negotiated through family (another factor in identity, Archer *et al.* 2012, 886), who appear to support and inspire her pursuit of it. She also described her dancing peers as '*like sisters'*, emphasising the strength of her connection with dance through those relationships. Olivia's self-reflections further revealed the impact of external influences on her identity: her enjoyment of history and her self-concept as imaginative were related to family and friends (Excerpt 8.12). Olivia's understanding of her own personality was fairly constant throughout the research period; she identified very strongly with dancing, but there was no indication that she associated this with STEM.

Olivia: *I enjoy my history because my family is quite good with history my cousin is in Bournemouth University and she does history and I really enjoy it*

Olivia: *I'm imaginative because my dreams at night are really creative, and my friends are quite imaginative* [laughs]. *My friend I, when we had a sleepover – when they all went to my house – she was sleeping and kicking, she was going "ahhh" because she was sat on a wall with Humpty Dumpty* [laughs]

Interviewer: *and how are* ***you*** *imaginative?*

Olivia: *I think that I have dreams like that as well*

Excerpt 8.12: Olivia's (int. 1 & 3) inclusion of 'enjoys history' and 'imaginative' in her self-reflections were linked to family and friends.

Cupcake's connection to dance was similar; she claimed to enjoy competing in dance and has achieved relative success (semi-finalist) with her solo work (Excerpt 8.11). Wanting to help people was another trait that Cupcake identified in her personality, though the cards she used to discuss this were different in each session: 'comes up with lots of new ideas', 'sensible' and 'likes helping others' (Excerpt 8.13). Cupcake did not prioritise STEM in her self-reflections, though she did mention some elements briefly. Cupcake made a single interview-based reference to a summer science camp which she attends each year, but did not explore this in her self-reflection. She also described herself as able to use computers, but with the following caveat: '*I can use them, but sometimes I struggle to use them, but then it's really fun to use them'*. While it appears that Cupcake held some interest in STEM, and even considered parts of it 'fun', she did not perceive it as an essential part of her identity.

Cupcake: *comes up with lots of new ideas… because sometimes I work with my* [friend] *she sits next to me and I also help her and I also help Blossom*
Interviewer: *okay, so you help them to come up with new ideas:*
Cupcake: *yeah, and help them answer questions*

Cupcake: *I'm always sensible…* [class teacher] *can trust me because when me and Blossom sometimes come up to ask* [to] *help in the class, he always says "oh yes, we have something for you to do, just go over there and tidy up the book corner" or something like that*

Cupcake: *and then likes helping others – I like to help Blossom and lots of people on her table help because they get stuck sometimes. And I also have to help some of my friends*

Excerpt 8.13: The theme of helping others was consistent in Cupcake's discussions.

Cleo's sporting identity was clear from the volume of her weekly engagements, and also appeared to benefit from a supportive family who no doubt facilitate these engagements and play sport with her (Excerpt 8.11). Cleo was one of the few participants who identified a link between sport/physical activity and STEM (see Chapter 7), and it is possible that she equated her enthusiasm for sport with STEM practice, though this was not something she discussed. Stanley's feelings about sport were very strong ('*I will never stop playing it*') and also seemed partly linked with his identity as a member of an athletics team (Excerpt 8.11). Olivia, Cleo and Cupcake described how other parts of their self-concepts were mediated through their identities as dancers and sportspeople (Excerpt 8.14). These examples demonstrate the strength of individuals' relationship with sport/dance *and* their ability to observe skill usage in their practice. Understanding skill usage in STEM practice is central to this thesis, and it was promising to see evidence that participants could observe skill usage in sport/dance contexts. The skills described here (teamwork, hardworking, competitive, being outdoors, creative) are arguably not unusual to associate with dance and sport, and so there may still be scope for these individuals to refine their ability in recognising skills outside of their common contexts.

Olivia: *I've chosen can work in a team because I'm in a dancing team and I think it's really good to work in a team*

Olivia: *hardworking, because sometimes at dancing, people will work really hard… I'm in the highest disco*

Cleo: *I am quite competitive sometimes – like with the sports*

Cleo: *I enjoy sport, because I do a lot of sport and I like being outdoors to do sport*

Cupcake: *can you be creative with dancing?... I like to create – a solo because I do a solo in the dance competition*

Excerpt 8.14: Olivia (int. 1 & 2), Cleo (int. 2 &3) and Cupcake (int. 3) discussed how their other skills were related to their identity as dancers and sportspeople.

Creatively aligned skills were common among these participants, with only one (Cleo) out of nine individuals not describing themselves in this way (Table 8.2). These skills included: artistic, creative, comes up with new ideas, enjoys building things, enjoys drawing, imaginative and inventive. Six participants (Buster, Blackjack, Pippin, Stanley, Cupcake, Blossom) chose creative-based skills to describe themselves in all three interviews. There were numerous instances of these individuals being recognised by interview peers as having aptitudes for creativity (Excerpt 8.15). These participants are likely to have felt a deeper connection to the creative parts of their identity having had them validated by a peer in the interview context. Pippin was recognised as being interested in creativity by multiple peers, who provided anecdotes and details of extra-curricular pursuits as evidence of her affinity for creative practice. Pippin also highlighted an aspiration to work in fashion with fellow interviewee, Molly, further demonstrating how creative skills/aptitudes were embedded in her self-concept.

Pippin: *imaginative, I make up a lot of things – I like making stories*

Molly: *yeah I remember in year 2 you said you were a robot!*

Pippin: *I **love** art, every day*

Barry: *you go to clwb celf* [art club]

Stanley: *and she does sewing club*

Pippin: *yeah I do sewing club… I **love** fashion, so I'm always designing clothing, stuff like that… me and* [Molly] *we really want to make a shop for fashion*

Stanley: *comes up with lots of new ideas*

Barry: *yep, that's him*

Stanley: *creative!*

Barry: *because you **are** creative*

Blossom: *artistical*

Interviewer: *do you think that you're artistic?*

Blossom: *she told me yes*

Cupcake: *yes, lots!*

Interviewer: *okay, what about imaginative?*

Blossom: *she says I overthink a little bit*

Cupcake: *you are **so** imaginative* [Blossom]*! Your drawings are perfect!*

Excerpt 8.15: Pippin, Molly, Barry, Stanley (int. 1 & 3), Blossom and Cupcake (int. 2) experienced and expressed recognition of creative-aligned aptitudes.

Blossom and Cupcake's interaction was interesting, as Blossom did not appear sure of her ability in creativity or imagination *despite* support from Cupcake. Blossom's second interview card choice was the result of Cupcake's opinion, rather than something she believed about herself. Blossom described herself with four different creative-aligned skills/aptitudes in other interviews, though also demonstrated uncertainty in these descriptions (Excerpt 8.16). Comparing her drawing ability to that of her friends, showed that peers are an important component in Blossom's self-concepts, though their reassurance (e.g. from Cupcake) does not appear to have cemented her confidence in this area. Blossom's discussions did not highlight an overt interest in STEM, though she did initially express a desire to understand how computers work: '*I really want to know how things work, how computers work'*. In her final self-reflection, Blossom selected 'can use computers'. It is tempting to interpret this as a developmental arc, where Blossom achieved her goal of understanding computers during the research project. However, her comments reveal that this choice was an aspiration rather than a description of ability: '*I really want to know how to use computers because I'm not really that good*'.

Blossom: *now I've got enjoy drawing because my friends have got really good drawing, but I think I've good drawing as well, but I don't know*

Blossom: *the next one is creative, so I like to – I can't really, I forgot how to say it*

Excerpt 8.16: Blossom (int. 1 & 3) appeared uncertain in her drawing and creative ability.

Some participants also received external validation for their creative abilities, both Buster and Stanley gave evidence that their creative interests were supported and encouraged in their home environments (Excerpt 8.17). Buster described access to art resources (e.g. canvases) at home, indicating that she is supported in this interest by her family. Stanley's claim that his grandad sells the sheds they make together may have increased Stanley's confidence in his creative ability, as he is contributing to something which people choose to buy. Buster and Pippin (Excerpt 8.15) also mentioned membership of creative after-school clubs, attendance at which reflects their enjoyment and commitment to creative practice.

Buster: *artistic because I have lots of art things at home and after school I go to art club*

Buster: *I do lots of art at home*
Interviewer: *what kind of art do you do?*
Buster: *lots of different types. I finished doing a painting on a canvas which is a sunset*

Stanley: *my grandad he helps me with building kites and…I like building sheds… my grandad he sold about 15 of them… I help him and he sells them…*

Excerpt 8.17: Buster (int. 2 & 3) and Stanley (int. 3) spoke about their creative experiences outside of school.

The breadth of experience that was linked with creative practice by participants was extensive (Excerpt 8.18). Participants' recognition of how creative skills are useful in a wide range of contexts is an important finding for this research. Their understanding of how skills are applied in multiple contexts is aligned with the research aim and objectives, though it is unclear how far these participants applied that understanding to STEM contexts. Stanley's description of Minecraft as 'really creative' might be an exception to this, however, his team had previously categorised 'computer games' as being 'unimportant' to someone pursuing STEM (Chapter 7), suggesting that he did not associate them with STEM.

Blackjack: *artistic because I really like making things…* [imaginative] *sometimes I think of very good things*

Blackjack: *imaginative because I think about different colours – like if I draw something, I might do another colour… if it's supposed to be an egg, because I'm imaginative I'd do a different colour… I like making fans, I like painting, drawing*

Buster: *I'm imaginative because I think of lots of different things to draw… sometimes I go on the internet and see things to draw … creative because I make lots of good paintings and drawings*

Stanley: *I love building stuff… I've built racing stuff, a hot glue gun house*

Stanley: *I like Minecraft and Minecraft is really creative… I like building stuff… I build stuff out of Lego*

Cupcake: *my last one is creative, I like drawing and I like being creative because I like cooking!*

Olivia: *creative because I make different colours – so I get two different colours, like really opposite colours, like maybe orange and blue and I try mixing them together to see what colour it will make*

Excerpt 8.18: Blackjack (int. 1 & 2), Stanley (int. 2 & 3), Buster, Cupcake and Olivia (int. 3) described a range of experiences relevant to their creative practice.

Another of Stanley's creative skills (enjoys building things) might also be considered more explicitly related to STEM, Bluebell also described himself in this way (as did Apple and Black Cat, see Table 8.1). 'Inventive' is another creative skill frequently associated with STEM, which was used by Buster to describe herself. It could be argued that in defining themselves with such skills/aptitudes, these participants demonstrated some affinity with STEM in their self-concepts. Both Stanley and Bluebell's descriptions of making things (real and imagined) can be interpreted as 'construction' activities, presumably involving STEM-related skills and knowledge (Excerpt 8.19). Buster, however, was unable to articulate why she identified with 'inventive' (Excerpt 8.19) and did not elect to describe herself in that way again. Instead, Buster prioritised reading, being outdoors and creative skills in her self-reflections (Table 8.2). Bluebell highlighted an interest in maths in his self-reflections, describing it as '*just fun*' and '*kind of easy*'. However, Bluebell appeared most confident identifying himself as an 'organised' person, who is highly influenced by home life (Excerpt 8.20).

Buster: *inventive because – I'm not sure why*

Stanley: *this goes with this: creative, enjoys building things… if you create something, you've built something*

Stanley: *I actually want to build a – I want to make a floating something, so put loads of fans underneath something and then – really powerful fans – and it hovers*

Bluebell: *at my house, I normally build loads of things… we're building some wood fence for some reason – oh deers are getting in our garden… and so I just like doing it*

Excerpt 8.19: Buster (int. 1), Stanley (int. 2 & 3) and Bluebell's (int. 3) rationales for choosing 'inventing' and 'enjoys building things'.

Interviewer: *what made you pick can work independently?*

Bluebell: *because at home, if I have something I have to do, and everybody else is busy normally, I've got to do it by myself, so I'm kind of used to it.*

Bluebell: *I like to be organised, but then not really organised… because every time I do be organised,* [brother] *just messes it up like this, because normally at home* [pause]

Bluebell: *I kind of enjoy sport because I like basketball and I have a basketball net at my house*

Bluebell: *organised, because I don't like messy stuff*

Interviewer: *what kind of things do you organise?*

Bluebell: [pause]

…

Bluebell: *I don't know, I just like organising my things, and I like organising art and how it looks*

Excerpt 8.20: Bluebell (int. 2 & 3) confidently described himself as organised and made repeated references to home life.

Though Stanley highlighted an enjoyment of maths and science along with 'building things' in his reflections, these were not emphasised as heavily as his love of sport (Excerpt 8.11) or his interest in visiting other countries (Excerpt 8.21). Stanley's interest in visiting other countries was strongly embedded in his identity, and may have also been influenced by his dual nationality[25] and experience of living outside of the UK at a young age. Stanley's perception of himself as a creative person who enjoys sport and travel was consistent throughout the

[25] Legal definition not confirmed with participant, but remains likely to have influenced his identity.

interviews. There was little indication that he particularly identified with STEM, or that this changed during the project.

Stanley: I like visiting other countries, I've just got that because I **love** visiting other countries
Pippin: yeah because his dad comes from [Place Name]

Stanley: I **love** visiting other countries because then I learn about them

Stanley: I like all of them, especially visiting other countries… because I've been to lots of countries and I've even lived in some of them… when I was about two months old, I was living in [Place Name]… I've been to about 50 countries

Excerpt 8.21: Stanley (int. 1-3) described his love of visiting other countries.

A final common theme amongst these participants was their identification with 'cleverness'. Cleo, Cupcake and Blackjack all described themselves as 'clever', though only Cleo did this consistently (Excerpt 8.22). Blackjack was unsure how to explain her choice, while Cupcake attributed this description to her class teacher rather than herself. It is unclear whether this self-concept existed before her teacher highlighted it, or whether Cupcake's confidence in it was isolated to that specific event. She did not choose to describe herself with the word 'clever' in the preceding or following interviews. Cleo's concept of cleverness was associated with working hard, enjoying learning, and working independently. In addition to this, Cleo's understanding of cleverness appeared to involve a perception of yourself as exceeding the norm. Cleo also highlighted that '*most of the time I get all of the answers right'*, which is likely to also be a factor in her identity as someone who is 'clever'. A love of learning, and desire for academic success appeared to be key elements of Cleo's identity; even her enjoyment of reading was linked to its potential to '*help with learning'*.

Cupcake: *my teacher said at my parents evening that I'm clever*

Blackjack: [pause] *I don't know why clever* [laughs]

Cleo: I'm clever because I work hard

Cleo: *I chose clever because I just like learning… and most of the time I get all of the answers right*

Cleo: *I'm clever because* [laughs] *I'm just clever*

Pepperoni: *she is clever*

Cleo: *and I can work independently because I'm clever*

Interviewer: *okay, what* ***is*** *being clever?*

Cleo: *it's kind of like being at a different level to other people – kind of?*

Excerpt 8.22: Cupcake (int. 2), Blackjack (int. 1), and Cleo (int. 1-3) described themselves as clever.

8.1.3 Inconsistent or limited responses

Some participants demonstrated very little consistency in their self-concepts, or gave extremely brief rationales for their choices, making it difficult to ascertain their relationship with STEM (Table 8.3).

Molly	Int. 1	Likes visiting other countries	Clever	Can take risks	Wants to understand how things work	Encourages others	Likes being outdoors
	Int. 2						
	Int. 3	Likes visiting other countries	Clever	Sensible	Hardworking	Organised	
Pasta	Int. 1	Enjoys science	Comes up with lots of new ideas	Can work in a team	Learns from their mistakes	Can use computers	
	Int. 2	Enjoys science	Clever	Sensible	Can work independently	Enjoys sport	
	Int. 3						
Bumble	Int. 1	Enjoys drawing	Creative	Resourceful	Likes helping others		
	Int. 2						
	Int. 3	Curious	Wants to understand how things work	Likes being outdoors	Honest		

Table 8.3: Inconsistent or limited self-reflections from participants in all three interview sessions.

Molly demonstrated the most consistency out of the three participants identified here, with her choices of ‘likes visiting other countries’ and ‘clever’. Her rationale for these choices was limited in the initial interview and can be subject to very little interpretation, though both descriptors appeared linked to academic achievement or knowledge acquisition in the third interview (Excerpt 8.23). Molly’s other choices were sometimes contradictory, for example she initially described herself as ‘*quite risky*’, but then identified with ‘sensible’ later in the year. There was no indication throughout that Molly held a particular interest in STEM, aside from her identification with ‘clever’, which her group consistently associated with STEM.

Interviewer: *What do you like about* [visiting other countries]*?*

Molly: *I like to see all the culture they have there? Like in Rome, I haven't been there but I did go to Venice and I saw the opera house, and I really like seeing landmarks and stuff. I also really like swimming pools abroad*

Molly: *I feel like I'm clever because when I was in Year 1 I was* ***really*** *dumb*

Interviewer: *can you tell us why you've chosen clever today?*

Molly: *because I get most of my spellings right and I can read really thick books*

Excerpt 8.23: Molly's (int.3) explanation for choosing 'likes visiting other countries' and 'clever'.

Both Pasta and Bumble made limited contributions to group discussions, and Pasta chose to withdraw from the final interview session before it began. Though both children chose descriptors that could be linked with an interest in STEM, their explanations were extremely limited and revealed little about their self-concepts. Pasta's choices ('comes up with lots of new ideas', 'learns from their mistakes') are indicative of a creative and experimental person who may enjoy a future in STEM, however it was not clear whether Pasta believed this about himself. Bumble's absence for the second interview may have impacted his ability to build confidence in the group interview setting. Though most participants were reserved in their initial interview, the majority displayed greater confidence in the following sessions. Bumble's difficulty in expressing his thoughts[26] (e.g. Excerpt 8.24) limited what can be understood about his identity, though general themes of creativity and curiosity were present.

Bumble: *I don't want that*

Interviewer: *you don't want to choose* [resourceful]*?*

Bumble: *I don't really know about that one*

Interviewer: *okay, so what's the other one that you've got there?*

Bumble: *helping others*

Interviewer: *okay and can you tell us about that one?*

Bumble: *I'm not really sure, but I know I have done it before*

Excerpt 8.24: Bumble (int. 1) appeared uncertain how to explain his choices.

[26] See also in Chapter 9, where some of Bumble's responses to the final survey were impacted by his confidence in communicating his thoughts.

8.2 Discussion of self-reflection results

Several themes arose from these results, which are discussed in the following section. These themes comprise: the influence of family in identity and aspiration development; participant confidence in describing themselves, and how feelings of success may contribute to this; common areas of interest amongst participants.

8.2.1 Having a STEM-based parent does not guarantee a sustained interest in STEM

The role of 'family habitus' is defined by Archer *et al.* (2012, 886) as being the '*broad spectrum of family resources, practices, values, cultural discourses, and ''identifications'''*; they argue that the interplay of these factors (including science capital) contribute to children's science aspirations (Archer *et al.* 2012, 888). In this discussion, the concept of 'science capital' is applied more broadly to encompass the whole STEM spectrum (Moote *et al.* 2020). Some research positions STEM-based parents as key factors in this, based on the assumption that they are more likely to elicit STEM aspirations in their children (Holmes *et al.* 2017, 663). Another study observed increased engagement in families with *two* adults working in STEM industries (Plasman *et al.* 2020).

NJ and Black Cat both hold increased STEM capital via a parent with a career in STEM. Both children had a reasonable understanding of their parents' work (albeit without exact details) and engaged in relevant STEM activities with that parent. They both also expressed interest in those areas of STEM and chose words to describe themselves that reflected this interest. However, as was recognised by Archer *et al.* (2012, 889), having a parent in a STEM occupation does not guarantee that a child will also align with STEM. This was observed amongst participants Stanley and Barry, who both mentioned parents in STEM occupations though neither child appeared to prioritise the STEM element of that relationship in their own identity. Though Barry did consistently identify with maths, he only once described himself as enjoying science (his mother's occupation). Neither child gave any indication that they had consciously rejected their parents' work, as was suggested by Archer *et al.* (2012, 889); both children discussed their parents in very positive terms. Instead it is likely that they identified alternative interests that were of more importance to them.

Buster also had a STEM-based parent, but did not seem to identify with STEM, instead emphasising creativity in her self-reflections. Buster mentioned that her parent worked in healthcare in the final interview, where it was clear that she was unsure if their job came under the umbrella of STEM. This example demonstrates how even children of STEM workers may have limited knowledge about 'what counts' as STEM; it is unlikely that parents use 'buzzwords' such as 'STEM' when discussing their work at home. This highlights a limitation of using such acronyms, as they become meaningless if used in isolation. Introducing young people to the concept of STEM must also be accompanied by an expansion of their knowledge about the breadth of opportunity available within it.

The results of these self-reflections reveal that family and home life remained an important influence in children's identity and experiences, whether a parent was in a STEM occupation or not. Numerous participants made reference to experiences that were facilitated at home when discussing their personalities; one of the most common examples was attendance at an extracurricular sports club. Children's access to sports clubs are largely mediated via a parent, e.g. paying registration fees or providing transport to practices and games (Kanters *et al.* 2008, 65). Parents may also provide access to other resources such as: art supplies, books, foreign holidays and 'screen time' allowances. By facilitating access, parents validate their child's interest which may enable them to incorporate that interest into their personality more easily. Parents can also impart their own interests upon a child; archaeology and heritage are widely popular amongst the general public for family outings (DCMS 2020), and so archaeology represents a way for these families to explore STEM together.

8.2.2 Participant confidence in describing themselves

Participants largely selected cards that described hobbies and interests: dancing, sport, playing computer games, reading, and learning languages. Other popular cards did not directly reference a hobby but were linked to one by participants; for example, 'creative' and 'artistic' were frequently used to discuss painting and drawing. In cases where cards were linked to a participant's interest, they were often consistently chosen in this exercise throughout the research period. 18 of 20 participants spoke about a specific interest in two or more self-reflections. Attending relevant extra-curricular clubs, also appeared to be a factor in whether a card was repeatedly chosen by participants. 10 of 20 participants attended clubs, the majority of which related to sport and dance (art clubs and a sewing club were also mentioned); of those 10 participants, 9 pupils consistently[27] highlighted the relevant interest in their self-reflection.

The way people describe themselves changes as they age, with young children expressing themselves via '*facts, habits, skills, preferences, and traits'*, while adults discuss their '*surgency, agreeableness, conscientiousness, emotional stability (vs. neuroticism), and intellect/ culture'* (Donahue 1994, 46). This relates to development of children's cognitive capacity, self-concept,

[27] Participants spoke about a hobby two or more times in the reflective exercise.

and verbal comprehension (Soto *et al.* 2008, 719); as people age they acquire vocabulary to better describe themselves and become more effective at self-reflection (Markey *et al.* 2002, 175). People also develop as social actors, and are able to expand their '*behavioural repertoire'* to express a broader range of personality traits as they age (Mervielde and Fruyt 2000, 102). It is not surprising then, that the participants in this study mostly described themselves via hobbies and interests (i.e. skills and preferences, see Donahue 1994, 50); not only is this something that is relatively simple to describe, but it also represents something that participants enjoy and may spend a fair amount of time doing. Consequently, these were areas of their lives that participants felt confident identifying and discussing. Participants like Molly, demonstrated a changing understanding of themselves even within the short period of the research project, shifting from 'risky' to sensible in her self-reflections.

The importance of capturing children's interest in STEM at a young age is well documented (Pell and Jarvis 2001, 860; Murphy and Beggs 2003, 114; DeWitt *et al.* 2013, 1055; Dou *et al.* 2019, 624), and this is also relevant to their identity development. Children who recognise how their self-concepts relate to STEM (e.g. curiosity and creativity) may be more likely to identify with STEM as they progress through education. While younger children are still learning how to be introspective, they might benefit from additional practice at this as part of a wider preparation for their futures. Children with a good understanding of their personality will be better equipped to make choices about their future.

There were some indications that familiarity with words may have been a factor in their selection, to the extent that some words were avoided completely, and others were chosen but not expanded upon, or interpreted incorrectly. For example 'methodical' and 'logical' were not chosen by participants at any point throughout this exercise[28]. Other words (e.g. resourceful) were selected by one participant, but that participant (Bumble) was unsure how to discuss them. It is likely that other cases of (un)familiarity motivated avoidance of words occurred, though they remain invisible in the data. Participants who demonstrated less consistency in the way they described themselves may have experienced this to some degree; a lack of confidence in completing the task may have resulted in them selecting random cards to follow instructions and presenting anything vaguely plausible as their explanation when asked.

[28] Both words also generated very little discussion in the word sorting exercise, see Chapter 7.

8.2.3 How do feelings of success impact identity?

Prior research has highlighted the importance of self-concepts in STEM; young people with greater confidence in their STEM-related abilities are more likely to pursue it in the future (Schulz 2005; Brown *et al.* 2008, 6; Gorad and See 2009, 107; Pinxten *et al.* 2015; see Chapter 2). The role that self-concepts of ability play in formation of identity has also been established (Carlone 2004, 409; Kyriacou and Goulding 2006, 17; Mendick 2006, 63). Young people who feel successful and confident in something are more likely to embed it into their identity. Many participants expressed confidence in something which interested them: Cleo and Cupcake's confidence in sport and dance was related to winning competitions; Apple and Skull Trooper derived confidence from their ability to help others with computer-related problems. Other participants' validation of success was not based in competitions or aiding peers, but was still evident in the way they spoke about current abilities or future aspirations. For example, NJ and Jelly's assertions '*I can code'* and '*I can have a full conversation* [in German]', and Pippin's desire to '*make a shop for fashion'*, demonstrate confidence in those areas. By prioritising these interests in the reflective exercise, participants indicated the importance placed on them within their identity.

This is something that in/formal educators should bear in mind when planning engagements: by recognising areas of interest that young people already feel confident in, it is possible to connect those children with STEM by exploring relevant connections. The breadth of possibility afforded by archaeology makes it a key tool when attempting to engage young people in STEM through current interests. While the STEM and archaeological learning opportunity for hobbies such as dance, fashion and languages may not be obvious to the children pursuing them, there is scope for experts in those areas to emphasise the ways they are relevant. Researchers have already begun to examine this: SHINE for Girls tackles maths confidence in girls via the medium of dance (Hally and Sinha 2018); Fashion FUNdamentals seeks to '*ignite curiosity'* about STEM through fashion (Hyllegard *et al.* 2016, 33); Zhang and Callaghan (2014) used creative writing and science fiction to teach English as a second language, and Bers (2019) has argued that coding ought to be taught '*as another language'*.

8.2.4 Most common skills, aptitudes and interests

When looking for ways to connect young people with STEM in areas that already interest them, it is important to understand major areas of interest for young people. The results of this study do not reflect interests of pupils across the whole of Wales and England, however it is possible to compare participants' preferences with more representative data from other studies. The two most commonly chosen cards were 'enjoys sport', and 'enjoys maths' (

Table 8.4). Other common cards were also related by participants to sports, such as 'enjoys dancing' and 'likes being outdoors'. 'Creative' and 'clever' were selected with relative frequency, and using computers or computer games was also popular. Although in/formal educators have begun the work to widen young people's understanding of the STEM underpinning their hobbies, there is scope to achieve this on a broader scale, as many of the young people in this project did not recognise STEM themes within their interests[29].

The proportion of participants aligning themselves with sport (60%[30]) and dance (40%) is mirrored in statistics for the whole of Wales and England, where sport is widely engaged with. In 2018 in Wales, 65% of all school children participated in extracurricular or community sport at least once a week (Sport Wales 2018, 8). In 2020 in England, 44.9% of school children were active for more than 60 minutes a day[31] (Sport England 2021, 5). Physical exertion and archaeological excavation are closely associated (though not mutually exclusive, see Phillips and Gilchrist 2012, 685), meaning that excavation may be of interest to young people who enjoy being physically active. There is also an obvious cross-over between excavation and an interest in 'being outdoors'. Outdoor heritage sites are a valuable resource in this case; engaging with outdoor heritage sites and community archaeological excavations have benefits for both physical and mental health (Historic England 2020a, 34). Constructivist learning theory highlights the importance of engaging people with things that are important or meaningful to them (Olusegun 2015; Zajda 2018). Local heritage can be extremely meaningful to surrounding communities (YouGov 2018, 8; Historic England 2020a), and so drawing upon this in educational contexts is likely to be particularly engaging.

[29] See Chapter 7 for further information about how interests and hobbies were discussed by participants in relation to STEM.

[30] Of participants who selected sport at least once.

[31] A reduction of 1.9% since 2019, before the impact of the COVID-19 pandemic upon youth activity.

Skills and personality traits	Int.1	Int.2	Int.3	Average
Enjoys sport	4	4	10	6
Enjoys maths	6	6	6	6
Creative	3	5	6	5
Can use computers	4	4	6	5
Enjoys dancing	5	5	4	5
Likes computer games	5	5	5	5
Likes being outdoors	4	2	5	4
Clever	4	4	3	4
Enjoys drawing	4			4
Artistic	1	4	4	3
Enjoys reading	2	3	3	3
Likes visiting new countries	3	2	4	3
Hardworking	3	3	3	3
Learns from their mistakes	3			3
Enjoys science	4	2	3	3
Enjoys history	4	2	4	3
Imaginative	4	3	2	3
Likes helping others	4	4	2	3
Honest	1	2	2	2
Enjoys building things	1	3		2
Can work independently	2	2	1	2
Sensible	2	2	3	2
Wants to understand how things work	2		1	2
Can take risks	2		2	2
Likes to try new things	2			2
Comes up with lots of new ideas	2			2
Can work in a team	3	3	1	2
Likes learning new things	4	1	1	2
Likes learning languages	1	1	1	1
Gets all of the answers right	1	1	1	1
Reliable	1	1	1	1
Organised	1	1	2	1
Competitive	1	1		1
Inventive	1		1	1
Practical	1		1	1
Encourages others	1			1
Reflective	1			1
Resourceful	1			1
Shares information with others	1			1
Curious		1	1	1
Determined		1	1	1
Listens to other people's opinions			1	1

Table 8.4: Frequency that cards were selected by participants in the reflective exercise. Dark grey indicates cards that were removed following first interview. Averages rounded to nearest whole number.

In 2018/19, a third of 5-10 year olds in England participated in dance (DCMS 2019, 4), and just over a third (36.9%) of 7-10 year olds did the same in Wales in 2018 (Arts Council of Wales 2018, 12). Dancing is culturally linked with femininity (Stinson 2005, 52; Schmalz and Kerstetter 2006, 545), resulting in a gendered divide in dance participation across Wales and England (Lakey *et al.* 2017, 29; Arts Council of Wales 2018, 10); which was also observed in the results of this study (Table 8.5). Sport (including dance) had previously been identified by participants as not being mutually exclusive with an interest in STEM, but unlikely to be of much importance to a person in their pursuit of it (Chapter 7). Six out of eight participants who appeared aligned with STEM also professed an interest in sport or dance. While these individuals' interest in sport and dance did not hinder their exploration of STEM, it is likely that they did not fully appreciate how their two interests might be combined. In addition to this, all of the nine participants who appeared ambivalent towards STEM expressed an interest in sport and/or dance, representing a prime opportunity to engage them with STEM in a personally meaningful way.

Skills and personality traits	Boys	%	Girls	%
Enjoys sport	7	35	5	25
Enjoys dance	2	10	6	30
Enjoys maths	7	35	2	10
Creative	2	10	7	35
Clever	3	15	4	20
Likes computer games	7	35	1	5
Can use computers	6	30	4	20

Table 8.5: Frequently chosen skills and personality traits, by gender. Individuals counted once for identifying a skill/ trait in at least one interview.

Sport and dance are intrinsically linked with STEM via concepts like physiology, nutrition and pharmacology, and sports technology (Paul and Ellapen 2016; Mamrack 2017; Kellman *et al.* 2018; Subic 2019; Benardot 2020), however, the links between sport, dance and archaeology may be less apparent. Archaeological study into the origins of dance does exist (Garfinkel 2010; Soar and Aamodt 2014), and dance has even been used to disseminate archaeological knowledge in museum installations and exhibits (Bird-Tobin and Bird 2018; Crawley 2020). Similarly, archaeological evidence for sport (e.g. stadia, artistic depictions, graves of athletes, Rebay-Salisbury 2012; Turner 2012) does exist, but aside from research carried out in response to modern Olympic events (Simandiraki 2005; Schofield 2012), has been subject to limited study. Archaeology is useful when engaging with 'modern' sporting concepts, such as heritage football grounds (Peterson and Robinson 2012; Wood 2016) and memorials in motorsport (Corkill and Moore 2012). Modern sport is also a vehicle by which archaeologists can understand past communities' relationships with significant places, such as Davis' (2015) exploration of identities in football stadia and Iron Age Hillforts.

The frequency of participants indicating that they enjoyed maths in this exercise (Table 8.4) might appear unusual, as maths is more commonly associated with anxiety than enjoyment (Lyons and Beilock 2012; Foley *et al.* 2017; Foyn *et al.* 2018, 79). Studies into primary children's perceptions of maths reveal that they are generally positive towards maths (Dowker *et al.* 2012), and so the finding is not unusual for the age group. It is also worth considering the demographics who chose to align their personalities with maths in this exercise. Of the nine individuals who prioritised maths in their self-reflections, seven were boys and only two were girls (Table 8.5). This is consistent with other research, where girls are often found to have less confidence and enjoyment in maths (Geist 2010, 25; Cvencek *et al.* 2011, 775), despite fairly even maths achievement between boys and girls (Schleicher 2019, 31). 'Getting girls into STEM' is one of the core messages at the centre of STEM education discourse, and so educators wishing to explore ways to improve female participation in maths have a wealth of information to draw upon (Fleischer *et al.* 2010; Milgram 2011; Dubetz and Wilson 2015; Mosatche *et al.* 2013; Levine *et al.* 2015; Young *et al.* 2019).

While enjoyment of maths was more common amongst boys in this study, creativity was more frequently reported by girls (Table 8.5). Engagement with visual arts is also very common amongst young people across Wales and England: in 2018, 87.2% of 7-10 years olds in Wales (Arts Council of Wales 2018, 18), and 71.5% of 5-10 years olds in England (DCMS 2019, 4) participated in arts and crafts. In both places, girls were found to be more likely to engage with visual arts than boys (Lakey *et al.* 2017, 29; Arts Council of Wales 2018, 16). When discussing examples of creativity, almost all participants placed their creativity into the context of visual arts (e.g. drawing, painting); the only exception to this was Pepperoni, who spoke about her creativity in completing an invention challenge for British Science Week. STEM and the arts are often perceived as being separate, though numerous researchers have argued otherwise, and for the integration of the two (Kind and Kind 2007, 6; Wallace *et al.* 2010; Henriksen 2014). Several programmes addressing STEM and the arts have produced promising results: from using robotic engineering to create pieces of art (Martin *et al.* 2007), to utilising STEM in other creative practices like fashion and textile design (Richard *et al.* 2015; Hyllegard *et al.* 2016). Not all of these examples specifically targeted female participation in STEM, however, the high proportion of female interest in visual arts makes this another interesting way in which to tackle issues of 'women in STEM'. Educators who wish to explore this must bear in mind the danger of playing to unhelpful stereotypes (Zecharia *et al.* 2014, 7; Godec 2018, 10), and must seek to engage girls in areas of genuine interest.

Experimental archaeology is one of the most accessible and creative archaeological engagement methods, and is used to generate public interest across the UK (e.g. Butser Ancient Farm; St Fagans National Museum; Jorvick Viking Centre; West Stow Anglo-Saxon Village; Scottish Crannog Centre), though not always with an explicit STEM focus. Examples of archaeological public engagement that centre creativity and STEM do exist, such as the Virtual Heritage Wales project, where young people trained in digital and virtual reality technologies to create a visitor experience for Caerwent Roman Town (Ellis and Oats 2016). Other archaeology and heritage organisations have collaborated with STEM partners to develop STEM-themed experimental archaeology activities: the science of making Stone Age cheese (STEM Learning n.d.a) and the chemical process of dying textiles (Creative Minds n.d.). However, there remains a great deal of scope for archaeologists to explore STEM-focused creative engagements, on a wider scale across Wales and England.

In 2019 79% of 8-11 year olds in the UK played digital games for an average of 9.5 hours a week (Ofcom 2020, 5). Gaming is largely done by boys, but is rapidly gaining popularity amongst girls: 55% of 8-11 year old girls played online games in 2019 (Ofcom 2020, 22). Despite concerns about the negative effects of games and digital media on young people (Billieux *et al.* 2015; Pontes *et al.* 2019), they are substantial contributors to the UK economy (Cabras *et al.* 2017, 306; Ofcom 2020; Ukie 2021), and represent a valuable opportunity to engage young people with STEM via an existing area of interest. The rise in popularity of gaming amongst girls has implications for STEM engagement, as there is evidence that girls who are interested in gaming are more likely to choose a STEM degree (Hosein 2019, 232). Gaming and archaeology are particularly well aligned; there is a rich (if often inaccurate) history of archaeology being featured in computer and video games (Meyers Emery and Reinhard 2015). Videogames are also useful in an archaeological engagement context (Ezzeldin 2019, 201); they have been used to explore common misconceptions about the work of archaeologists, such a 'treasure hunter' portrayals (Meyers Emery and Reinhard 2015, 140; Thoresen 2021) in Tomb Raider (1996) and Indiana Jones (1982), but also as educational tools which depict realistic excavation experience through gameplay (García-Raso 2011, 87; Reinhard 2018, 65), such as Roman Town (2010) and Buried (2014).

It is argued by Livingstone and Hope (2011, 4) that digital games encapsulate '*the UK's twin strengths… creativity and technology*'. Creativity is cited by game developers as a key part of their identity (Keune *et al.* 2018, 244), and research has demonstrated that playing videogames is related to multiple dimensions of creativity in children (Jackson *et al.* 2012, 374). Therefore digital gaming represents an opportunity to explore STEM with young people who align themselves with creativity; which researchers wishing to impact female STEM engagement have begun to explore (Liao *et al.* 2016). It is clear that there is enough interest among young people, and demand within the games industry, to justify appropriately skilled in/formal educators in exploring this avenue of engagement.

8.2.5 Participant alignment with 'cleverness'

Cleverness is a key topic at the centre of discourse around STEM uptake: the perception that only the most clever people are suited to STEM is both pervasive and damaging (Carlone 2004, 408; Brown *et al.* 2008, 8; Archer *et al.* 2013b, 183; Macdonald 2014, 12). It is therefore relevant to examine the prevalence of participants who chose to describe themselves in this way. Seven individuals described themselves as 'clever' at least once, though only three of them did so in two or more sessions. Some were confident in using this word to describe themselves and gave clear examples of why they believed it to be true, such as Cleo, Molly and Jelly. Others displayed more hesitancy when speaking about this trait: Blackjack's response to the card was to laugh and state that she wasn't sure why she'd chosen it; Cupcake explained that her teacher had described her as clever, but did not reveal whether *she* believed it.

Five participants provided additional insight into their personal understanding of what makes someone 'clever', many of which were located in a school context (Figure 8.1). Examples that were not directly related to school were still framed within educational and academic success, like learning and reading books. The perceived association between intelligence and academic success has roots in the original concepts of intelligence, where researchers attempted to 'measure' it using tests (Schlinger 2003, 16). Although theories have developed to recognise intelligences beyond test scores (Gardner 1983; Goleman 1995; Sternberg 2000; Drigas and Papoutsi 2018), the perceived link between cleverness and academic work amongst children remains reflected in the work of other researchers (Scherer 2016, 394; Listiara and Rusmawati 2019, 630).

Cleo	Jelly	Pasta	Barry	Molly
• Work hard • Like learning • Like doing new things • Work independently • Different level to other people	• Answer very hard questions in a short amount of time	• Put your hand up all the time	• Reading makes you clever	• Get spellings right • Read thick books

Figure 8.1: Qualities that participants associated with the 'clever' card, when using it to describe themselves.

How children incorporate 'cleverness' into their identity is complex, and differs based on the learning environment they inhabit. Researchers have found that children carefully navigate cleverness to preserve status within classroom hierarchies (Reay 2006, 176). Many children prefer to avoid their intelligence becoming weaponised with the label of 'nerd' (Foyn *et al.* 2018, 86). Other researchers note that pupils may occupy positions of high status by using academic skills to help others (Benjamin *et al.* 2003, 554). Participants did not explore those concepts in this exercise, though 'nerds' were discussed by YP and NB participants elsewhere (see Chapter 7). When reflecting, both Blackjack and Cupcake established distance between themselves and their choices. This mirrors findings from Foyn *et al.* (2018) and Benjamin *et al.* (2003) who observed that explicit performance of cleverness was less common amongst girls than boys; Foyn *et al.* (2018, 86) suggested that occupying this position may represent a social risk for girls. It is possible that Blackjack and Cupcake were attempting 'damage control' in their responses, where they wished to identify as 'clever', but avoid potential social consequences of describing themselves this way.

Children are aware of classroom-based hierarchies, and understand where they fit into them, based upon things like 'top sets' and 'gifted and talented' programmes (Reay 2006, 179; Scherer 2016, 396). Cupcake understood that her teacher believed her to be 'clever', and chose to prioritise this aspect of herself in the exercise. However, it was not clear how she had internalised this perception of herself: whether she related 'cleverness' to any specific part of her skillset, or if this was repetition of a (potentially high status) word that someone else had used to describe her. Cleo's assertion that a clever person is '*at a different level to other people'* demonstrated an awareness that 'cleverness' can be used to distinguish between individuals, with the cleverest people positioned above others in particular contexts. Her immediate follow up to this – '*kind of'* –may have been enacting 'damage control'; she may have been reluctant for the interviewer to have the impression that she believes *she* is above other people.

While feeling 'not clever enough' is often cited as a rationale for not pursuing STEM (Brown *et al.* 2007, 7; Archer *et al.* 2013b, 183), this is not an argument to remove the concept of cleverness from social discourse. Instead, intelligence is something which can be broadened beyond stereotypes of 'nerds' and people who are 'naturally clever'. This is widely recognised within education, where ability is considered in terms of 'key skills' such as creativity, problem solving and critical thinking (Welsh Government 2020, 25-6), and was demonstrated in the discussions of participants elsewhere in the interviews. Reflective practice and determination were highlighted by a number of groups as routes to success, and many individuals mentioned the 'Growth Mindset' approach to achievement (Dweck 2006). Of the children who identified as ‘clever’ in this exercise, only three also indicated a specific interest in an area of STEM[32], while six participants indicated an interest in STEM, but did not choose to describe themselves as ‘clever’. Amongst the pupils sampled, an interest in STEM was not dependent upon a self-concept of being clever. However, it is important to draw a distinction between feeling ‘clever enough’ to be interested in STEM as a 7-10 year old vs. feeling ‘clever enough’ to pursue it as a young adult.

Entrance to professional archaeology is primarily mediated through higher education: in 2019/20 only 1% of archaeologists’ did not have a bachelor’s degree or higher (Aitchison *et al*. 2021b). UCAS lists 44 universities offering undergraduate archaeology courses (UCAS n.d.a), most with minimum entry requirements of BBB at A level (UCAS n.d.b), though some institutions have lower requirements for foundation year courses (Birkbeck University of London n.d.). In 2018/19 the most commonly awarded A level grades in Wales and England were B and C (Wales: B= 26.3%, C= 25%, Welsh Government 2019b; England: B= 25.9%, C= 24.1%, DfE 2020). In this context, BBB entry grades for archaeology may be attainable for many pupils, and archaeology can be considered less exclusive than STEM subjects with higher grade requirements (Table 8.6), and may represent a more accessible route into a STEM profession. However, many STEM industries employ a high proportion of people without a bachelor’s degree (or equivalent, The Royal Society 2014a, 20; UKCES 2015, 28). While archaeology may be a more accessible route to HE, there is extremely limited scope to enter professional archaeology without a degree, unlike other areas of STEM. Additionally, rising rates of archaeologists with Masters and PhD qualifications (Aitchison *et al*. 2021b) may cause the profession to become even more exclusive in the future.

[32] Pasta identified as clever, though discussions with him were not extensive enough to establish a potential interest in STEM, so has not been counted in this figure.

Subject	Average grade requirement
Aerospace engineering	A*AA
Chemical engineering	AAA
Chemistry	AAB
Dentistry	AAA
Electrical and electronic engineering	ABB
Mathematical sciences	AAB
Mechanical engineering	AAB
Medicine	AAA
Molecular biology, biophysics, and biochemistry	AAB
Physical sciences	ABB
Veterinary science	AAA

Table 8.6: Average grade requirements of STEM degree courses according to UCAS.

8.3 Chapter 8 summary

This chapter documented and discussed the results of a reflective exercise carried out in interview sessions. The reflective exercise explored participants' self-concepts and sought to understand whether these descriptions changed in response to archaeological interventions. Results revealed themes such as, family influence on identity and interests; pupils' confidence in describing themselves; most frequently identified traits and interests. Results were examined in relation to existing literature on personality, identity and STEM engagement.

The majority of STEM interests were established prior to project commencement, and participants who developed an interest during the research period (e.g. Jelly), described experiences that did not reflect intervention experiences. The volume of participants with an established interest in STEM may be related to the sampling strategy (see Chapter 3): teachers may have picked children they thought would be most happy to talk about it. Children who did not prioritise interest in STEM in their reflections also demonstrated little shift in their self-concepts, suggesting that at this age, children have a consistent understanding of who they are and the things that interest them. It is likely that the time participants spent engaging with this research project was not extensive enough to produce a substantial impact on their STEM self-concepts. Instead a more consistent approach is needed to effect this kind of change.

Participants predominantly described themselves via hobbies and interests (e.g. enjoys sports, likes computer games), a likely reflection of participants' age-related ability to observe and describe themselves. While many schools encourage reflective practice in terms of pupils' work, there may be scope to broaden this by encouraging children to also reflect on their abilities and identity. Consistent reflections would allow children to cultivate positive self-concepts, and to make decisions about their future with confidence. It is recognised by the author that teachers are under substantial time pressure (see Chapter 4), and recommendations of this thesis should not increase this. Resources already exist to support teachers, such as those that inspired this activity, including the WISE Campaign's 'People Like Me' (Macdonald 2015), and Godec *et al.*'s (2017) Science Capital teacher's pack. The Science Capital teaching pack places particular emphasis on how teachers might incorporate the approach into their current practice in a way that does not require a substantial amount of additional work.

As hobbies and interests comprise a big part of how children perceive themselves, it is sensible to identify areas of current interest when attempting to approach STEM engagement. This has implications for educators seeking to engage children with STEM, and this chapter highlights areas where that may be possible. It established that the most common interests of this sample are also popular amongst other Welsh and English children in this age group, and therefore represent areas of opportunity. Sports, creative practice, and gaming were three areas of major interest for these participants, none of which were consistently recognised as being relevant within STEM by them. This is especially important, as it highlights a need that is largely unmet; the researchers already working in these areas should not be overlooked, but it is likely that substantial portions of the Welsh and English population are not yet engaging with STEM in this way. This thesis is primarily concerned with how children can engage with STEM through the lens of archaeology, so it is necessary to consider how these findings are relevant to archaeological education. Use of creative practice or videogames are not novel concepts in archaeology, though placing a specific focus upon STEM (particularly in the case of arts and crafts) in these areas is an interesting route for archaeological education to explore in the future.

This chapter demonstrates participants' relatively fixed self-concepts in terms of skill, aptitude and interests, but does not reveal how individuals related those skills/aptitudes to potential future STEM engagements. The following chapter examines the results of an interview-based survey, which asked participants to consider their skillsets, aptitudes and interests in a hypothetical future STEM context. The survey also serves as a final 'snapshot' of participants' STEM perceptions, experiences of the project, and potential STEM aspirations.

9 Chapter 9: Final survey results

Inconclusive results from the first two interviews raised concerns about how to measure the efficacy and impact of this research study on its participants. Questions remained about how participants recognised the relevance of their skills and aptitudes within STEM practice, and whether this had impacted their STEM self-concepts and identity. A qualitative survey was devised to examine pupils' perceptions of their participation in the project, their understanding of STEM-based skill/aptitude usage, and their potential STEM aspirations (indicative of a STEM aligned identity). The survey was completed at the end of the project and represented a valuable opportunity to gather a final 'snapshot' of participants' experience and perceptions of STEM.

9.1 Results

This section outlines the results to each of the three survey questions. Results of each question are presented according to primary themes in pupil response, such as increased awareness of the STEM acronym, and a reliance on the acronym when identifying skills/aptitudes for future STEM practice.

9.1.1 Have your thoughts or feelings about STEM changed during this project?

This question was intended to broadly capture the impact of the project on participants' perceptions of STEM. Of 19 participants 16 gave an affirmative response, while two participants responded with 'a bit', and one that their thoughts had not changed. The most common reason provided was that the project had introduced participants to the concept of STEM itself (Table 9.1). Other responses referenced things they had experienced during the project, though these did not always reveal exactly how that experience had impacted their perception of STEM.

Awareness of STEM acronym	Positive change in attitude to science	Experiences of the project					No difference
		Aqueduct	Faunal analysis	Learned new things	Influenced by others	Had fun	
Videogame Guy Blackjack Buster Bluebell Black Cat Olivia Cupcake Blossom Cleo	Molly	Pippin Cupcake Buster Blackjack Barry	Cupcake Skull Trooper Blossom	Jelly Buster	Apple	Pepperoni	Bumble

Table 9.1: Participant rationales for whether their perceptions of STEM had changed during the project. Some participants provided more than one response and are included in multiple columns.

9.1.1.1 Awareness of the STEM acronym

Nine participants explained that the biggest change in their perception of STEM throughout the research period was to have the acronym brought to their attention, as they were unfamiliar with it prior to participating in the project (Excerpt 9.1 and Figure 9.1).

Videogame Guy: *before this started then I was thinking STEM like the 'stem of a flower'*

Blackjack: *before I had no idea STEM was a thing*

Buster: *at the start I didn't really know what STEM stands for but now we've had quite a few lessons with you, I do know what STEM stands for*

Bluebell: *I've learned the meaning: science, technology, engineering, maths*

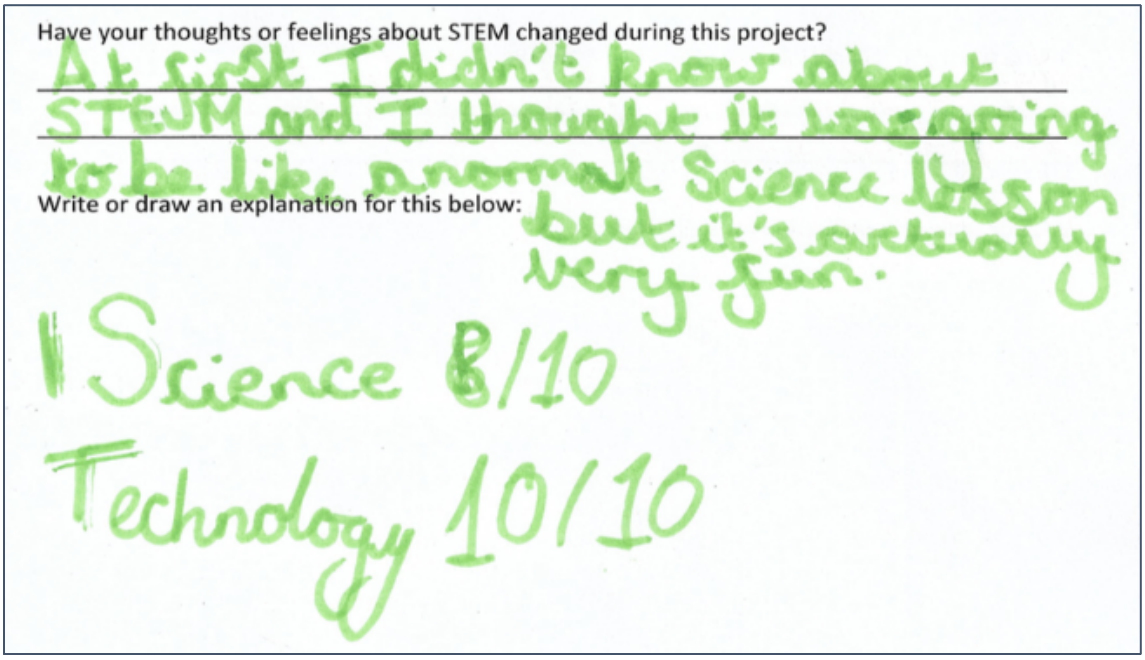
Black Cat: *when I was first in the conversation I was thinking "what does STEM actually mean?"*

Olivia: *I never knew what STEM means, I used to be like "what does it mean?" and "what if she asks me?" and I was put on the spot because I didn't know*

Cupcake: *Before you came I didn't even know the word STEM existed, and now I know lots more about STEM*

Blossom: *I only thought STEM existed like* – [a plant stem]

Excerpt 9.1: Comments from the final set of small group interviews where participants discussed learning the STEM acronym via this project.


Have your thoughts or feelings about STEM changed during this project?

At first I didn't know about STEM and I thought it was going to be like a normal Science lesson but it's actually very fun.

Write or draw an explanation for this below:

Science 8/10

Technology 10/10

Figure 9.1: Cleo's response to the question of how her perceptions of STEM had changed throughout the project. Text reads: 'At first I didn't know about STEM and I thought it was going to be like a normal science lesson but it's actually very fun'. Cleo has also rated the words 'science' and 'technology' out of 10. Science has scored either a 6 or an 8 (unclear) and technology a 10.

For Black Cat and Olivia, this learning experience was accompanied by a feeling of nervousness due to unfamiliarity with the STEM acronym. Both spoke about their concerns at the start of the project, and how they had navigated those feelings. These participants were interviewed at the same time, and there are clear similarities in their written responses (Figure 9.2 and Figure 9.3). Both explanations were accompanied by a drawing of two heads, where one person had a 'wobbly mouth' to signify nerves and the other was smiling to represent 'happy'. It is necessary to consider how far these two participants' responses were influenced by each other. While both children may have felt genuinely similar things, the fact that their words and drawings are so similar raises the question of whether their responses may have been different if they had been interviewed separately.

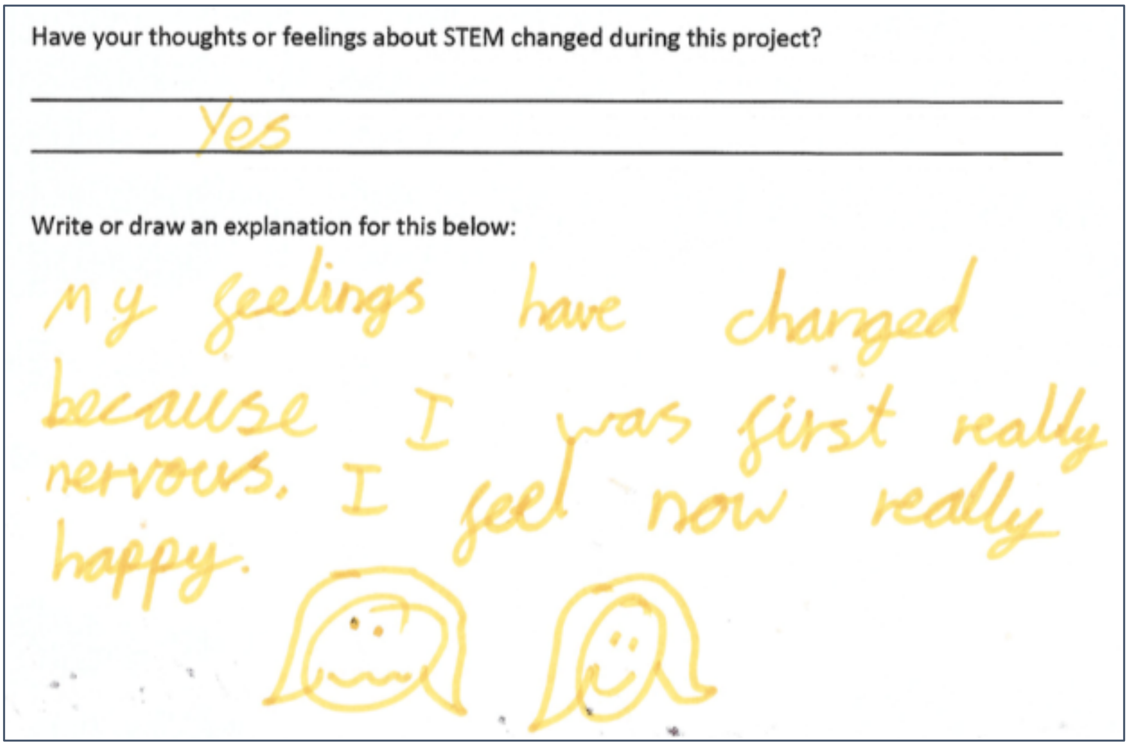


Figure 9.2: Black Cat's response to the question of how her perceptions of STEM have changed throughout the project. Text reads: 'my feelings have changed because I was first really nervous. I feel now really happy'. Black Cat has also drawn an image of two people, one who looks worried and one who is smiling.

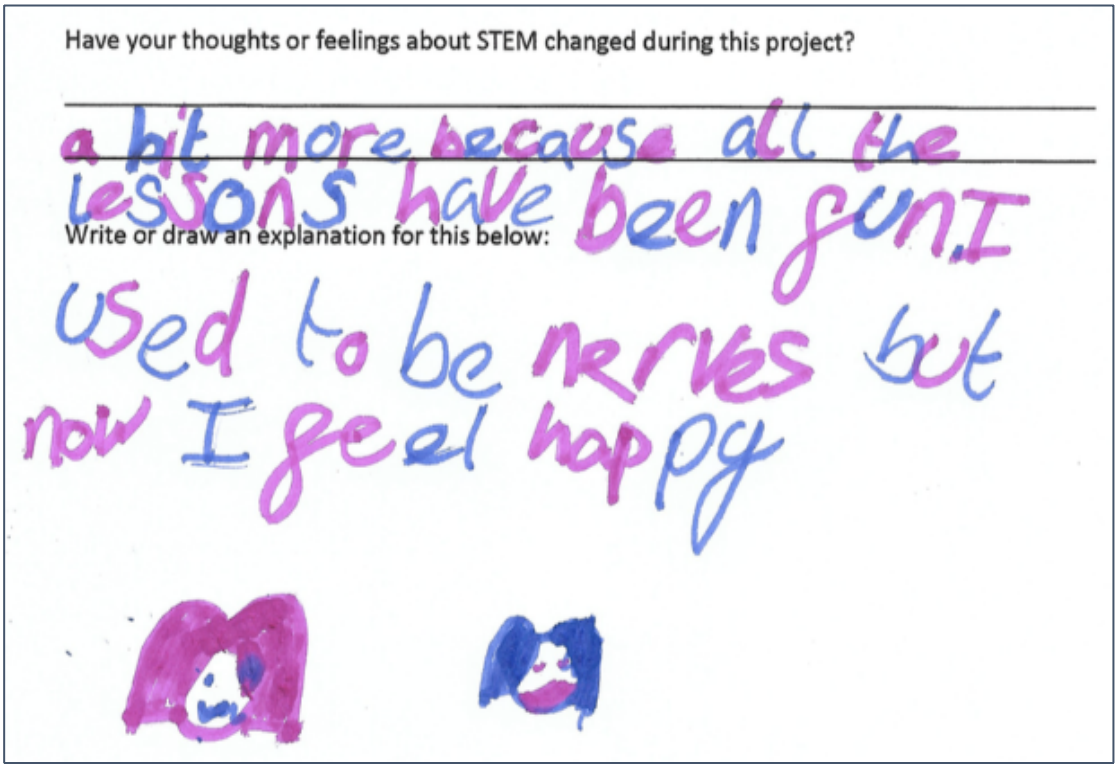


Figure 9.3: Olivia's response to the question of how her perceptions of STEM have changed throughout the project. Text reads: 'a bit more because all the lessons have been fun. I used to be nervous but now I feel happy'. Olivia has also drawn an image of two people, one who looks worried and one who is smiling.

Despite similarities in their written responses, Black Cat and Olivia gave slightly different verbal explanations of their answers which shed more light on the issue (Excerpt 9.2 and Excerpt 9.3). Black Cat's concerns were a potential requirement to leave school grounds, and unfamiliarity with the STEM acronym. Olivia's concerns were based in the fear that she would be ridiculed for not knowing something; her fears were resolved by learning the meaning of the STEM acronym.

Interviewer: [in response to Olivia's drawing] *so you used to feel nervous as well, what did you feel nervous about Olivia?*

Olivia: *because like what Black Cat said, I never knew what STEM means, I used to be like "what does it mean?" and "what if she asks me?" and I was put on the spot because I didn't know?*

Interviewer: *okay*

Olivia: *then everybody started laughing, so I felt quite nervous. But now I actually know what it means, I feel quite happy*

Excerpt 9.3: Comments from Olivia's discussion about her feelings of nervousness at the start of the

Black Cat: *at first I was nervous about it because I was thinking "are we gonna go to somewhere?" because I usually get really nervous when I go to trips or something like that*

Interviewer: *yeah?*

Black Cat: *but then once we've done a few weeks, I was really happy and I started to like it*

Interviewer: *so does the way you feel about STEM feel different now?*

Black Cat: *yeah, so when I first was in the conversation, I was thinking "what does STEM actually mean? I haven't really got a full explanation so I'm going to have a bit of work on it" like that*

Interviewer: *and how do you feel about STEM now?*

Black Cat: *I feel like it's things which I like doing: I like doing maths, I like doing science, I even sometimes like our computing lessons, so it's quite fun*

Excerpt 9.2: Comments from Black Cat's discussion about her feelings of nervousness at the start of the project and how they changed.

Other participants did not explicitly state that the project had introduced the concept of STEM to them, though their answers alluded to it. NJ and Stanley identified participation in the project as a catalyst for becoming more interested in STEM or beginning to think about it more often. NJ made specific reference to interview sessions in his written (Figure 9.4) and verbal (Excerpt 9.4) responses to this question, suggesting that these activities (rather than archaeological interventions) were major stimuli for change. His comments suggest that he did not think about STEM much before participating in this project, though this is no guarantee that he will continue to think about it outside of the research period. Stanley reported that learning about STEM resulted in him being 'very interested' and considering using it in the future (Figure 9.5). Stanley and NJ regularly mentioned a STEM-based parent in interview sessions, so it is possible that they were familiar with the acronym before joining the project. However, both children indicated that their participation elicited a change in how they thought about STEM, which suggests that having a parent with a STEM background does not guarentee the parent will discuss it with the child *or* that the child would retain the knowledge afterwards.

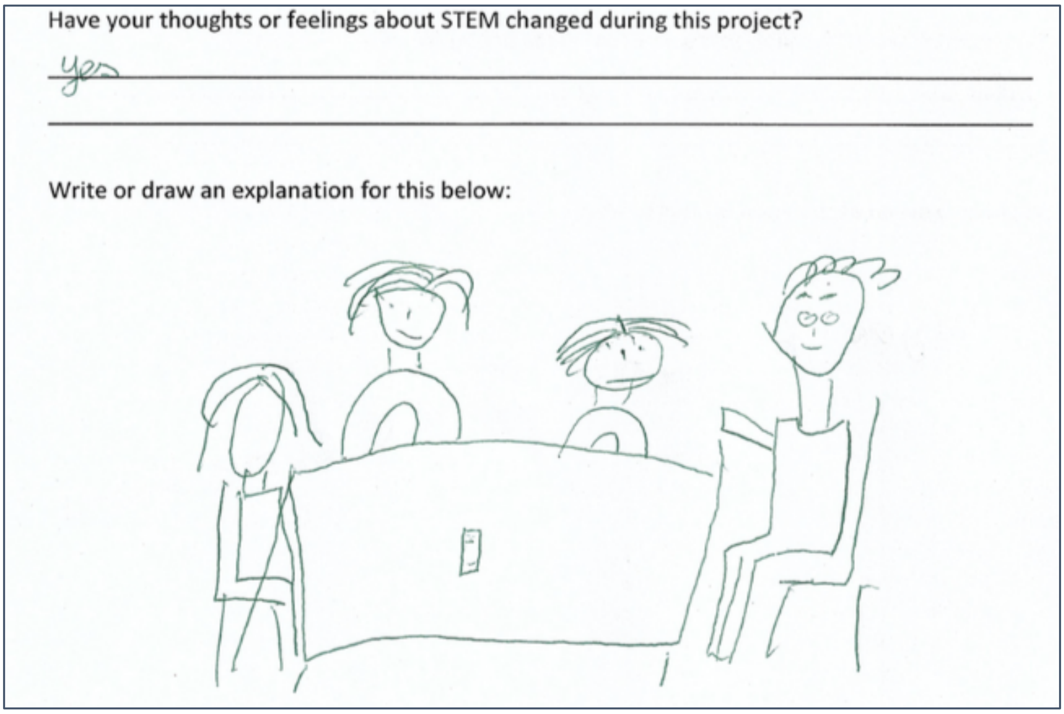


Figure 9.4: NJ's response to the question of how his perceptions of STEM have changed throughout the project. Text reads: 'yes'. NJ has drawn an image of himself and his fellow interview participants sat around a table.

NJ: *I've drawn a picture of us on the table because I've started to think about and understand a bit more*

Excerpt 9.4: NJ's comments that accompanied his written response in the final interview session.

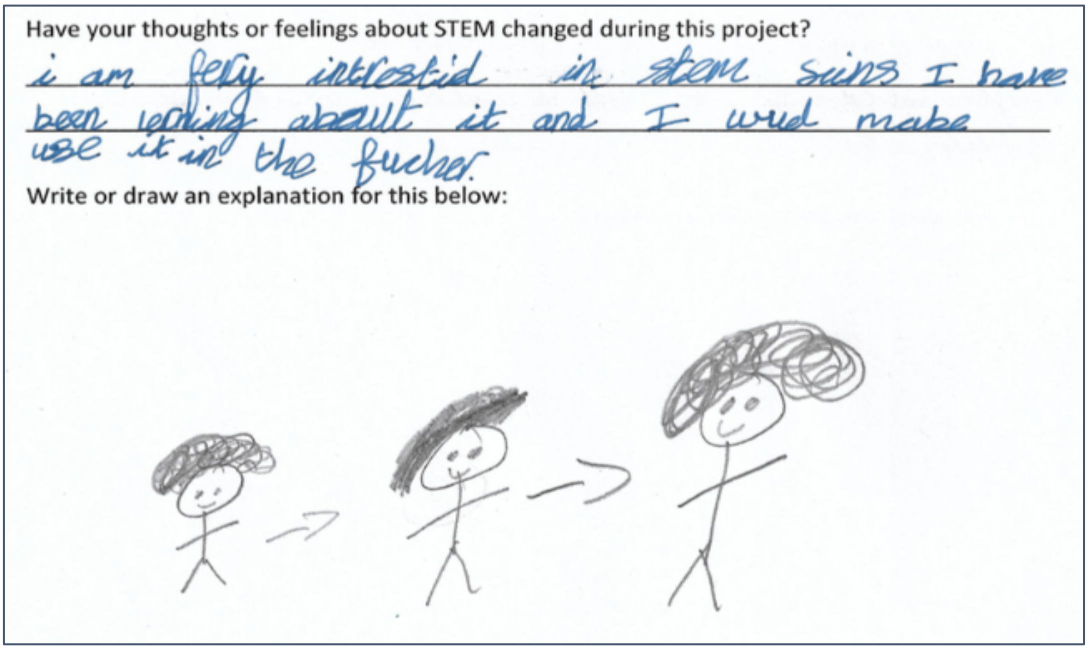


Figure 9.5: Stanley's response to the question of how his perceptions of STEM have changed throughout the project. Text reads: 'I am very interested in STEM since I have been learning about it and I would maybe use it in the future'. Accompanied by an image which Stanley explains is him in different life stages from child to grown up.

Despite widespread use of the STEM acronym amongst educators and policymakers, its meaning does not appear to have permeated to learners, therefore learning the acronym was a major change identified by participants of this project. The focus on 'learning the STEM acronym' left little room for participants to explore changes to their thoughts or feelings about STEM; they recalled a simple fact rather than engaging with the objectives of the project more deeply. There was also evidence that engagement with the acronym – however shallow – was beneficial to participants, who cited improved confidence when discussing STEM, thinking about STEM more frequently, and their enjoyment and interest in the project.

9.1.1.2 Change in attitude to science

Molly's response was an extremely promising reflection of the project's impact; she revealed that since participating in the project she had changed her perception of science (Figure 9.6). Time restrictions in Molly's final interview prevented her from speaking more about her answer, though it appears that she associates her participation with her newfound enjoyment of science. Having the opportunity to experience science learning through the novel lens of archaeology may have been crucial in Molly's new perception. This finding does not seek to diminish the efforts of the other people in Molly's life who may also have positively influenced her feelings about science during this time. YP school has been commended by Estyn in its approach to STEM education (Excerpt 9.5) and Molly's parent with a background in STEM[33] may also have helped to elicit this change.

A particular feature of the school's work is the way in which they enrich learning by providing lively and exciting experiences for pupils as a trigger for class work. For example, older pupils studied plants that grow from seeds that were sent from international space station of the astronaut, Tim Peake. Provision to develop pupils' standards of science across the school is exceptional.

Excerpt 9.5: Excerpt from YP's most recent Estyn report.

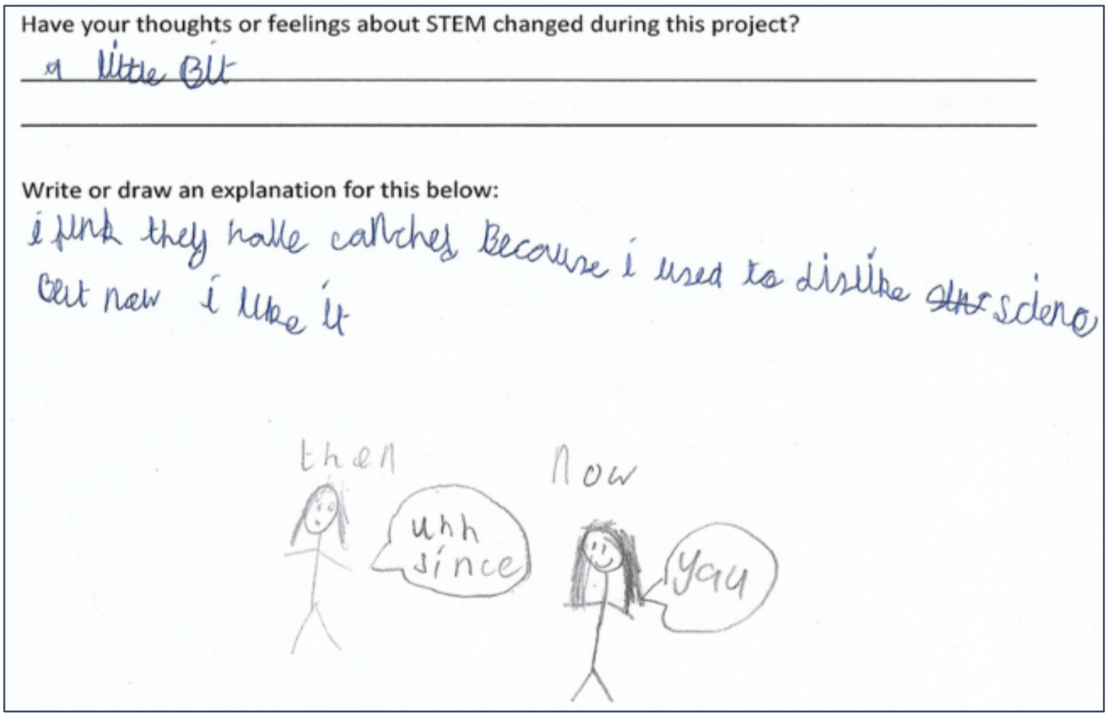


Figure 9.6: Molly's response to the question of how her perceptions of STEM changed throughout the project. Text reads: 'A little bit. I think they have changed because I used to dislike science but now I like it'. Accompanying image is of a person labelled 'then' and 'now', in the 'then' picture, the person is saying "uhh science" and in the 'now' picture they are saying "yay".

9.1.1.3 Experiences of the project

Other responses referenced participants' experiences throughout the project. Images of and references to aqueducts were common across responses, likely due to the most recent intervention. Pippin (Figure 9.7) and Cupcake (Excerpt 9.6) referenced aqueducts whilst describing what they had enjoyed about the project; building and creating. Pippin did not specify exactly how her thoughts had changed, but it can be assumed that Pippin's positive response ('*loved*') reflects a positive change in her perceptions of STEM. The practical and creative aspect of the aqueduct workshop appear particularly influential; the relative novelty of working in this way may be why aqueducts featured in so many responses. Other examples of

[33] Molly described her father's job as '*inspect*[ing] *ships when they come in…* [like] *a car MOT*'.

aqueduct drawings did not directly relate to participants' written response (Figure 9.8 to Figure 9.9), but may be a more general representation of participants' experiences of the project and 'doing' STEM.

Cupcake: *I liked it because you've used maths. I liked it because we were looking at bones and we've never really done that before… it's been nice building, I liked building the aqueduct and looking at the bones and what animals they've come from*

Excerpt 9.6: Comments from Cupcake in answer to the question of how her perceptions STEM have changed throughout the project.

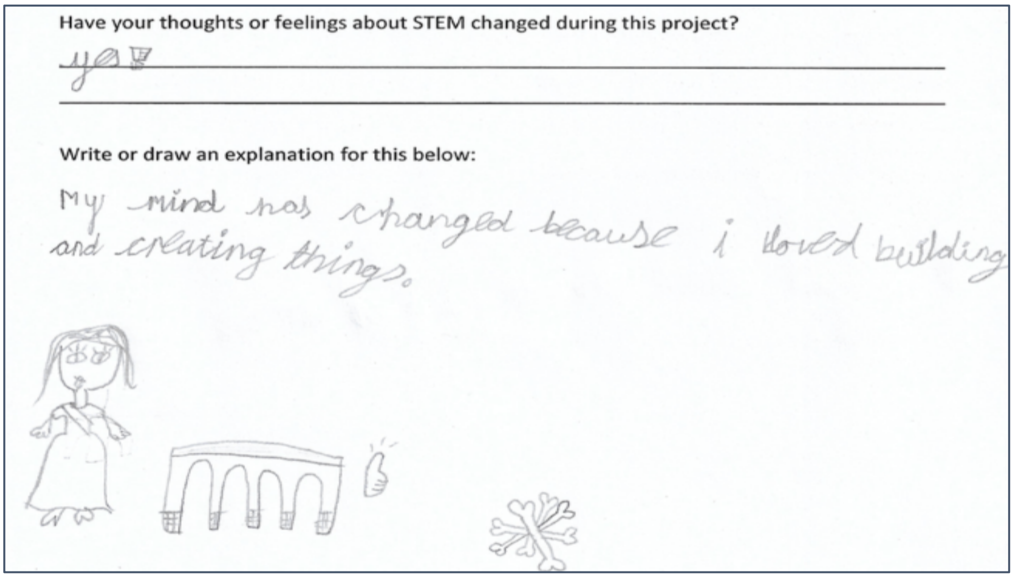


Figure 9.7: Pippin's response to the question of how her perceptions of STEM changed throughout the project. Text reads: 'Yes! My mind has changed because I loved building and creating things'. Pippin has drawn a person stood next to an aqueduct with a thumbs up.

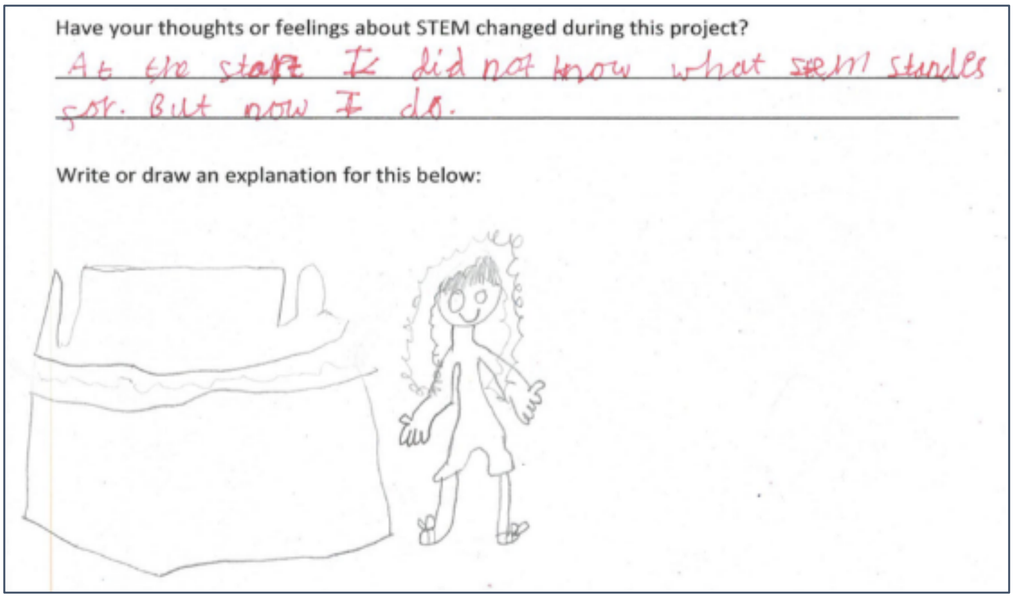


Figure 9.8: Buster's response to the question of how her STEM perceptions changed throughout the project. Text reads: 'At the start I did not know what STEM stands for. But now I do'. Accompanying image is of Buster with her aqueduct from the day before – as described by Buster.

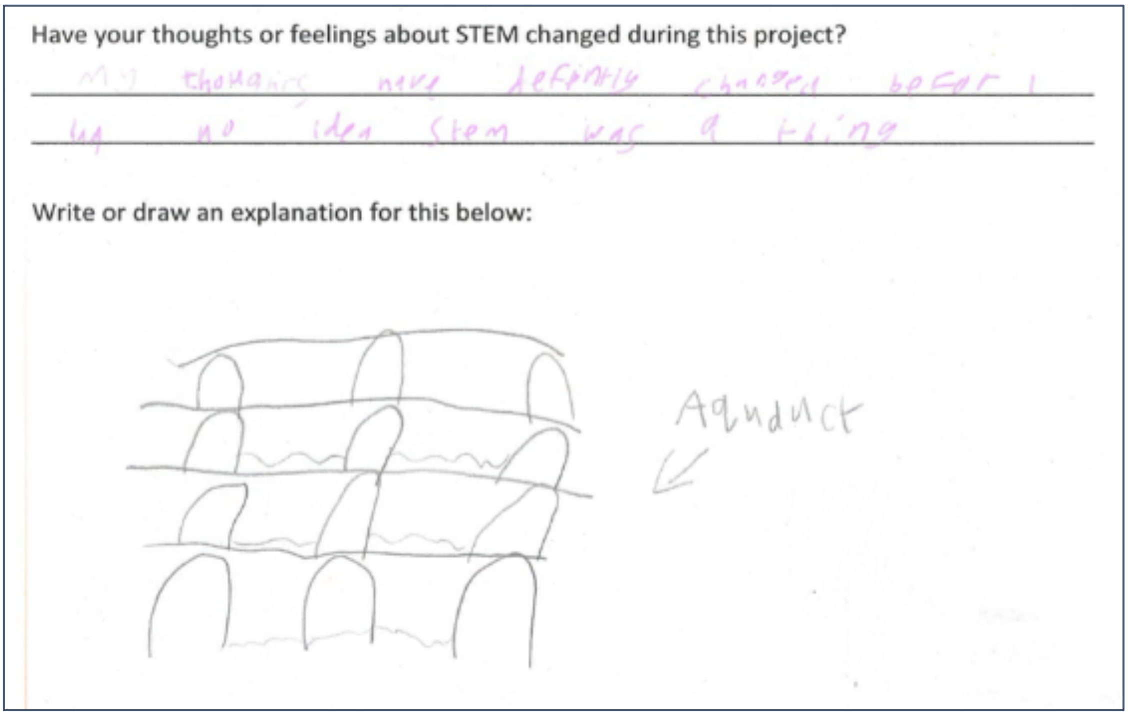


Figure 9.10: Blackjack's response to the question of how her STEM perceptions changed throughout the project. Text reads: 'My thoughts have definitely changed before I had no idea STEM was a thing'. Blackjack has also drawn an image of an aqueduct with flowing water which she has labelled 'aqueduct'.

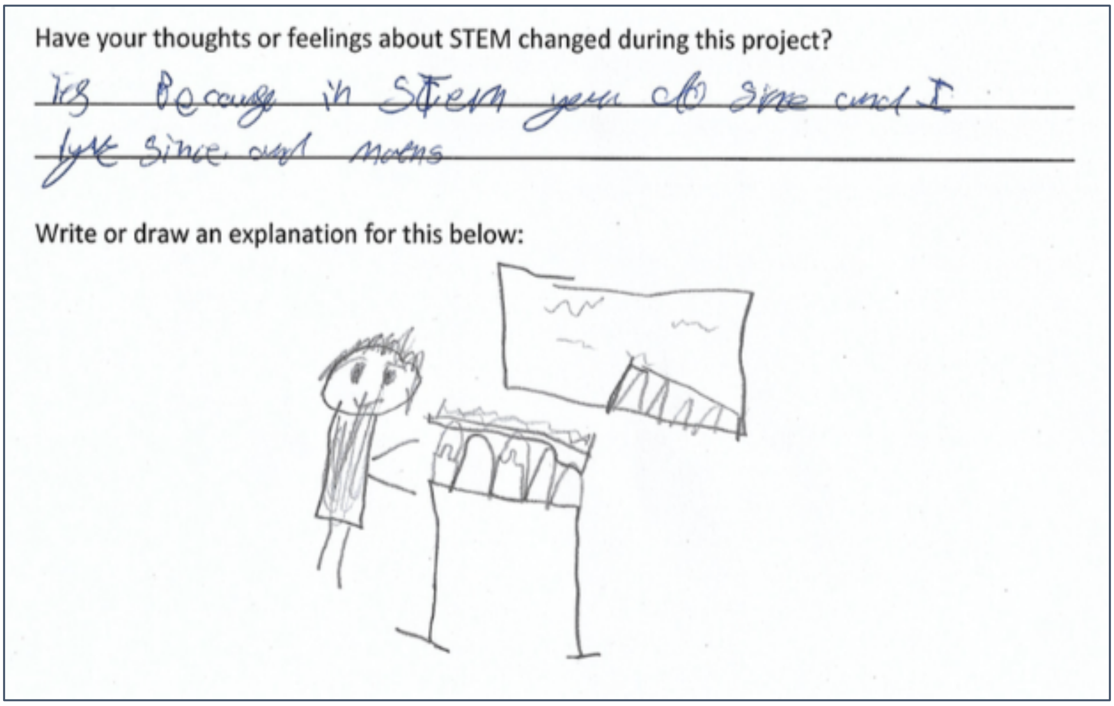


Figure 9.9: Barry's response to the question of changes in his perceptions of STEM throughout the project. Text reads: 'yes, because in STEM you do science and I like science and maths'. Accompanying image is of a person and an aqueduct made from bottles with water running along the top.

Participants also referred to their experience in the faunal analysis intervention. Cupcake highlighted how she had not experienced working with animal remains before and that she enjoyed identifying specimens (Excerpt 9.6), Skull Trooper drew his memory of the session (Figure 9.11), and Blossom included a bone in her drawing (Figure 9.12). Skull Trooper explained that undertaking faunal analysis had impacted the way he thought about STEM, as prior to the session he would not have thought or known about the work of zooarchaeologists (Excerpt 9.7). Initially he described the person in his drawing as a 'her' but corrected to 'he'; this may have been a slip of the tongue, or may indicate that he was imagining two separate people when drawing and explaining his work. Blossom's reference to the faunal workshop was subtle, but suggests that there is a link between faunal analysis and STEM in her mind (Figure 9.12).

Figure 9.11: Skull Trooper's responded 'yes' to the question of whether his perceptions of STEM had changed throughout the project, and drew an image of a person sat at a table with a computer and a bone in their hand – as described by Skull Trooper.

Skull Trooper: *my drawing is when we were looking at those bones in 2018*

Interviewer: *yeah?*

Skull Trooper: *we were looking at those bones and I draw a picture of a person on a computer and a bone in her hand – in his hand. And they're trying to figure out what bone is the animal from*

Interviewer: *okay – and how does that show how your thoughts have changed? Or if your thoughts have changed?*

Skull Trooper: *I think it had because, usually I wouldn't really think of people searching up bones that much – because I don't really think about bones, but I like old shark teeth*

Excerpt 9.7: Skull Trooper's description of his drawing and explanation of how it related to his STEM perceptions.

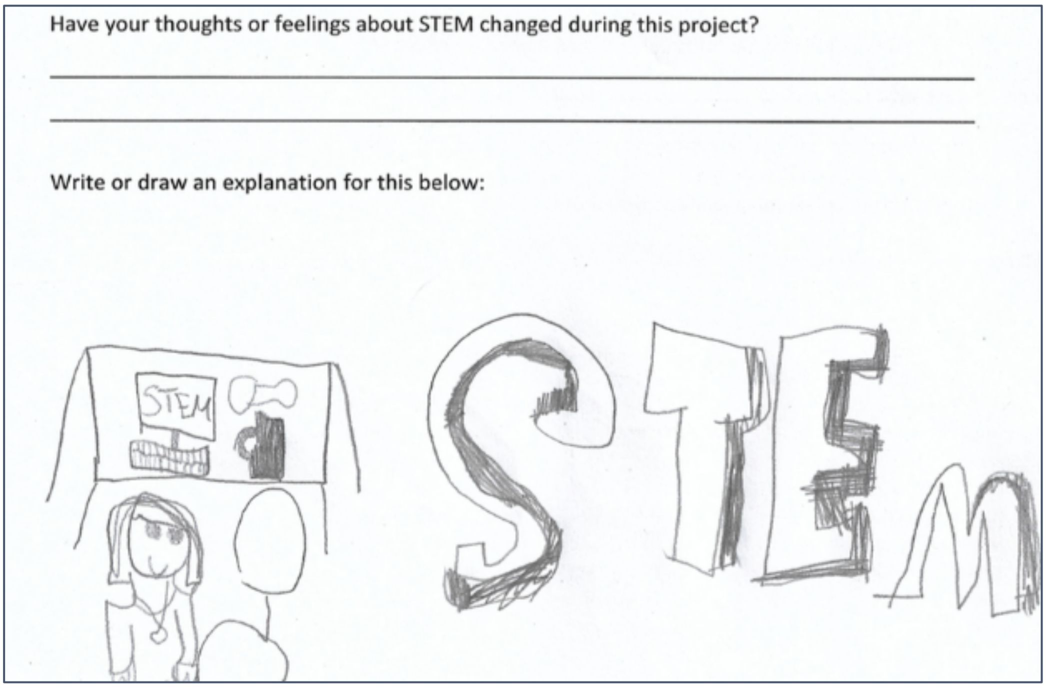


Figure 9.12: Blossom's response to the question of how her perceptions of STEM had changed throughout the project. There is no text, but she has drawn an image of a person at a table with a computer, a coffee mug and a bone – as described by Blossom. The acronym STEM has also been drawn in very large block letters.

Jelly and Buster framed their experience in terms of learning new things. Jelly's written response revealed that he felt he had learned 'lots of new things', though there was not sufficient time in his interview session to elaborate on this. Buster's response was slightly different, as she had been asked how thinking about STEM made her feel (Excerpt 9.8). Her response was in the present tense, which lent her words a more dynamic tone than Jelly's. By presenting 'learning something new' as a current action, Buster made it sound as though her engagement with STEM is ongoing, even as the project comes to an end. It is clear that both children felt that their participation in the project resulted in engagement with novel content and knowledge.

Interviewer: *how do you feel when you think about STEM?*

Buster: *I didn't really write what I feel, but I feel like I'm learning something new*

Excerpt 9.8: Buster's comments regarding how she feels when thinking about STEM.

Apple also spoke about the impact of a specific project experience: the interview sessions. His drawing referenced the previous interview activity (Figure 9.13) with a depiction of three specific cards: 'likes maths', 'sport' and 'comg'[34]. The 'sport' and 'computer games' cards were subject to extensive debate during the activity and are likely a reflection of how Apple's understanding changed following the group discussion.

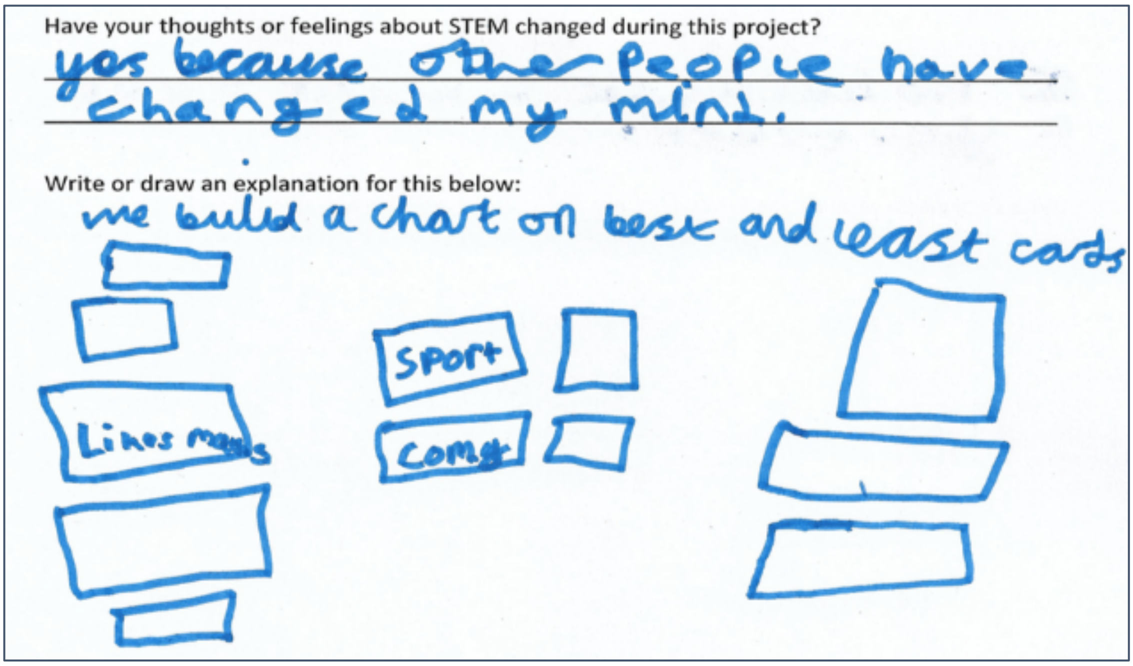
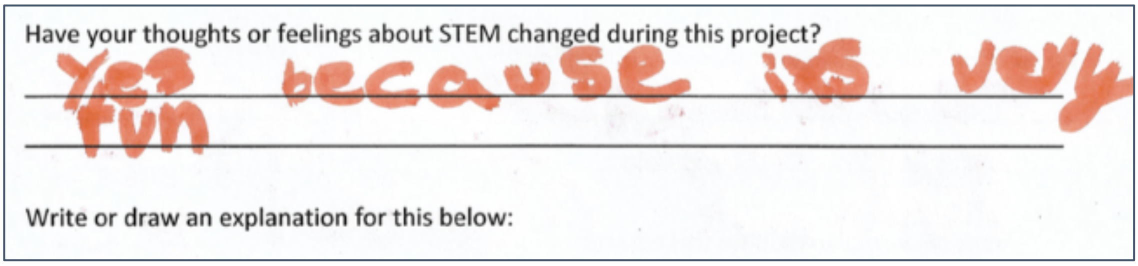


Figure 9.13: Apple's response to the question of how his perception of STEM changed throughout the project. Text reads: 'yes because other people have changed my mind. We build a chart on best and least cards'. Accompanying image is of the cards used by participants in their interview sessions organised into three columns, three cards read: 'likes maths', 'sport' and 'comg'.

Pepperoni discussed her current attitude to STEM, though she did not outline what her previous perception had been. Her assertion that she finds STEM 'very fun' indicates that she enjoyed participating in the interventions, and is also likely to refer to her STEM engagement outside of this research project[35]. What is unclear is whether her participation in the project was the catalyst for this change in her perspective or whether this change should be attributed to her broader experience of STEM over the research period.

[34] Apple later confirmed that this represented the 'likes computer games' card.

[35] For example NB School participated in British Science Week, see Chapter 6 for a more detailed discussion of this.


Have your thoughts or feelings about STEM changed during this project?

Yes because it's very fun

Write or draw an explanation for this below:

Figure 9.14: Pepperoni's response to the question of how her perceptions of STEM had changed throughout the project. Text reads: 'yes because it's very fun'. Pepperoni did not draw a picture for this answer.

Pepperoni: *it's very fun – it's not really the question, but it's very fun*

Interviewer: *so you think STEM's fun? What did you think about it when we started the project?*

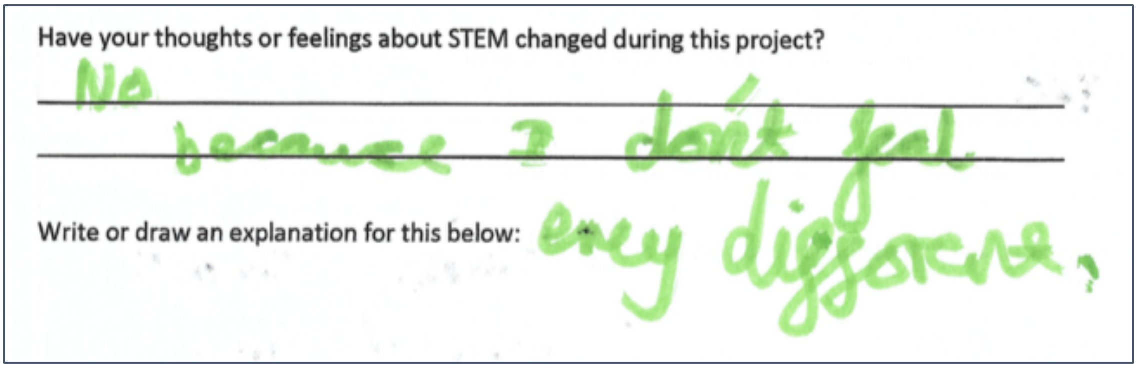
Pepperoni: *I don't know*

Excerpt 9.9: Pepperoni's comments on her current perception of STEM given in her final interview.

Novel experiences – which archaeology is particularly well-suited to provide – are key to creating long term memories, and it is clear that this project succeeded in presenting participants with memorable opportunities to engage with STEM and archaeology. The accessibility of archaeology is also key here; something as abstract as animal physiology is made relatable to learners through its use as a tool to understand past human behaviour. By engaging with STEM learning through this lens, children experience a new angle to STEM content, and those who have not previously connected via traditional avenues may find an alternative way to access STEM. Generating positive STEM experiences for learners is necessary to effect long term changes in STEM self-concepts and identities. Utilising archaeological content consistently throughout primary education could create greater scope for these experiences, and therefore more opportunities for learners to access STEM.

9.1.1.4 No change to thoughts or feelings about STEM

The only participant who did not report any kind of change in STEM perception was Bumble (Figure 9.15). He reported not feeling any different about STEM, though he did also recognise that he'd learned something from the project: '*how to build stuff*' (Excerpt 9.10). Bumble's response seems to reflect an uncertainty of how to articulate his thoughts, and may reflect a shallow relationship with STEM; while he understood the acronym, he was unable to engage with the concept in relation to personal thoughts and feelings. This finding reflects the reality that all learners are different, and that pursuing an agenda of self-concept and identity in STEM engagement may not be effective for everyone. It also highlights the potential need for learners to gain practice in introspection and metacognition; had Bumble been more confident in identifying and expressing thoughts and feelings, he may have provided a different answer to this question. Consistent engagement with reflective practice in educational settings is likely key to achieving this.


Have your thoughts or feelings about STEM changed during this project?

No

because I don't feel

Write or draw an explanation for this below: eny diffrence,

Figure 9.15: Bumble's response to the question of how his perceptions of STEM changed throughout the project. Text reads: 'No because I don't feel any different'. Bumble did not draw a picture.

Bumble: *I'm not sure what to write about this*

Interviewer: *so why have you said 'no'? What was your reason for that?*

Bumble: *because I'm not sure what I've really – actually I've learnt how to build stuff*

Interviewer: *yeah?*

Bumble: *no, my thoughts and feelings haven't changed, but I'm not sure how to say why*

Interviewer: *okay, so when we started – what did you think or feel about STEM?*

Bumble: *just – it's just STEM*

Interviewer: *okay, and do you feel the same way now?*

Bumble: *yeah*

Excerpt 9.10: Conversation between Bumble and the interviewer regarding whether his perceptions of STEM had changed during the project.

9.1.2 Which skills or personality traits do you have that would help you use STEM in the future?

The word sort activity participants engaged with throughout all three interviews was designed to broaden their understanding of what 'kind' of person might pursue a career in STEM. Reflecting on positive STEM experiences in terms of skill and aptitude allows young people to observe personal STEM competence, and to therefore construct an identity which is aligned with STEM. This question established whether participants would use that approach when considering their own STEM practice. Some participants mentioned more than one skill or personality trait in response to this question, resulting in a total of 37 responses (Table 9.2). Of these skills and traits, 21 were specifically related to the STEM acronym (e.g. 'I like maths') and 16 were not STEM-specific. Six participants suggested more than one skill or aptitude, and 13 gave a single skill or aptitude. This section will consider participants' responses in three categories: those who selected skills and traits specific to the STEM acronym, those outside the STEM acronym, and participants who combined both.

Participants	STEM-specific	Non STEM-specific
Stanley	Like science	
Barry	Science and maths	
Pippin		Resourceful
Molly		Honest
Blossom	Good at maths	
Cupcake		Good at helping people
NJ	Technology	
Skull Trooper	Using computers	
Apple	Using computers	
Pepperoni	Using computers	
Cleo	Using computers	Used to studying
Jelly	Mathematics	Likes to study certain things
Videogame Guy	Like maths, technology, engineering and science	Sensible, enjoy drawing
Blackjack	Know a lot about computers and IT, love science	Love art
Buster		Creative, imaginative
Bluebell	Like computing and technology	
Olivia	Using computers	
Black Cat	Like science and maths	
Bumble	Unclear response	

Table 9.2: Interview participants' responses to the question of which skills an aptitudes would help them to use STEM in the future.

9.1.2.1 Skills specific to the STEM acronym

Nine participants highlighted skills and aptitudes that were derived from the STEM acronym; eight of these participants selected a single skill/aptitude and one chose two. Some participants noted their chosen skill or aptitude's relationship to the STEM acronym as an explicit rationale for choosing that word (Figure 9.16 to Figure 9.21 and Excerpt 9.11). These responses indicate that when asked to consider their use of STEM in the future Stanley, Blossom and Bluebell imagined themselves using specific elements of STEM i.e. 'using a computer' or 'doing some maths'. These participants appear to have interpreted the question very literally, and have given answers that most directly reflect the STEM acronym.

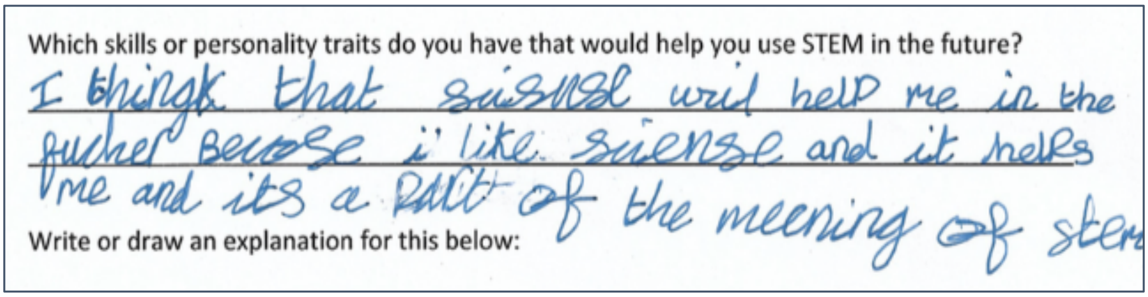


Figure 9.16: Stanley's response to the question of which skills or personality traits may help him to use STEM in the future. Text reads: 'I think that science will help me in the future because I like science and it helps me and it's a part of the meaning of STEM'. Stanley did not draw a picture.

Blossom: *I think I'm really good at maths – I don't think I'm that good because I – so I've done this. In maths I think I do higher than my group because in my group there's different to me and I don't really know why, so I just do maths*

Interviewer: *okay, you think you're good at maths – how do you think that would help you with STEM in the future?*

Blossom: *because the word STEM has got maths in it, with a 'm', and I think it would be really good*

Excerpt 9.11: Blossom's explanation of her drawn response to the question of which skills or traits she has that will help her with STEM in the future.

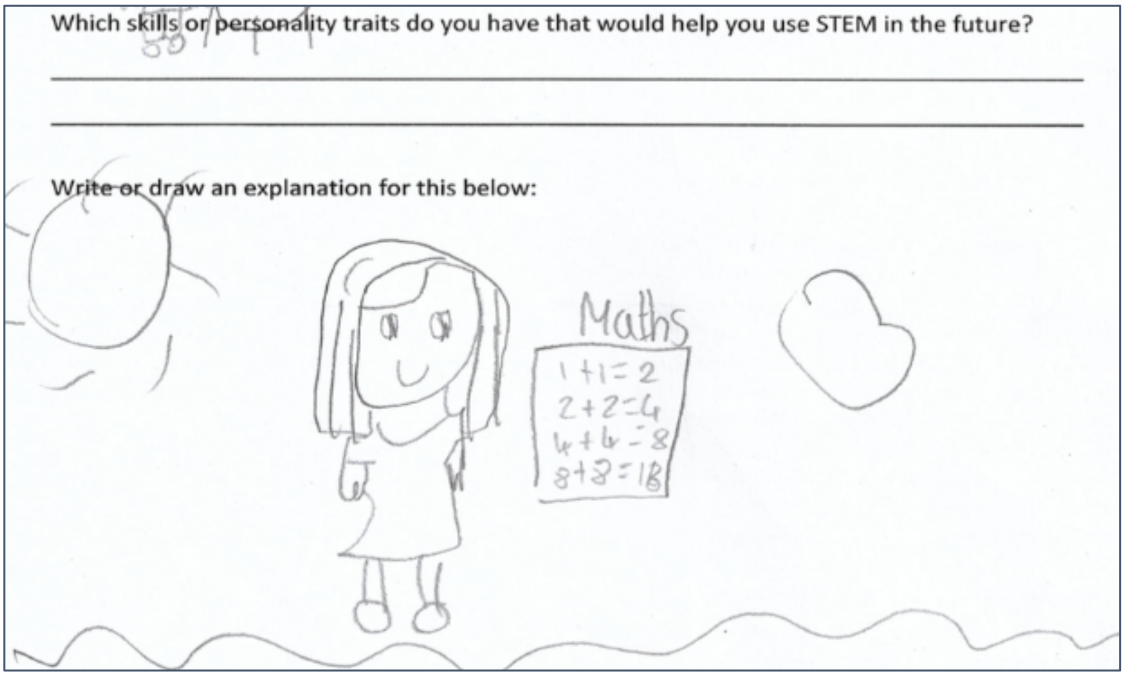


Figure 9.17: Blossom's response to the question of which skills or personality traits may help her use STEM in the future. Blossom has drawn a person stood next to some sums with the word 'maths' above them.

Other participants also cited STEM-acronym specific skills and traits in their responses without directly referencing the acronym. Enjoyment of maths and science were seen as key attributes for future pursuit of STEM (Figure 9.19 to Figure 9.22), computers and their connection to 'technology' were referenced frequently (Figure 9.20 to Figure 9.24, Excerpt 9.12 and Excerpt 9.13). Amongst these participants traditional ideas about what constitutes 'STEM practice' continued to dominate, despite their engagement with non-traditional STEM practice in the archaeological engagements, and their extended discussions about broad STEM skill usage throughout all three interview sessions. Additionally, some comments further demonstrate individuals' continued reliance on the acronym in their personal understanding of STEM.

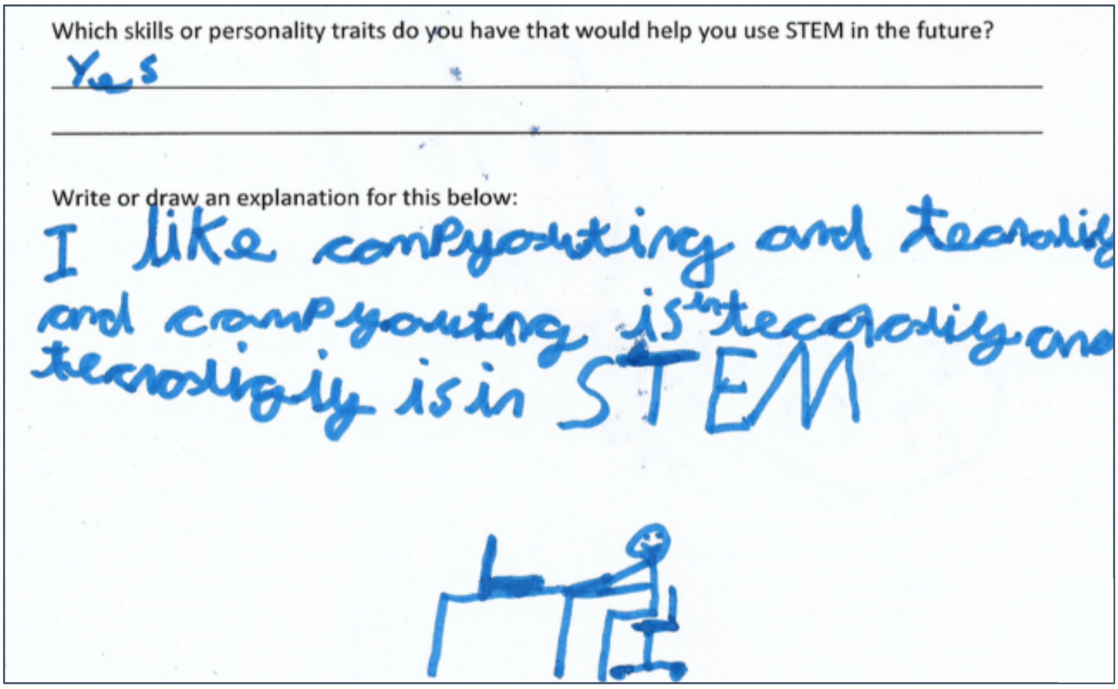


Figure 9.18: Bluebell's response to the question of which skills or personality traits he has that may help him to use STEM in the future. Text reads: 'Yes. I like computing and technology and computing is in technology and technology is in STEM'. Bluebell also drew an image of a person sitting at a desk with a laptop.

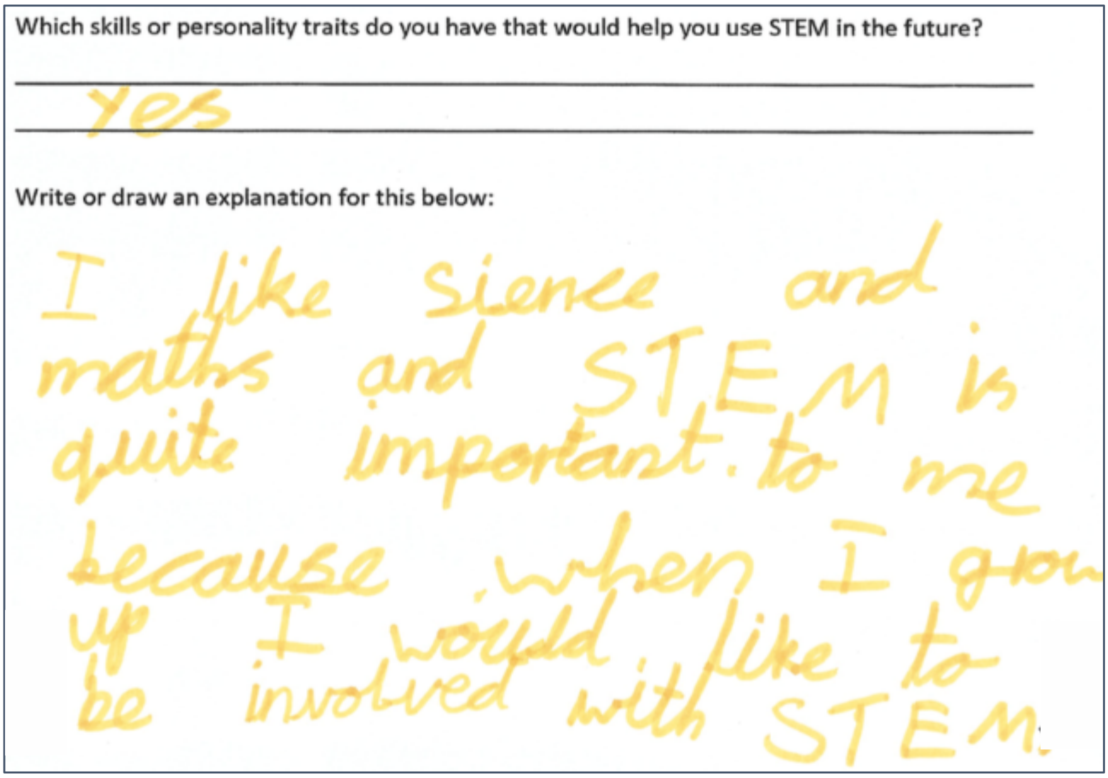


Figure 9.19: Black Cat's response to the question of skills or personality traits that may help her to use STEM in the future. Text reads: 'Yes. I like science and maths and STEM is quite important to me because when I grow up I would like to be involved with STEM. Black Cat did not draw a picture with her answer.

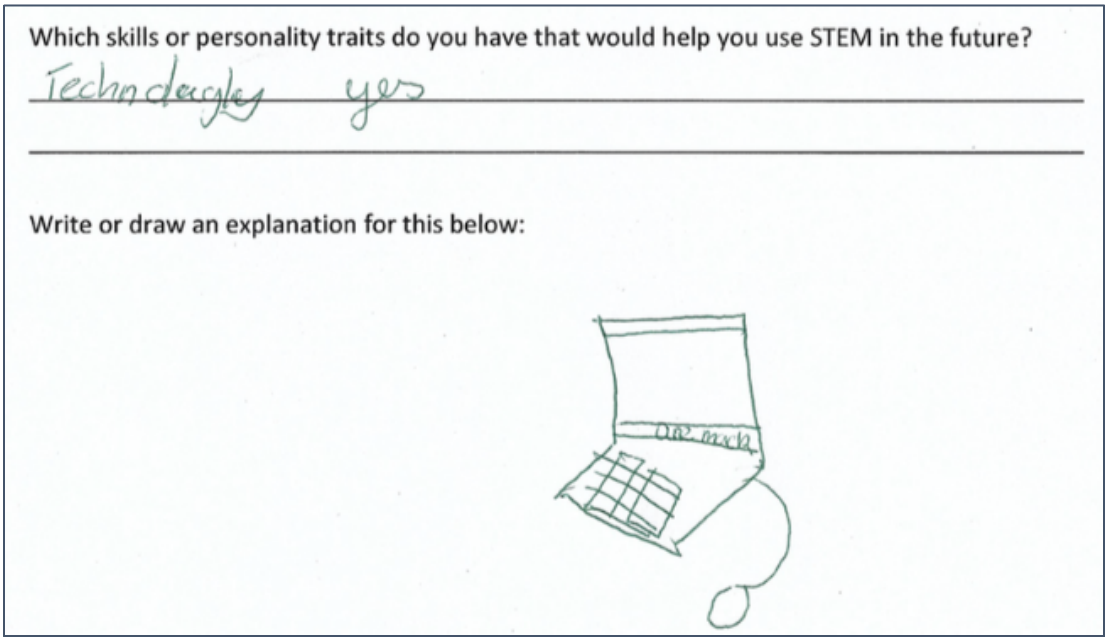


Figure 9.20: NJ's response to the question of skills or personality traits that might help him to use STEM in the future. Text reads: 'technology yes'. NJ has also drawn an image of a computer.

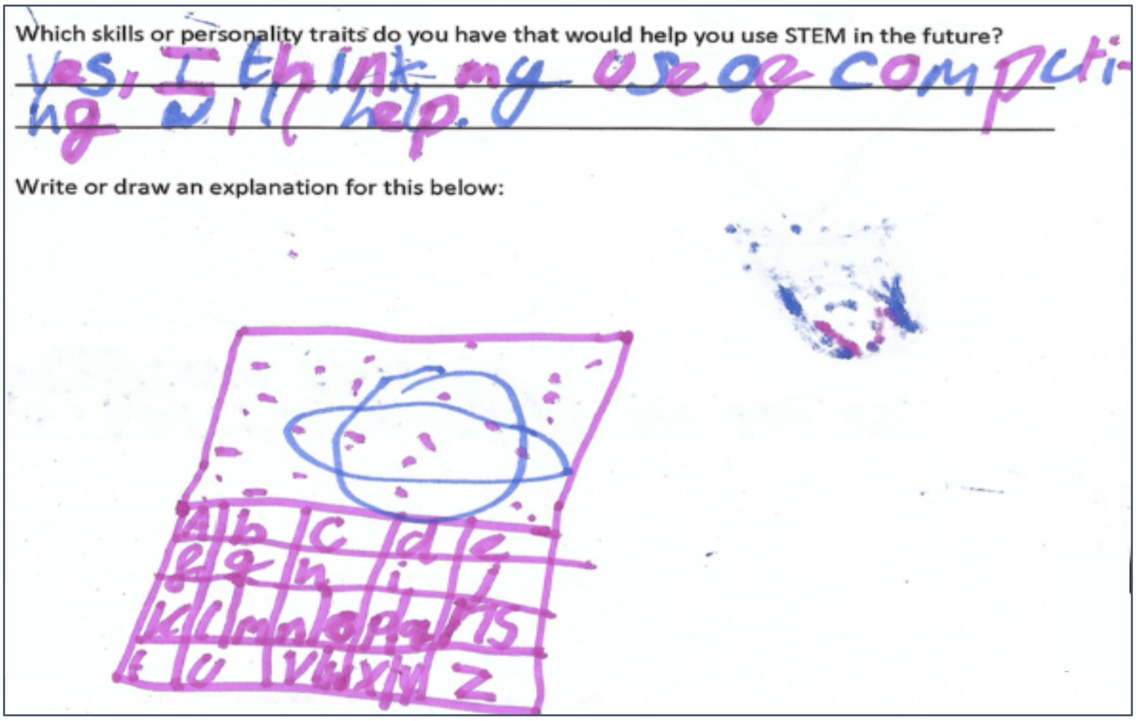


Figure 9.21: Olivia's response to the question of which skills or personality traits may help her to use STEM in the future. Text reads: 'Yes, I think my use of computing will help'. Olivia has also drawn an image of what appears to be a laptop, although the letters on the keyboard are arranged in alphabetical order rather than the typical QWERTY layout.

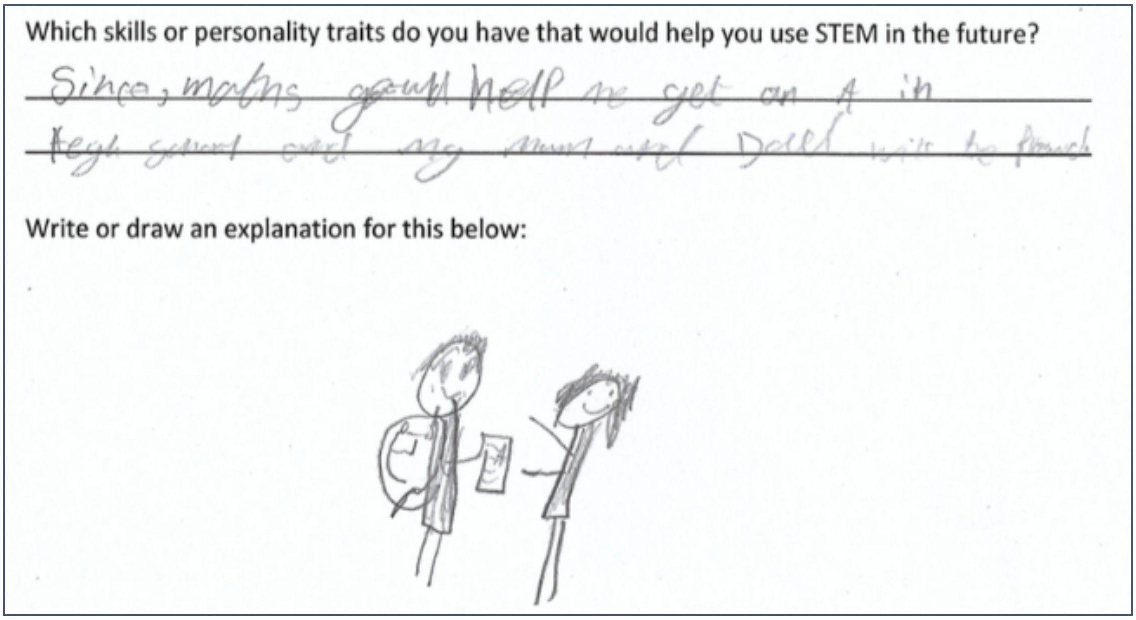


Figure 9.22: Barry's response to the question of skills or personality traits that may help him to use STEM in the future. Text reads: 'Since maths would help me get an A in high school and my mum and dad would be proud'. Barry has also drawn an image of two people smiling, one of them is holding a piece of paper with an 'A' on it.

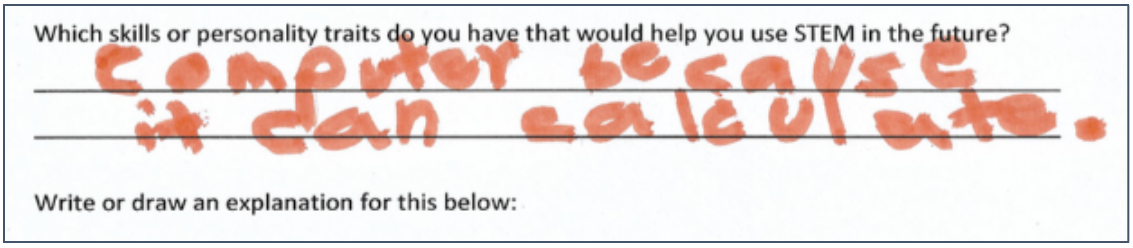


Figure 9.23: Pepperoni's response to the question of skills or personality traits that may help her to use STEM in the future. Text reads: 'computer because it can calculate'. Pepperoni did not draw a picture to

Interviewer: *so what are you good at? What do you like?*

Pepperoni: *sports*

Interviewer: *and how would that help you use STEM in the future?*

Pepperoni: *don't know… oh computer – I'll just do computer, even though it's not my best*

Excerpt 9.12: Pepperoni's verbal response to the question of what skills or personality traits might help her to use STEM in the future.

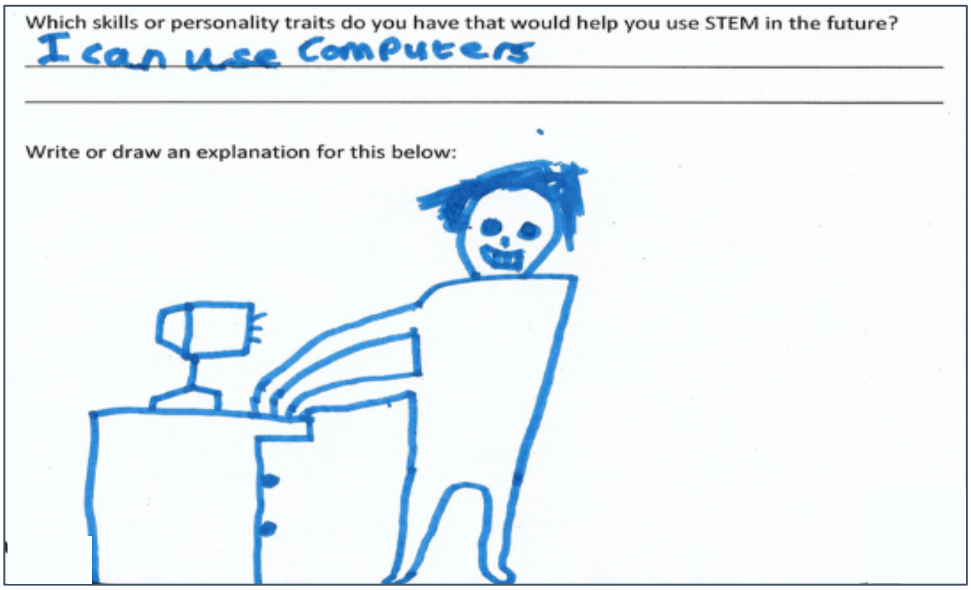


Figure 9.24: Apple's response to the question of skills or personality traits that might help him to use STEM in the future. Text reads: 'I can use computers'. Apple has also drawn a picture of a person stood at a desk using a computer.

Apple: *computers are tech and tech is part of the STEM*

Apple: *I think it's important because if you like computer games it might help you with all the keyboard, keys and things like that*

Excerpt 9.13: Apple spoke about the relationship between computers and STEM, as well as how computer games might provide transferrable skills in his final interview.

9.1.2.2 Participants who combined STEM acronym specific and broader skills

Other participants who identified STEM specific skills/aptitudes within themselves also highlighted skills/aptitudes that are not explicitly related to STEM, but they felt were relevant within STEM practice. Videogame Guy initially highlighted each branch of STEM, though when pressed further by the interviewer about the cards he had chosen to describe himself in the previous task, he did also speak about skills/aptitudes outside of the STEM acronym. Videogame Guy's drawings reveal interesting information about his perceptions of necessary STEM skills (Figure 9.25). The depiction of a simple sum to represent maths and a computer to represent technology are very similar to other images drawn by participants in this activity. These depictions of 'STEM' likely reflect the limited ways that primary aged children engage with them. A 'house with scaffolding' and a 'potion' inaccurately represent the work of an engineer or a scientist, and are likely Videogame Guy's interpretation of information he had about both professions. Though engineers are unlikely to engage in the physical act of building a house, this appears to be how Videogame Guy interpreted the message that 'engineers build things'. Additionally, Videogame Guy conflated the work of chemists and pharmaceutical scientists with magic or science fiction; while scientists may develop drugs to alter human physiology, they are unlikely to describe them as 'potions' (Excerpt 9.14).

BG school had generously set aside a substantial portion of time for the final interview, making it possible to explore participants' responses more deeply than with other groups. The interviewer pressed Videogame Guy to consider some of the other skills and aptitudes that he had identified in the self-reflection activity, and examine how they might help him use STEM in the future (Excerpt 9.15). Videogame Guy's comments about being sensible to prevent 'explosions' in a lab are similar to those made by other participants in the project (see Chapters 7 and 8). His consideration of the link between Minecraft and engineering skills demonstrates a more nuanced understanding of engineers' work than indicated by his initial drawing, as the scope for 'building' in Minecraft is much broader than house construction. Games and other forms of entertainment media have great potential to impart STEM knowledge to young people via an avenue of current interest. Though Videogame Guy expressed a simplistic view of engineering, his interest in construction in Minecraft could be utilised to cultivate his understanding and knowledge of engineering. An intervention explicitly examining the links between game-based and 'real world' engineering, would equip children like Videogame Guy with a more accurate perception of engineering via a personally meaningful access point.

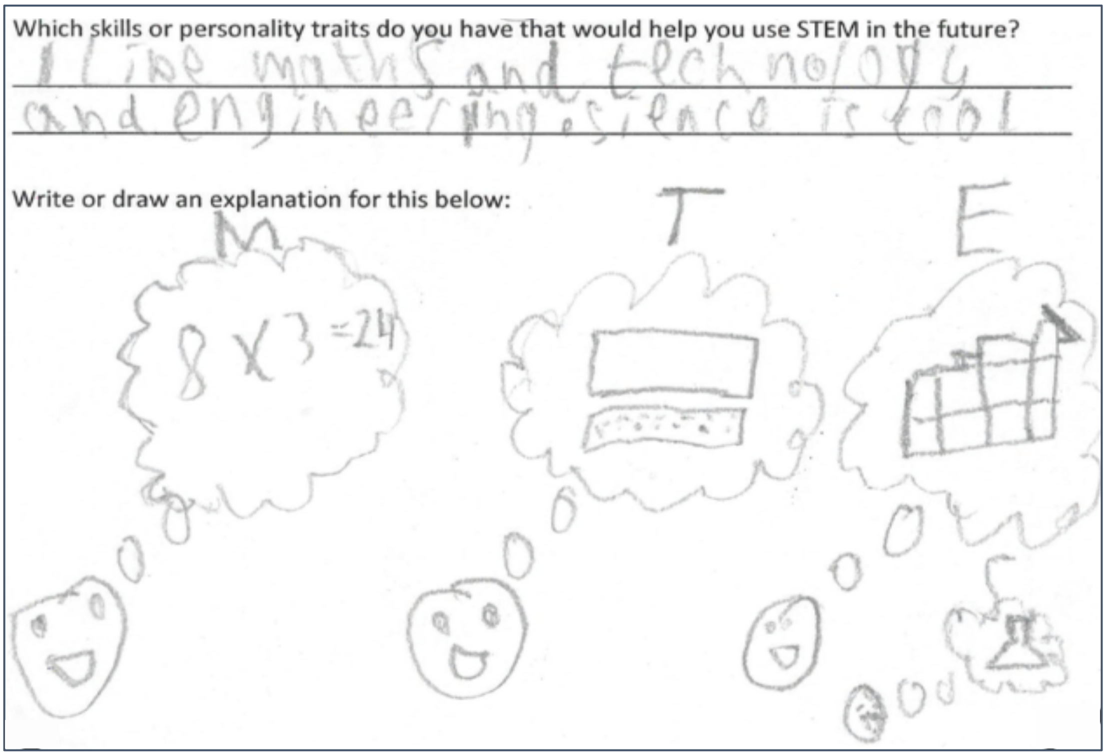


Figure 9.25: Videogame Guy's response to the question of skills or personality traits that would help him to use STEM in the future. Text reads: 'I like maths and technology and engineering. Science is cool'. Videogame Guy has also drawn an image of four faces all thinking about a different branch of STEM.

Videogame Guy: *there's a potion*

Interviewer: *a potion? Is that to represent science?*

Videogame Guy: *yeah*

Interviewer: *what does the potion mean for you?*

Videogame Guy: [pause] *well when I think of science, I think of potions*

Interviewer: *okay, what kind of potions?*

Videogame Guy: *I don't know*

Interviewer: *okay, what is a potion?*

Videogame Guy: *something that you drink that gives you a special ability for a certain amount of time*

Interviewer: *okay, and is that something that relates to science?*

Videogame Guy: [pause] *well…*

Interviewer: *only in your mind, this isn't a yes or no answer – this is just what you think*

Videogame Guy: *yes. Well yeah, that's what I think of sciences*

Excerpt 9.14: Videogame Guy's description of 'potions' in science.

Interviewer: *you mentioned before that you were sensible, do you think that would help you in STEM at all?*

Videogame Guy: [pause] *well if you weren't sensible and you were doing science, then you might cause –something that could happen is it might cause the lab to explode, because you could break chemicals and if they go together they might make an explosion?*

Interviewer: *okay* [pause] *are there any other things? So sensible is part of your personality, is there anything else that you think would be really helpful?*

Videogame Guy: [pause] *I don't think so*

Interviewer: *you also mentioned before that you really enjoy drawing out plans for things that you're going to do*

Videogame Guy: *yeah, oh yeah. And I was going to say, but I don't physically know – I said about planning stuff for Minecraft... Minecraft is building, and engineering is building so yeah – that might be a little bit helpful*

Excerpt 9.15: Conversation between Videogame Guy and the interviewer about skills and aptitudes that could help him to use STEM in the future.

Blackjack touched on similar themes in her drawing of 'potions' to represent science (Figure 9.26). She demonstrated an understanding of the links between creativity and STEM in her comments about engineers' artistic skills (Excerpt 9.16). It appears that Blackjack's affinity with using computers and IT stems from her enjoyment of playing games and the role that computers play in her 'entertainment'. Blackjack is another example of a child who would likely benefit from interventions that introduce STEM concepts via computer games. Roblox is a creative programming tool, which allows users to create and play each other's games; an educational engagement which focused specifically on developing and programming Roblox-based games would appeal to many of Blackjack's interests. 'Fun' also plays a key role for Blackjack in the way she relates to science: she finds learning enjoyable and believed that this enjoyment would enable her to have a long career in science.

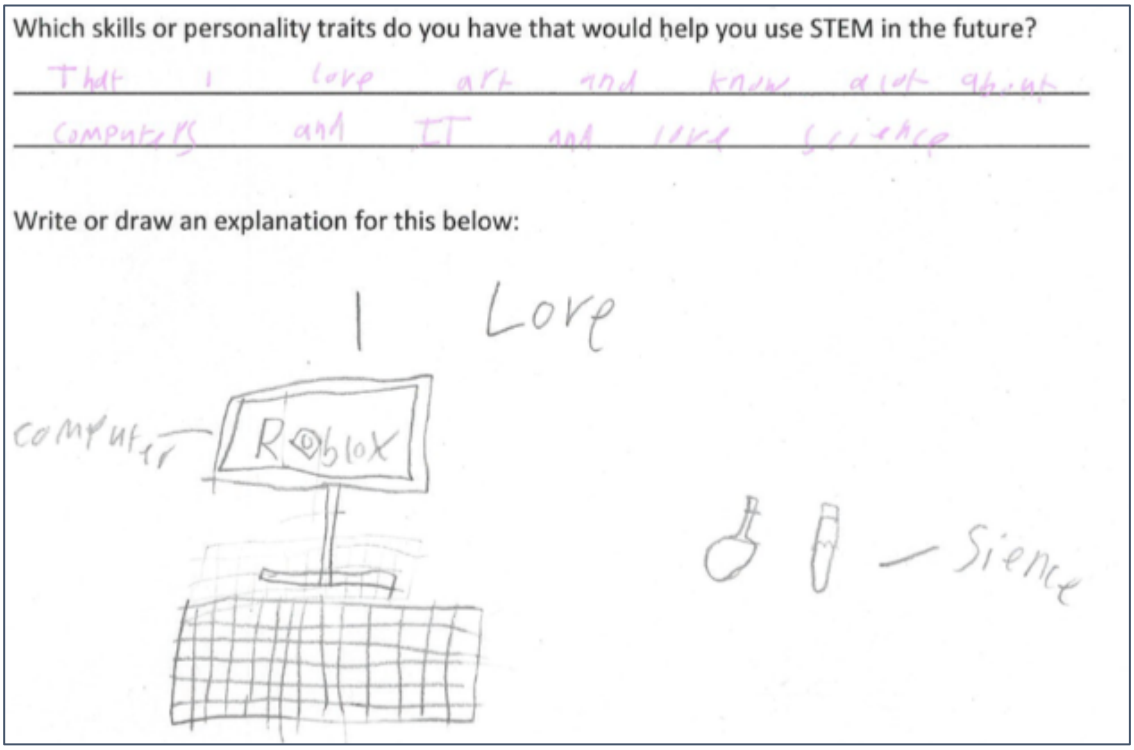


Figure 9.26: Blackjack's response to the question of which skills or personality traits might help her to use STEM in the future. Text reads: 'That I love art and know a lot about computers and IT and love science'. Blackjack has also drawn an image of a computer with the game Roblox on the screen with the label 'computer'. Above the computer she wrote the words 'I love'. There is also an image of 'tube potions' with the label 'science' – as described by Blackjack.

Blackjack: *that I love art, and I know about computers and IT, and I love science!*

Interviewer: *right, okay. So how would art be helpful in STEM? Or loving art?*

Blackjack: *if you're creating something when you're an engineer?*

…

Blackjack: *and then it says "I love" and I drew a computer with Roblox on*

Interviewer: *ah because you love Roblox? … And then you've got computers and IT. What do you love about computers and IT?*

Blackjack: *I don't know, I just find it… entertaining*

Interviewer: *okay. And what do you love about science?*

Blackjack: *it's just* [pause] *fun and I like learning about new things in science*

Interviewer: *okay and how do you think that all these things will help you use STEM in the future? Why would they be helpful maybe?*

Blackjack: *because if I'm a scientist, I know that I love that job and I would carry on for a long time*

Excerpt 9.16: Blackjack's explanation of the drawings in her response to Q2.

Skull Trooper drew upon personal experience in his response (Excerpt 9.17 and Figure 9.27). By observing veterinary practitioners during his pets' medical care he had identified skills in their work that he felt would suit his interests and personality. He believed that his love of animals and ability with computers would ensure his success in veterinary medicine. While veterinarians use computers in their day to day work, it is unlikely that they consider them as the defining feature of the job. This highlights the importance of conversations and information exchange between young people and STEM practitioners, and represents a key opportunity to broaden Skull Trooper's understanding about veterinary medicine. It was notable that Skull Trooper recognised the value of knowing animal skeletal anatomy in veterinary medicine, but did not consider himself to have that knowledge (Excerpt 9.17). This demonstrates the limitations of even the most memorable learning engagement; though many participants retained memories of handling faunal specimens, in Skull Trooper's case, specific knowledge of skeletal anatomy was not retained. An alternative explanation is that Skull Trooper did not equate urban veterinary practice with the farm animal anatomy covered in the faunal analysis intervention. Either way, this is evidence of the need for repeated engagements to embed and refine pupils' knowledge and skills.

Interviewer: *and what is it about you that might make you good at being a vet?*

Skull Trooper: *because I really love animals, and I mostly go to the vet a lot because my cat is always a flea bag and then my dog sometimes gets bit by other dogs, and she's only got three legs*

Interviewer: *okay, and what is it about you that would make you good at being a vet? As well as seeing what the vets do a lot, is there anything about your personality that might make you good as a vet?*

Skull Trooper: *because I know how to use computers quite well, and vets have to use computers a lot*

[pause]

Interviewer: *is there anything else in STEM that vets do at all?*

Skull Trooper: [pause] *science? Because they need to know the bones in animals bodies?*

Interviewer: *yeah! So do you think you have any skills that would help with that?*

Skull Trooper: [pause] *no, no more*

Excerpt 9.17: Skull Trooper's explanation of the skills/ personality traits he has that would help him be a vet.

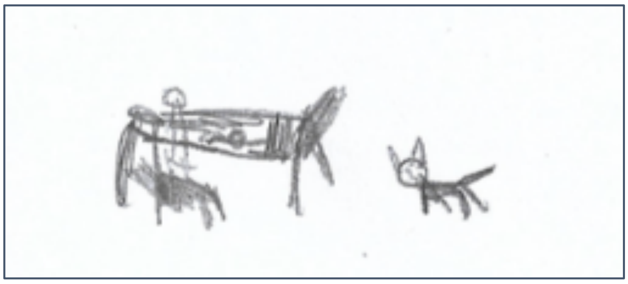


Figure 9.27: Skull Trooper's response to the question of which skills or personality traits might help him to use STEM in the future. Image of a vet using a computer to research treatment for a cat with a broken leg – as described by Skull Trooper.

Cleo and Jelly discussed study skills and explored how their current ability in this area might be applicable in a wider STEM context (Figure 9.28 and Figure 9.29). Jelly also explored his self-identification as 'a nerd' (Excerpt 9.18). The participants outlined in this section drew upon skills outside of the STEM acronym, such as a love of art, animals, studying, and playing creative computer games. These participants moved beyond simple consideration of the acronym to think about themselves and their STEM practice more deeply. The case of Videogame Guy – who discussed these skills only when pressed by the interviewer – indicates that even those who initially focus on acronym-related skills can access deeper thinking when supported to do so. The above responses also revealed clear scope for broadening young peoples' understanding of and access to STEM professions via areas of current interest, such as appropriately themed computer games.

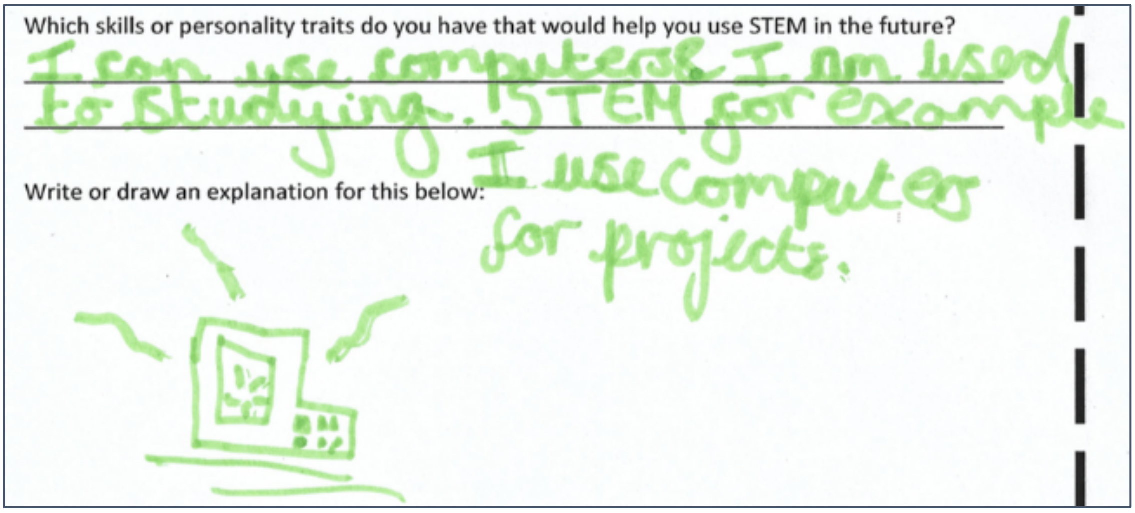


Figure 9.28: Cleo's response to the question of skills or personality traits that might help her to use STEM in the future. Text reads: 'I can use computers. I am used to studying STEM for example I use computers for projects. Accompanying image appears to be a computer.

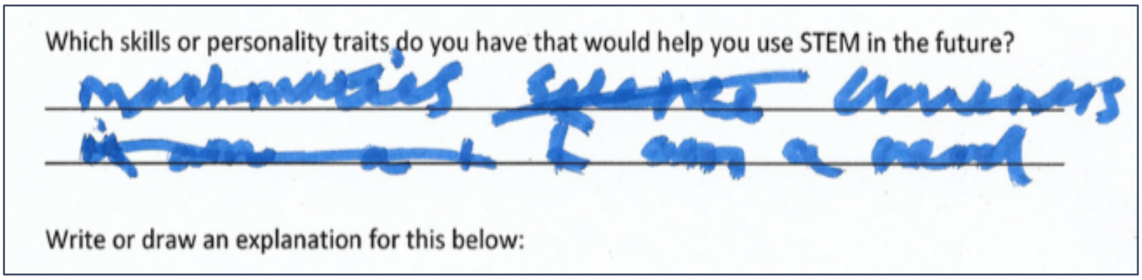


Figure 9.29: Jelly's response to the question of skills or personality traits that might help him to use STEM in the future. Text reads: 'mathematics because I am a nerd'. Jelly did not draw a picture with his answer.

Jelly: *I am a nerd in science and that's pretty much all I know about*

Interviewer: *so why is being a nerd helpful in science?... What is a nerd?*

Jelly: *I call myself a nerd because a nerd is someone who likes to study certain things. It doesn't mean a certain thing it just means someone who likes to study, and that's me*

Excerpt 9.18: Jelly's explanation of what 'being a nerd' means to him.

9.1.2.3 Skills and personality traits beyond the STEM acronym

Some participants identified skills and personality traits that did not explicitly link to the STEM acronym. In some cases this could be argued to demonstrate a deeper level of thinking about this question, where participants recognised how a wide range of skills and attributes might be useful within the world of STEM. However, not every example of this is entirely convincing as it is unclear how some responses were linked with STEM in the participants' mind, and often it was not possible to explore the response further due to time constraints within particular interviews. When asked to explain her answer further, Buster was initially unsure which skills she might have that would enable her to design houses (Figure 9.30 and Excerpt 9.19). Buster's understanding of how designing houses links to STEM is unclear in her written and verbal responses. Her explanation of applying creativity and imagination relied on simplistic examples, likely linked to the practice of a primary level child (Excerpt 9.19). She also touched upon the concept that these skills might be used to play Minecraft (which had been linked to STEM by another participant in BG group).

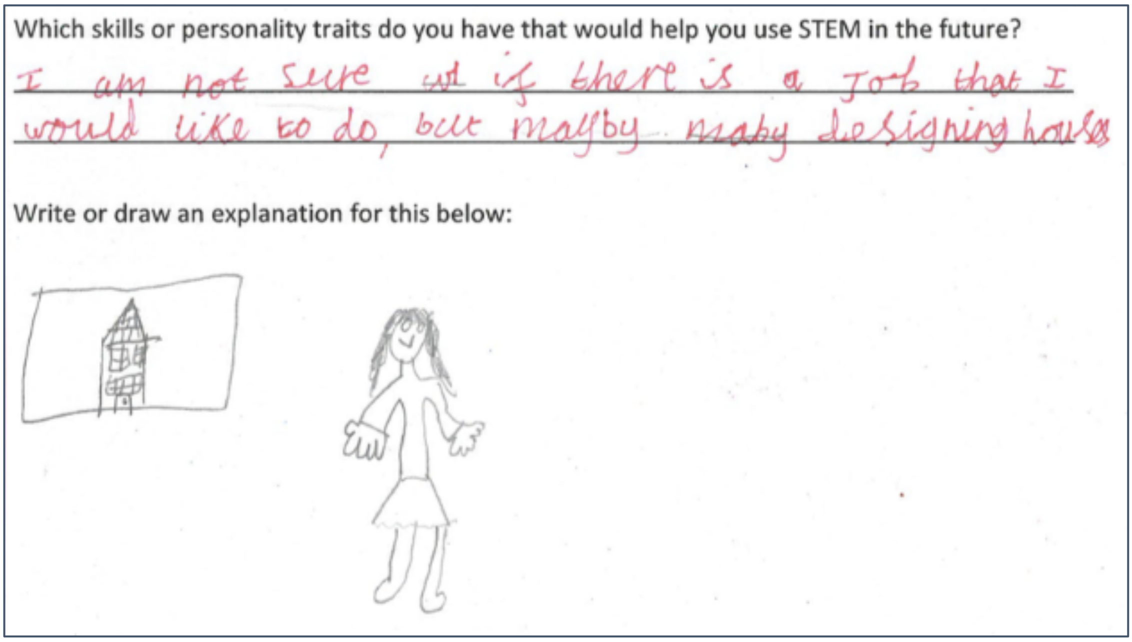


Figure 9.30: Buster's response to the question of skills or personality traits that might help her to use STEM in the future. Text reads: 'I am not sure if there is a job that I would like to do but maybe designing houses'. The accompanying image is of Buster looking happy with a drawing of a house on a piece of paper – as described by Buster.

Interviewer: *what skills do you have – what things are there about you, that you think would make you successful at designing houses?*

Buster: [pause] *maybe – I'm not sure*

Interviewer: *you mentioned before that you were quite creative and imaginative, do you think that those might be helpful?*

Buster: *if the owner of the house thought it was quite dull and thought it needed some new paint, but the owner couldn't really paint very well, so I could do the painting for her or him*

Interviewer: *okay, what if somebody came to you, and they said "I don't have a house, but I need someone to help design it" – what is it about you that would make you good at that?*

Buster: *I'm not sure, but sometimes my brother lets me play Minecraft and I get to build things like railway tracks and hotels*

Excerpt 9.19: Conversation between Buster and the interviewer about the skills she has that might help her to design houses.

Molly and Pippin’s responses were unclear in how their skills would be applicable in a STEM context. Pippin appeared unsure of the definition of the word she was using to describe herself: resourceful (Excerpt 9.20). Her explanation (Figure 9.31) relied heavily on the glossary definition, and did not focus on the key aspect of resourcefulness: to ‘source’ things. This highlights a flaw in the glossary definition and also suggests that she was unfamiliar with the concept prior to her participation in this session. Both of these factors indicate that ‘resourcefulness’ was a new concept for Pippin and that this perception of herself was in response to the content of the interview sessions. Molly’s choice of ‘honesty’ (Figure 9.32) was partially supported by her discussion about that trait in the previous task. She had discussed honesty in relation to an archaeologist, though she appeared more concerned with honesty as ‘good citizenship’ rather than professional integrity (see Chapter 7).

Pippin: *how do you write resourcefulness?*

Interviewer: [spells word]

Pippin: *I’ve just forgotten what it means – sorry. I keep forgetting what things mean! And I’ve forgotten again. Oh I’ve completely forgotten what it means*

Excerpt 9.20: Pippin's comments about the personality traits she identified as helping her to use STEM in the future.

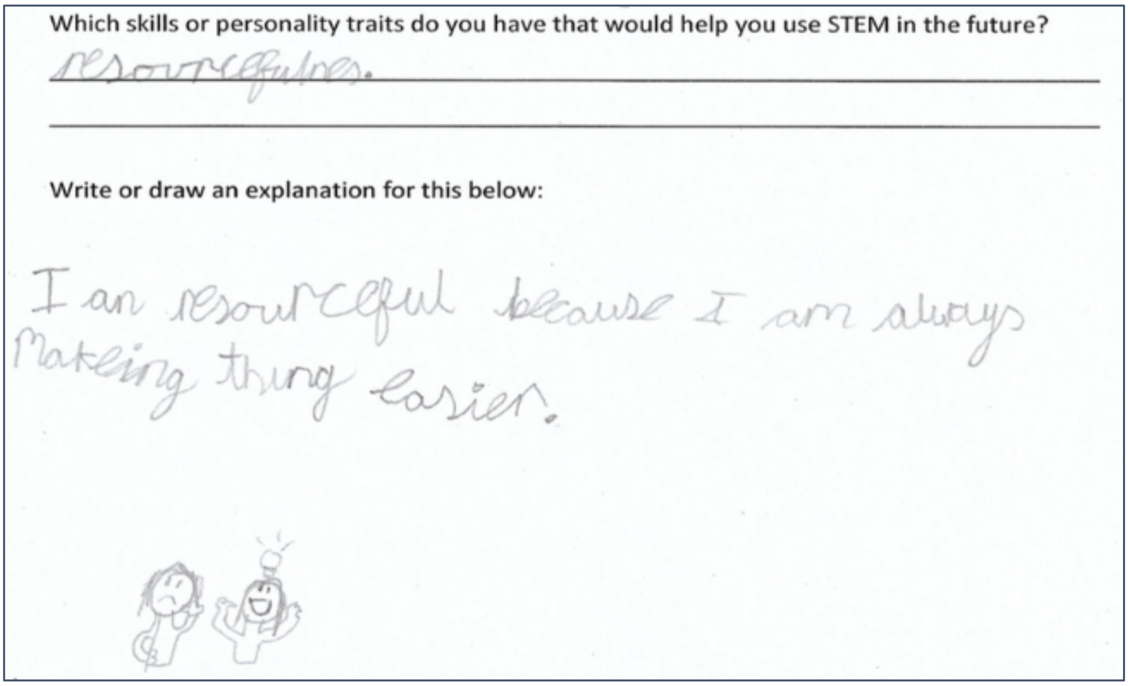
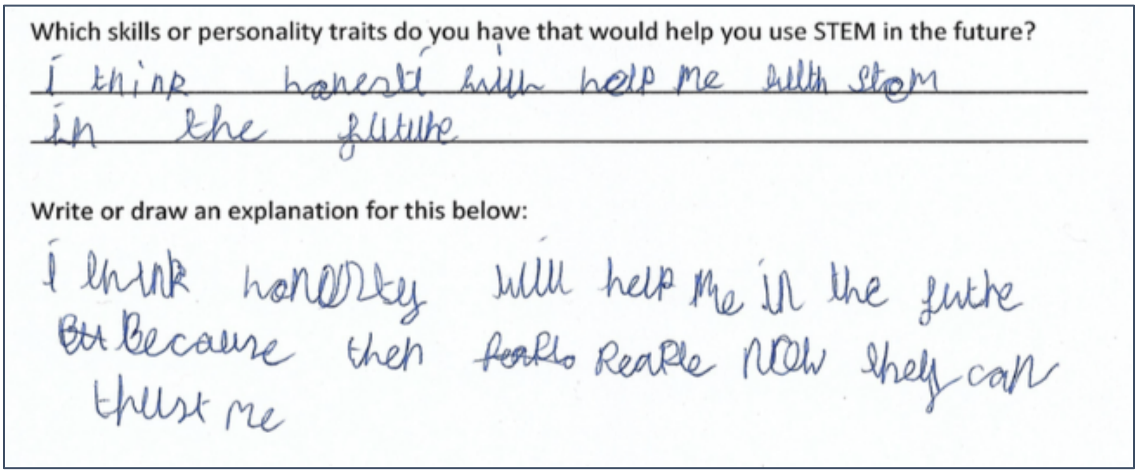


Figure 9.31: Pippin's response to the question of skills or personality traits that might help her to use STEM in the future. Text reads: 'resourceful I am resourceful because I am always making things easier'. Pippin has also drawn an image of two people, one with a ‘thinking’ downturned face and the other smiling with a lightbulb above their head.


Which skills or personality traits do you have that would help you use STEM in the future?

I think honesti will help me with stem in the future

Write or draw an explanation for this below:

I think honosty will help me in the futhe ~~Bt~~ Because then ~~peple~~ Peaple now they can thust me

Figure 9.32: Molly's response to the question of skills and personality traits that might help her to use STEM in the future. Text reads: 'I think honesty will help me with STEM in the future. I think honesty will help me in the future because then people know they can trust me'. Molly did not draw a picture with her answer.

Cupcake's response to this question was similar to Skull Trooper's in that her career aspirations were influenced by observing specialist diabetes nurses during her sister's medical treatment (Excerpt 9.21 and Figure 9.33). Cupcake drew upon this experience as her rationale for why she would be '*good to help people*', though it is notable that her response focused on the job role rather than the skill or personality trait, despite what the question asked of her. In the previous activity (see Chapter 8), Cupcake had identified 'likes helping others' as a way to describe herself, but only alluded to this trait in her verbal response to the question here.

Cupcake: *I kind of want to be a nurse or something*

Interviewer: *what is it about you that might make you good at being a nurse?*

Blossom: *because you're smart!* [laugh]

Cupcake: *because – my sister has type 1 diabetes so she has to manage stuff, my family had to go through lots of tests about what to do with it. So I think I'd be quite good to help people*

Blossom: *to help your sister?*

Cupcake: *yeah – to do stuff to do with diabetes in a hospital*

Excerpt 9.21: Conversation between Cupcake, Blossom and the interviewer about which qualities would help Cupcake be a successful nurse.

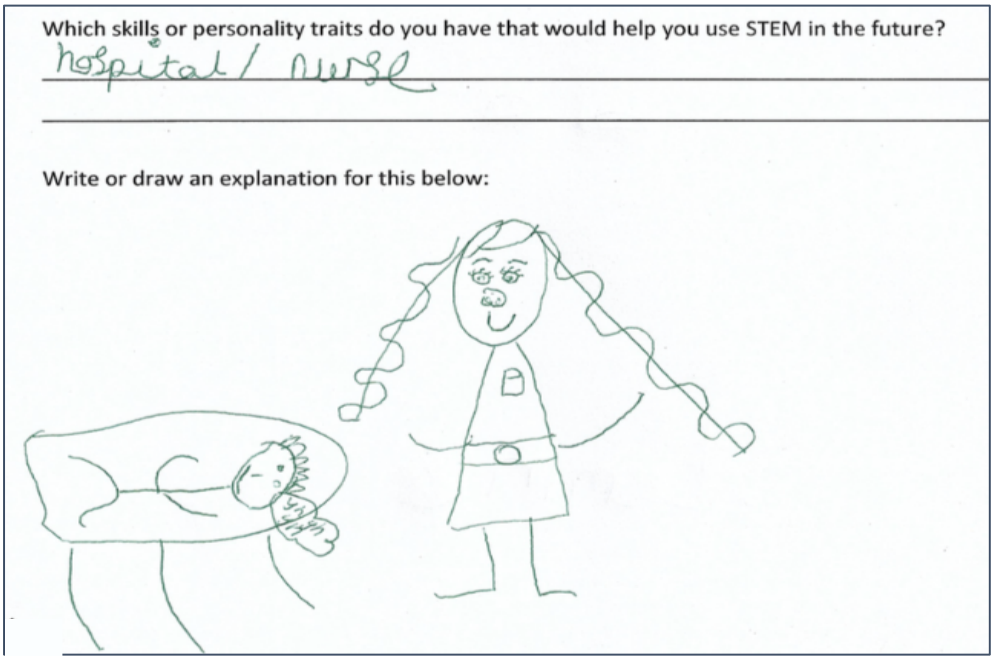


Figure 9.33: Cupcake's response to the question of skills or personality traits that might help her to use STEM in the future. Text reads: 'hospital/ nurse' and is accompanied by a drawing of a person who is ill and Cupcake as a doctor – as described by Cupcake.

Bumble's answer was tricky to interpret, as it is unclear what he was referring to and he did not wish to discuss his response any further in the session (Figure 9.34). His response alludes to research skills ('*find out more stuff*'), but it is unclear what the 'it' might be. Bumble's difficulty in expressing himself is a consistent theme in this exercise; an alternative response elicitation activity may have enabled him to articulate his perceptions more effectively. Though the skills/aptitudes outlined by participants in this section were not explicitly derived from the STEM acronym, it was not always clear how they believed those skills might be beneficial in the pursuit of STEM. It is likely that these individuals would benefit from additional support in recognising STEM applications of their skills – or in the case of Cupcake, identifying skills rather than job roles – in the future.

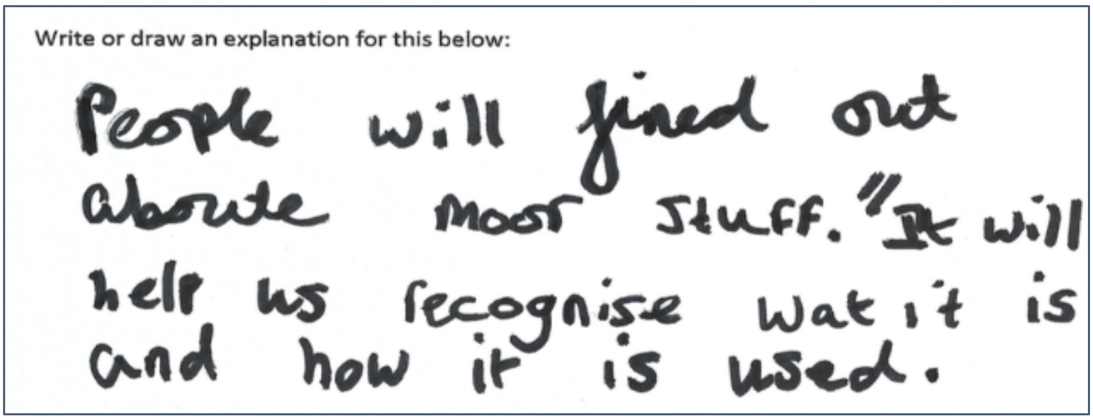


Figure 9.34: Bumble's response to the question of skills or personality traits that might help him to use STEM in the future. Text reads: 'People will find out about more stuff. It will help us recognise what it is and how it is used'. Bumble did not draw a picture with his answer.

9.1.3 Do you think you'd like a job that uses STEM when you're older?

This question addressed two factors: participants STEM aspirations (denoting individuals' positive STEM self-concepts), and their understanding of the breadth of STEM-related careers (such as archaeology). There was a range of response to this question; 8 participants said 'yes', seven 'maybe' and four 'no'. This section outlines additional evidence provided by participants with their responses and highlights where respondents are known to have a parent or family member who works in a STEM field[36] (Table 9.3) to consider how this may have impacted their response.

Participant	STEM aspiration	STEM-based parent
Stanley	Maybe	Dad designs plane wings
Barry	Yes	Mum is a science teacher
Pippin	No	
Molly	No	Dad does ship MOTs
Blossom	Maybe	Dad works somewhere to help the planet, so there's no plastic
Cupcake	Maybe	
NJ	Maybe	Dad works in technology for Barclays
Skull Trooper	Yes	
Apple	No	
Pepperoni	Yes	
Cleo	Yes	Mum is a software engineer
Jelly	Yes	
Videogame Guy	Maybe	
Blackjack	Yes	
Buster	Maybe	Mum is a hospital nurse
Bluebell	Maybe	
Olivia	No	
Black Cat	Yes	Mum works in horticulture
Bumble	Yes	

Table 9.3: Participant expressions of STEM aspirations and reported parents in STEM occupations.

9.1.3.1 Yes

Eight participants responded 'yes' to this question, two of whom have parents that work in a known STEM field: Barry and Cleo. For Skull Trooper's rationale, see section 9.1.2.2. Barry and Bumble focused on maths in their responses, though neither explained precisely how they'd like to use maths in a career. Barry's written answer did not explicitly refer to maths (Figure 9.35) when writing his response. It is also likely related to his previous response where he highlighted an affinity for maths (Figure 9.22), and is consistent with his comments throughout self-

[36] This approach is limited by participants' level of knowledge about their family member's occupations. Pupils who are unaware of a STEM background within their family will not be effectively recorded with this method.

reflection exercises (see Chapter 8). It appears that Barry felt confident that maths/STEM are such a significant part of his identity that ‘*of course’* he will pursue it in the future. Bumble demonstrated less confidence (Excerpt 9.23), which is consistent with his other comments in this exercise. However, this does not mean that he felt unconfident in his maths ability, and it appeared that neither child knew exactly how they wanted to used maths in the future.

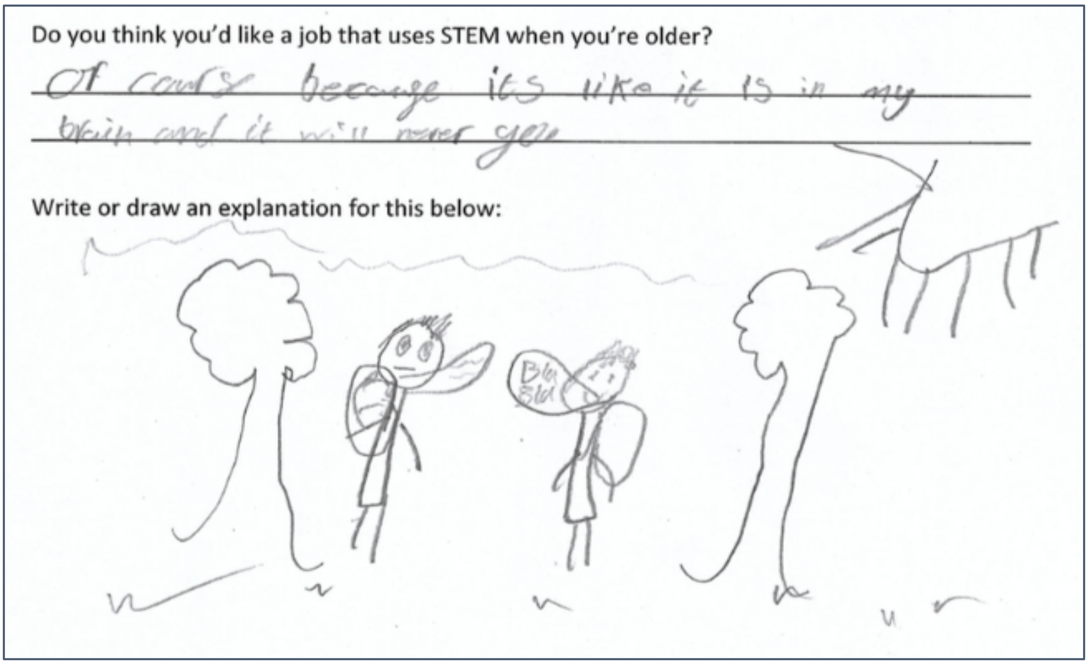


Figure 9.35: Barry's response to the question of whether he'd like to use STEM in his job when he is older. Text reads: 'Of course because it's like it is in my brain and it will never go". Barry also drew a picture of two people in a landscape scene with two trees and the sun in the top right corner. One of the people has a ‘flat’ expression and has a speech bubble with wiggly lines in it, the other person is smiling and has a speech bubble with ‘bla bla’ in it.

Interviewer: *so do you think you'd like a job that uses STEM when you're older? That doesn't have to be every part of STEM, it might just use a bit of STEM*

Barry: *like maths?*

Interviewer: *yeah, exactly*

Excerpt 9.22: Exchange between Barry and the interviewer when discussing Q3.

Bumble: *I don't know what to write for the explanation*

Interviewer: *is there a particular part of STEM that you might want to use when you're older?*

Bumble: [pause] *maths*

Interviewer: *maths okay?*

Black Cat: *do you want to be a maths teacher Bumble? If you want to be maths?*

[Bumble indicates no]

Interviewer: *you don't want to be a maths teacher? Do you know how you'd like to use maths?*

Bumble: *no*

Excerpt 9.23: Conversation between Bumble, Black Cat and the interviewer about Bumble's response to

Pepperoni also discussed maths in relation to career aspirations: she identified two potential careers: a YouTuber or a footballer, and suggested that both might use counting and numbers (Excerpt 9.24 and Figure 9.36). While both of these professions *do* use elements of STEM, they are generally more complex than counting and number recognition (e.g. filming, video editing, sport science, nutrition). This represents an excellent opportunity to develop Pepperoni's engagement with STEM in areas that already interest her.

Pepperoni: *I want to be a youtuber or something like that*

Interviewer: *being a youtuber, would that use STEM?*

Pepperoni: *maybe because you might have to count up how many subscribers you've got*

Interviewer: *what do you use as a Youtuber?*

Cleo: *technology*

Excerpt 9.24: Conversation in NB Group about Pepperoni's aspiration to be a YouTuber.

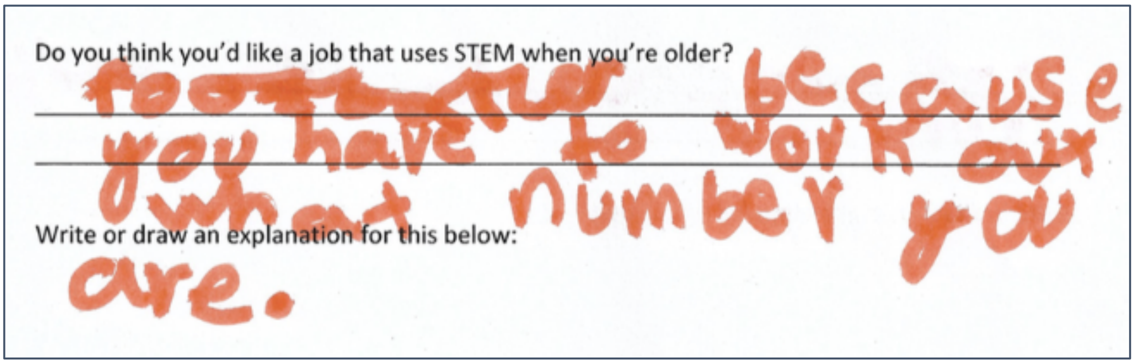


Figure 9.36: Pepperoni's response to the question of whether she'd like a job that uses STEM when she is older. Text reads: 'footballer because you have to work out what number you are'. Pepperoni did not draw a picture with her answer.

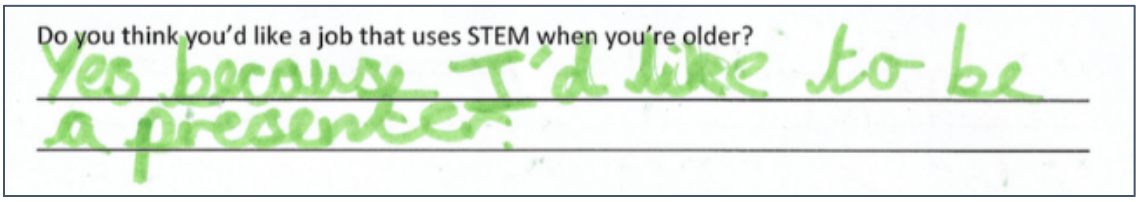
Cleo recognised the application of technology when creating YouTube content (Excerpt 9.24), and referred to this in her own answer to the question of future careers in STEM (Figure 9.37 and Excerpt 9.25). Cleo's sports presenter aspiration is consistent with previous conversations about her enjoyment of sport and her answer demonstrates a reasonable – if vague – understanding of how STEM might be used within that career.

Cleo: *I would like to be a sports presenter or commentator*

Interviewer: *okay and how would that use STEM?*

Cleo: *it would use technology, it would use* [pause] *it might use some maths because you would need to know the scores and stuff, and league tables maybe*

Excerpt 9.25: Cleo's comments on her aspiration to be a sports presenter or commentator.


Do you think you'd like a job that uses STEM when you're older?

Yes because I'd like to be a presenter.

Figure 9.37: Cleo's response to the question of whether she'd like a job that uses STEM when she is older. Text reads: 'yes because I'd like to be a presenter'. Cleo did not draw a picture with her answer.

Blackjack identified two potential career aspirations she felt were related to STEM: a builder and a scientist (Figure 9.38). Her explanation that building is linked with engineering (Excerpt 9.26) is similar to that of Videogame Guy (Figure 9.25); it appears that for BG pupils, the description of engineers as 'people who build things' resulted in the understanding that engineers physically engage in the construction of buildings. While outside the scope of this research project, it seems that this group would have benefited from clarification on roles in engineering. There are two things that stand out in Blackjack's depiction of herself as a scientist: her inclusion of test tubes, and the statement that she *'can't do it'*. The test tubes indicate that Blackjack was relying on imagery of science that she had not encountered in this research project, as test tubes were not used in any of the interventions. She also seemed to believe that a level of difficulty is involved in working in science, though whether she thought that this difficulty would be experienced only by her or by all scientists is unclear (Excerpt 9.27). It is notable that Blackjack used the pronoun 'he' when discussing the image of herself as a 'scientist'. Blackjack's response relied on common preconceptions about STEM and those working in it.

Figure 9.38: Blackjack's response to the question of whether she'd like to use STEM in her job when she is older. Text reads:' yes probably a builder or a scientist'. Blackjack drew a picture of herself as a builder and a scientist. The builder version is labelled 'builder me', is wearing a t-shirt with the text 'staff' on it, and is next to some bricks and cement whilst thinking "I love building". The scientist version of Blackjack is labelled 'scientist me' and is next to a table covered with test tubes whilst looking sad and thinking "I can't do it" – as described by Blackjack.

Interviewer: *which bit of STEM would building be a part of?*

Blackjack: *engineering*

Interviewer: *engineering – so would you just be building things, or would you be doing other things as well?*

Blackjack: *yeah, probably like fixing things as well*

Interviewer: *oh okay, what about – is there anything else that engineers do?*

Blackjack: *they probably do, but I don't know*

Excerpt 9.26: Blackjack discussed her aspiration to be a 'builder'.

Interviewer: *What's this picture down here?*

Blackjack: *he's a scientist and there's lots of test tubes!*

Interviewer: *okay, and what are you thinking there?*

Blackjack: *I'm thinking "I can't do it!" – that's why he's got a sad face*

Interviewer: *okay, and why do you think you can't do it?*

Blackjack: *it's too difficult for him – oh her! Me!*

…

Interviewer: *so do you think that you would like to be a scientist? What would happen if you were a scientist and you found something that was difficult – and you thought "I can't do it"?*

Blackjack: *I'll ask someone to help, or say "can we work together?"*

Excerpt 9.27: Blackjack discussed her aspiration to be a scientist.

Black Cat and Jelly were the only participants to express an aspiration to become an archaeologist, though both children also highlighted other STEM careers that they might also pursue. In addition to archaeology, Black Cat expressed an interest in zoology (Excerpt 9.28 and Figure 9.39), which is consistent with previous conversations about observing animals around her home (see Chapter 8). Black Cat was also interested in animals of the past (animals '*which have already been*'), which appears to be partly influenced by a television show about woolly mammoths (Excerpt 9.28). Jelly's alternative STEM career choice was a 'scientist' (Figure 9.40), an aspiration he had highlighted a number of times previously in the interview.

Black Cat: I would like to study more about wild animals – because wild animals, I don't often see. I would like to do some which have already been – because I really like dinosaurs, so maybe do some about dinosaurs… or maybe you might study a woolly mammoth, one of the programmes on tv is 'can we bring the woolly mammoth back to life?' and I sometimes watch it

Excerpt 9.28: Black Cat discussed her aspiration to be a zoologist.

Although these participants all hold STEM aspirations (indicating an identity which is aligned with STEM), their current perceptions of how those aspirations might play out are vague or hold inaccuracies. There are clear opportunities to broaden these children's understanding of how STEM is used across their dream professions (e.g. Pepperoni as a Youtuber or footballer, Cleo as a sports presenter, Blackjack as an engineer or scientist), or what professions their interests are aligned with (e.g. Barry and Bumble with maths). Future STEM engagement and education could focus on providing this support.

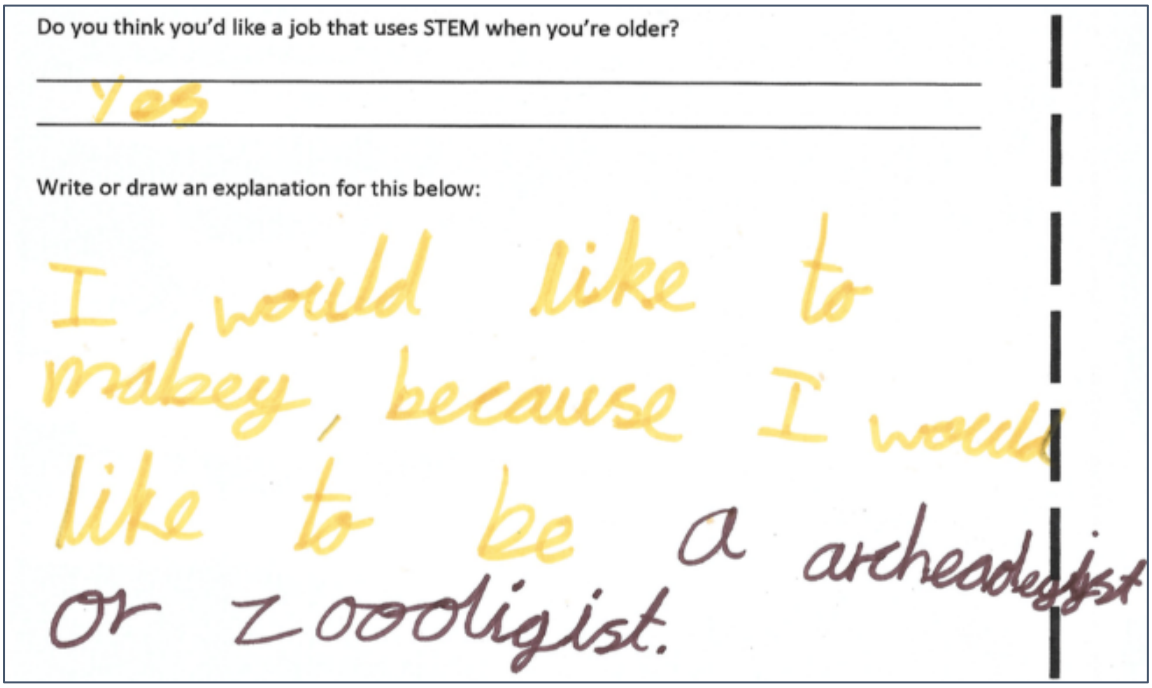


Figure 9.39: Black Cat's response to the question of whether she'd like a job that uses STEM when she is older. Text reads: "Yes, I would like to maybe because I would like to be a archaeologist or a zoologist'. Black Cat did not draw a picture with her answer.

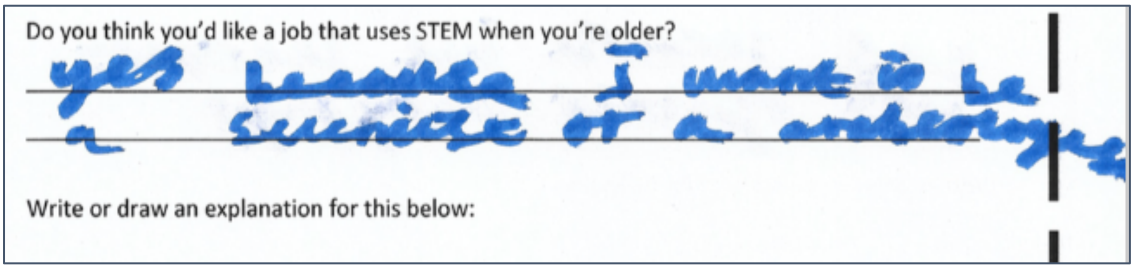
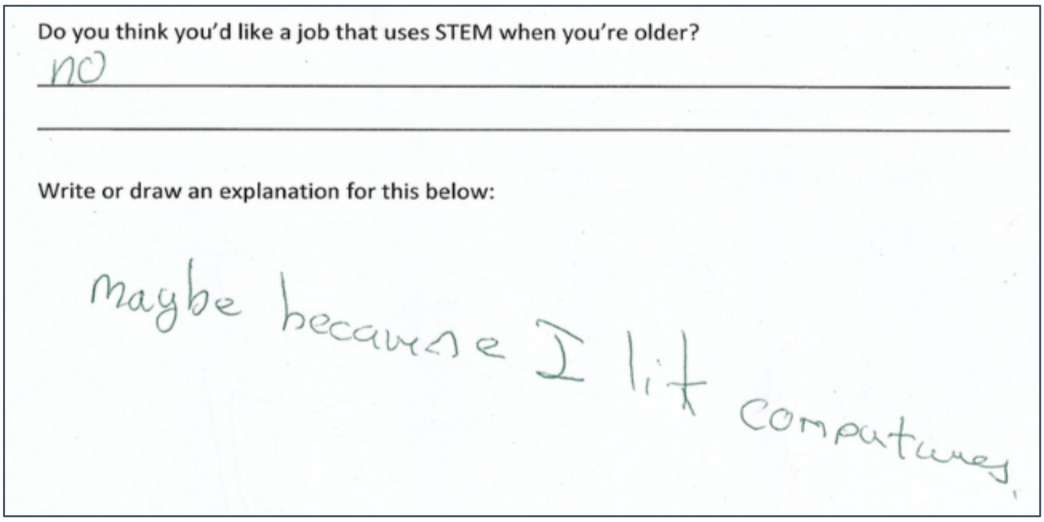


Figure 9.40: Jelly's response to the question of whether he'd like to use STEM in his job when he is older. Text reads: 'Yes because I want to be a scientist or a archaeologist'. Jelly did not draw a picture with his

9.1.3.2 Maybe

Of the seven children who responded 'maybe', three had parents who work in a STEM field: Stanley, NJ and Blossom. NJ and Stanley's answers were brief; neither participant elaborated upon their rationale. NJ initially responded 'no', but then changed to 'maybe' with the comment '*because I like computers'* (Figure 9.41). NJ didn't provide any additional information to this verbally or in writing, but his answer was consistent with previous discussions about his interest in computers, gaming and programming. Stanley's 'maybe' was accompanied by the assertion that he'd learned *'so much'* about STEM (Figure 9.42), suggesting that his knowledge and STEM perceptions had developed in response to participation in the project. This also highlights how children with a familial STEM background are not automatically interested in STEM. Stanley and NJ referred to their STEM-based parents regularly in each interview; while Stanley's parental connection to STEM did not appear to link with the interests he described, NJ's interest in programming was directly fostered and encouraged by his STEM-based parent. Despite NJ's specific STEM interest, which is negotiated via his STEM-based parent, this did not guarantee a STEM aspiration.

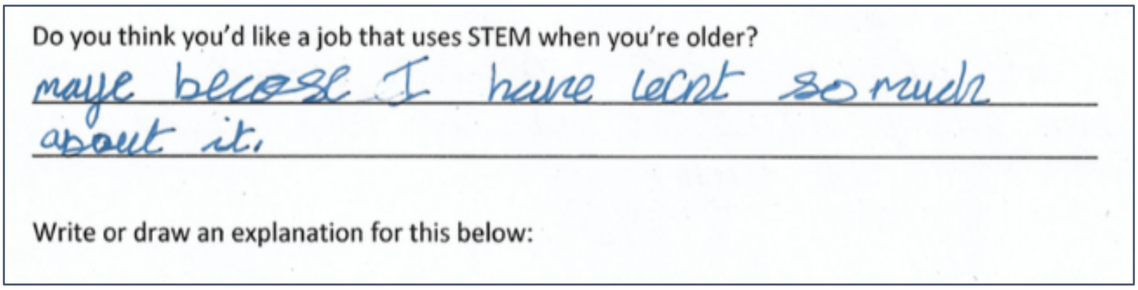

Do you think you'd like a job that uses STEM when you're older?

no

Write or draw an explanation for this below:

maybe becaune I lit computures,

Figure 9.41: NJ's response to the question of whether he'd like a job that uses STEM in the future. Text reads" No maybe because I like computers'. NJ did not draw a picture with his answer.


Do you think you'd like a job that uses STEM when you're older?

maye becose I have lecnt so much about it.

Write or draw an explanation for this below:

Figure 9.42: Stanley's response to the question of whether he'd like a job that uses STEM in the future. Text reads: 'maybe because I have learned so much about it'.

Blossom and Bluebell's answers indicated uncertainty about the future (Excerpt 9.29 and Figure 9.43); neither child was opposed to using STEM in the future, but both were unsure about how they would do so. Blossom was inspired by her aunt and grandmother's nursing careers, demonstrating the influence that family members can have on children's ambitions (Excerpt 9.29). Cupcake's 'maybe' response was also rooted in uncertainty about her future, but in this case that was due to an abundance of ideas for future careers. Initially Cupcake indicated that she might like to work with computers in a hospital or hotel reception (Excerpt 9.30). Cupcake appeared unaware that her nursing and medicine aspirations (see section 9.1.2.3) are related to STEM until this point, though even afterwards she explained that she also aspired to a dancing career, and that her future would depend on how these interests all panned out. She also mentioned that additional engagement with the concept of STEM within school might influence her choices.

Blossom: *I don't really know what I wanna be when I'm older, and what I'm gonna be so I put maybe because it could be a no or a yes*

Interviewer: *okay, so you're just not sure yet?*

Blossom: *no*

Interviewer: *okay, do you think that you might like to do something that was related to STEM when you're older?*

Blossom: *yeah*

Interviewer: *any ideas what kind of thing related to STEM?*

Blossom: *I really wanna be a nurse because my aunty and my nan is a nurse*

Excerpt 9.29: Blossom's discussion about whether she'd like to use STEM in her job when she is older.

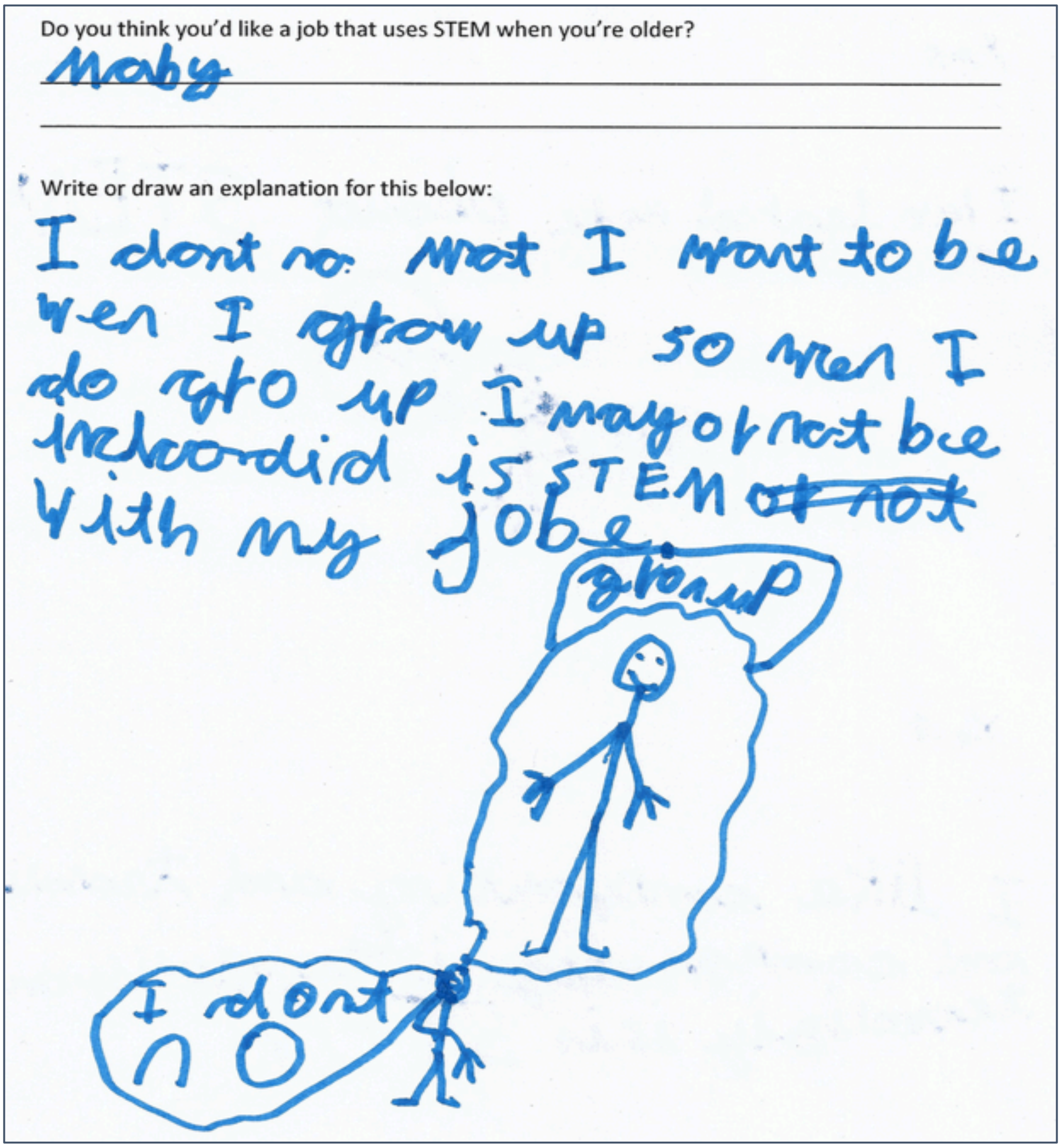


Figure 9.43: Bluebell's response to the question of whether he'd like a job that uses STEM in the future. Text reads: 'Maybe. I don't know what I want ot be when I grow up. I may or not be included is STEM with my job'. Bluebell also drew a person with a thought bubble that has another person in it labelled 'grown up', the person is also saying "I don't know" while thinking about being 'grown up'.

Cupcake: [describing her drawing] *so he has a straight face – like that – because he's thinking "do I wanna-"*

Interviewer: *he? Who is this person?*

Cupcake: *she! It's me*

Interviewer: *it's you?*

Cupcake: *thinking 'should I do it or no? should I not?'*

Interviewer: *which job do you think you might want to do if you did?*

Cupcake: *maybe a hospital – a reception area, maybe in a hotel working with computers? Because I quite like checking people into their rooms and stuff like that*

Interviewer: *okay – what about the things that you were talking about* [in Q2]*? Who was this person?*

Cupcake: *ah that was me!*

…

Interviewer: *so were you a nurse in this picture?*

Cupcake: *yeah*

Interviewer: *you were? So being a nurse, that's a job in STEM*

Cupcake: *is it?*

…

Interviewer: *sometimes people write* [STEM] *with two 'm's and the second one stands for medicine – which is what nurses do*

Cupcake: *oh!*

…

Interviewer: *does that help you think about this question a bit more?*

Cupcake: *yeah, but then I do have another ambitions – not to do with STEM, like dancing, so it depends*

Interviewer: *it depends? Okay. What do you think would change your mind either way? What would be the thing that would make you make up your mind?*

Cupcake: *well maybe if we did more stuff in school to do with STEM, that may help me change my mind about doing that. But it depends because I may get better in dance, then maybe I want to be a dancer when I'm older. It just depends*

Excerpt 9.30: Cupcake's conversation with the interviewer about her answer to Q3.

Videogame Guy and Buster also had a lot of ideas about future careers, though a number of their ideas appeared to be based upon a narrow understanding of the work involved in various areas of STEM (Figure 9.45 and Figure 9.44). Videogame Guy's description of technology was limited to 'fixing' and 'making' personal devices (e.g. computers, tablets, phones; Excerpt 9.32). Videogame Guy was initially unsure how maths could be used in a STEM career, but suggested an engineer would need it when building a boat or bridge, demonstrating some nuance in his understanding of engineering. Videogame Guy demonstrated also broader knowledge of engineering by discussing robotic engineering (Excerpt 9.31). Buster considered a range of STEM and non-STEM professions, including hairdressing, house design and building, baking, and writing (Figure 9.44). Buster's decision to list 'baker' as 'in STEM' followed a conversation about potential STEM skills used in baking (Excerpt 9.33), which highlights the important role that peer discussion can play in young people's construction of STEM perceptions. Activities that facilitate such discussions have substantial potential to impact young people's relationships with and understanding of STEM and its associated careers.

Videogame Guy: *when I grow up, I want to build robots – would that be in STEM?*
Interviewer: *I think it probably would be: which bits of it do you think would be in STEM?*
Videogame Guy: *well probably technology or apparently it's called robotics engineering*

Excerpt 9.31: Videogame Guy spoke about an interest in robotic engineering.

The responses outlined in this section are largely indicative of young people who are open to a future in STEM, but do not intend to commit to it yet. For some participants, this appears to be due to limited knowledge of how STEM manifests in a career, and how STEM relates to their current aspirations (e.g. Cupcake's interest in nursing and dancing). Other pupils appeared uncertain of their future pursuit of STEM due to an abundance of potential options. Regardless of which group individuals fall into, it is essential that all children are supported to explore ways in which their interests and skills might be suited to a future in STEM.

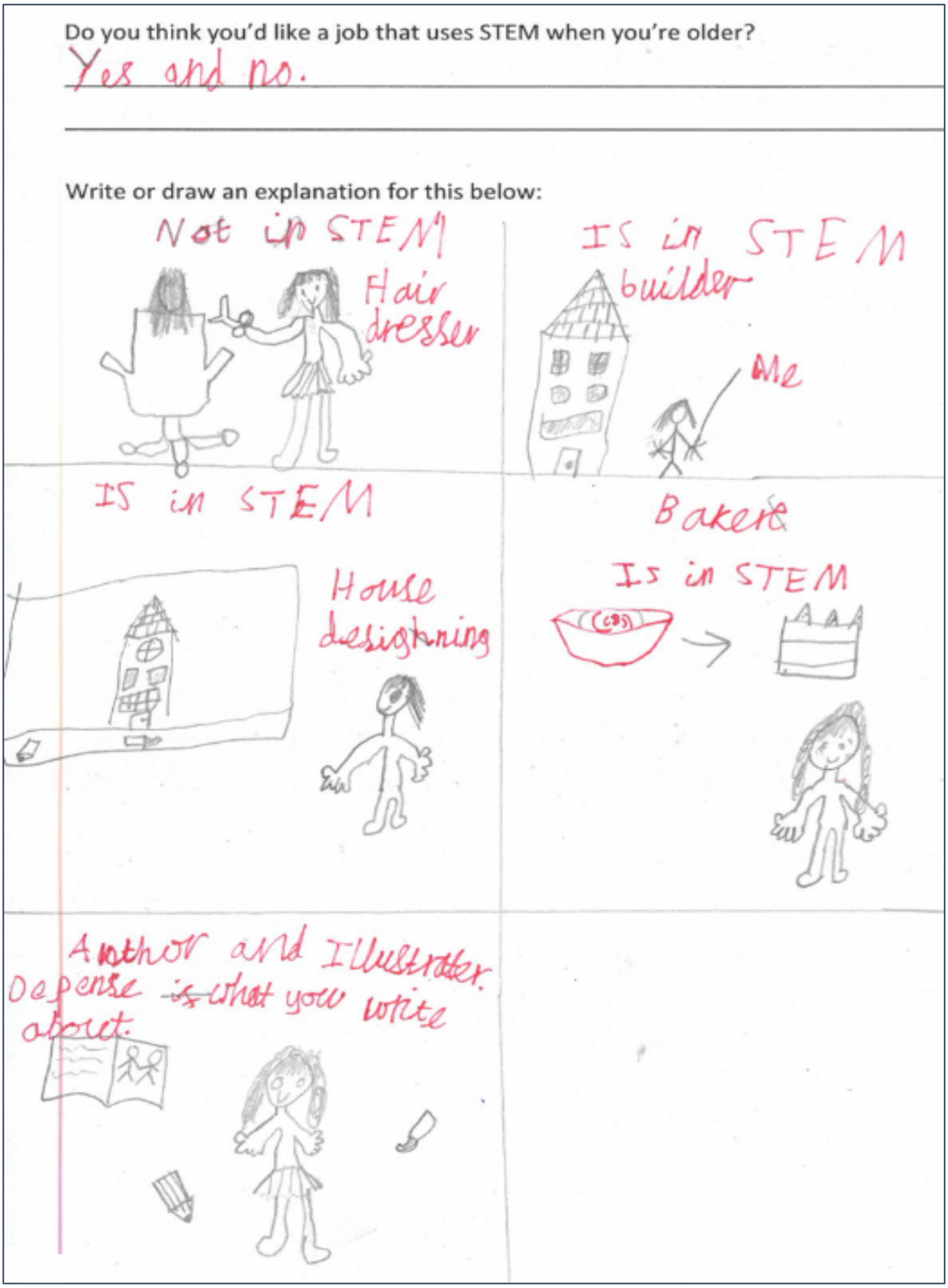


Figure 9.44: Buster's response to the question of whether she'd like a job that uses STEM in the future. Text reads: 'Yes and no. Not in STEM Hairdresser, is in STEM Builder, is in STEM house designing, baker is in STEM, author and illustrator depends what you write about'. Buster has drawn pictures of herself working in five professions: a hairdresser, a builder, a house designer, a baker and an author and illustrator. Hairdresser Buster is holding a pair of scissors and standing next to someone with their back turned in a hair. Builder Buster is stood next to a house. House Designer Buster is stood with a drawing of a house. Baker Buster is underneath a mixing bowl with an arrow pointing to a cake. Author Buster has a pencil, a paintbrush and a book. As described by Buster.

Figure 9.45: Videogame Guy's response to the question of whether he'd like to use STEM in his job when he is older. Text reads: 'maybe' and is accompanied by a drawing split into four sections, Videogame Guy has drawn himself in four potential STEM careers. For science, he has drawn himself putting 'ingredients into a potion cup'; for technology he is fixing a broken computer with a hammer; for engineering he is building a house with bricks and cement; for maths he has drawn out sums (as described by Videogame Guy). There is also a 'tick and cross' method to indicate whether a job is 'cool' or 'not cool' – every picture has a tick.

Videogame Guy: *in that picture, there's a computer and it's broken so I got a hammer to fix it*

Interviewer: *is there anything else that you do with technology?*

Videogame Guy: *you could make them – that picture, it could either be fixing a computer, or making a computer*

Interviewer: *is there anything else that if you work in technology you make? As well as a computer?*

Videogame Guy: *maybe iPads and iPhones*

…

Videogame Guy: *I don't know the types of jobs that are to do with maths – wait, would engineering be to do with maths? So say you were going to build a boat, you would need to use maths in it wouldn't you?*

Interviewer: *yeah, how would you use maths when you were building a boat?*

Videogame Guy: *maybe measurements and how big and how long it would be*

Interviewer: *okay – what about when you're designing a building, or a bridge?*

Videogame Guy: *well, you could draw the surface of it and then you could write how many centimetres it would be, or how many metres, or kilometres even. And you would times it together to find out how many kilometres, or metres, or centimetres squared it would need to be*

Excerpt 9.32: Videogame Guy's comments about his response to Q3.

Buster: *would a baker be in STEM?*

Interviewer: *a baker? So which part of STEM do you think baking would relate to?*

Buster: *not sure*

Interviewer: *what do you in baking, when you're baking something what do you do?*

Blackjack: *make cakes*

Interviewer: *how do you make cakes?*

Videogame Guy: *by using ingredients and putting them together to put in the oven*

Interviewer: *how do you know how many ingredients to use?*

Blackjack: *you measure it*

Videogame Guy: *from instructions*

…

Interviewer: *so you could follow a set of instructions, and put lots of ingredients together, and weigh them out – does that sound like something that would relate STEM to you?*

Buster: *maybe in a bit maths maybe… so should I write that it is in STEM?*

Interviewer: *well do **you** think it's in STEM? What do you all think?*

Blackjack: *yeah, kinda*

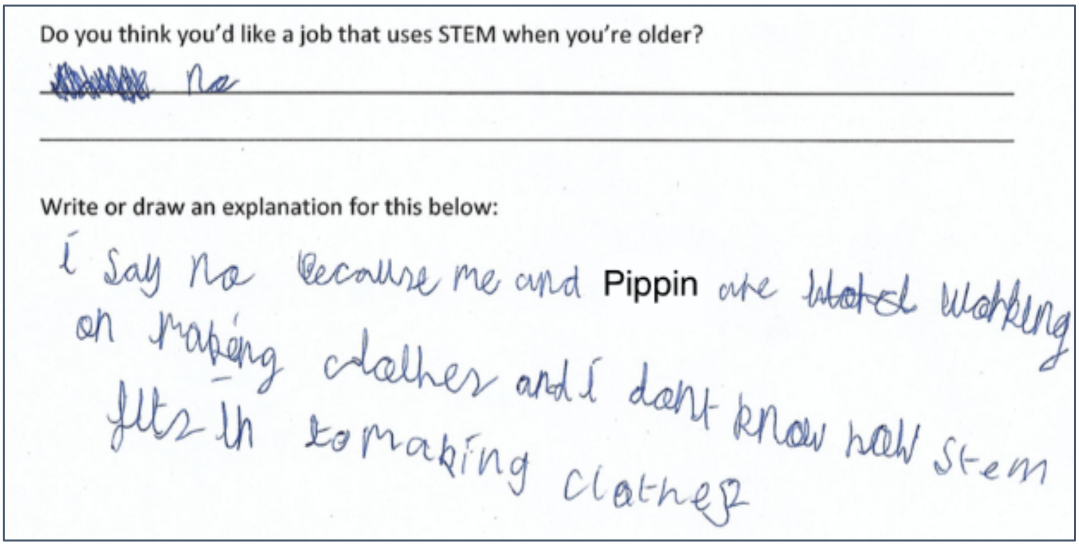
Videogame Guy: *kinda*

Buster: *in the middle*

Excerpt 9.33: BG discussion about potential STEM skills in baking.

9.1.3.3 No

Four individuals had alternative aspirations, which they felt would not come under the umbrella of STEM. Pippin and Molly aspired to work in fashion (Figure 9.47 and Figure 9.46), Apple wished to become a YouTuber (Figure 9.48), and Olivia a professional dancer (Figure 9.49). Apple and Olivia's responses are consistent with interests they had discussed throughout all three interviews. However, these aspirations are not incompatible with STEM; all three industries mentioned use STEM skills in some form or another, and this represents another key opportunity to engage young people with STEM via areas that they are already interested in. Framing future STEM engagements around pupils' interests (even beyond archaeology) will allow individuals like those outlined in this section to understand the value that their interests have within the world of STEM.

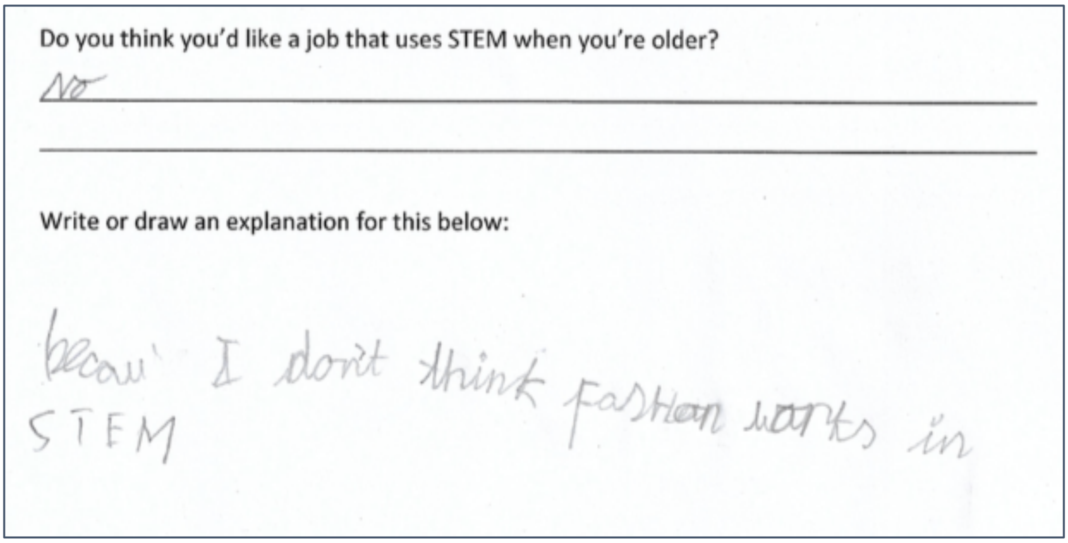

Do you think you'd like a job that uses STEM when you're older?

No

Write or draw an explanation for this below:

i say no becallse me and Pippin are ~~whated~~ wokking on maping clothes and i dont know how stem fits in tomaking clothez

Figure 9.47: Molly's response to the question of whether she'd like to use STEM in her job when she is older. Text reads: 'No, I say no because me and Pippin are working on making clothes and I don't know how STEM fits into making clothes'. Molly did not draw a picture.

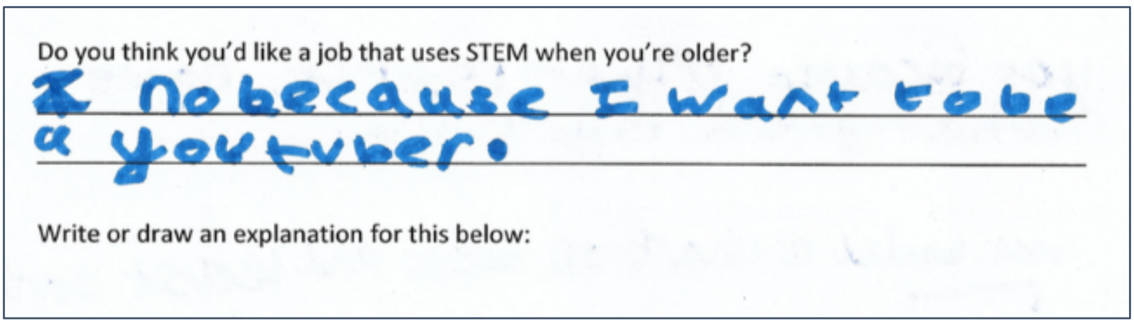

Do you think you'd like a job that uses STEM when you're older?

No

Write or draw an explanation for this below:

becau' I don't think fashion warks in STEM

Figure 9.46: Pippin's response to the question of whether she'd like a job that uses STEM when she is older. Text reads: 'no because I don't think fashion works in STEM'. Pippin did not draw a picture.


Do you think you'd like a job that uses STEM when you're older?

~~I~~ no because I want to be a youtuber.

Write or draw an explanation for this below:

Figure 9.48: Apple's response to the question of whether he'd like to use STEM in his job when he is older. Text reads: 'no because I want to be a YouTuber'. Apple did not draw a picture with his answer.

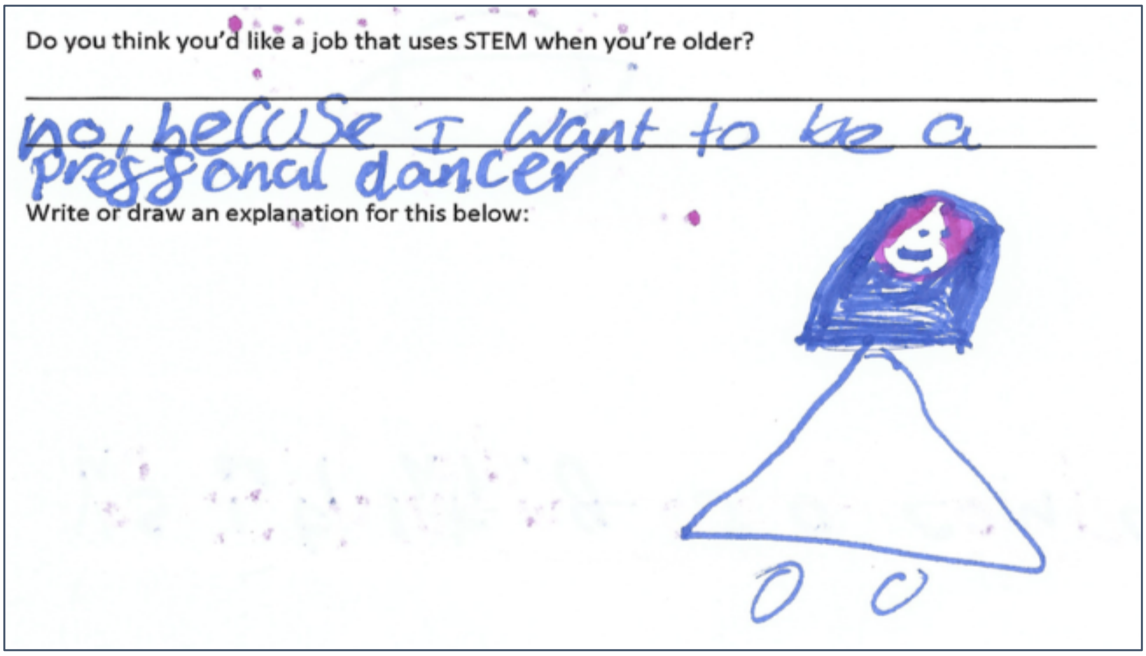


Figure 9.49: Olivia's response to the question of whether she'd like to use STEM in her job when she is older. Text reads: 'no, because I want to be a professional dancer'. Olivia has also drawn a picture of a person who appears to be wearing a dress.

9.2 Discussion of final survey results

Reviewing these responses shed light on the efficacy of interventions in this project, and highlighted opportunities for future STEM engagement. The following outlines findings thematically and reflects on their relevance within the wider literature around STEM engagement.

9.2.1 Impact of the project on STEM perceptions of its participants

The majority of respondents indicated that their perceptions of STEM *had* changed during their participation in the project. The most commonly reported change was participants' introduction to the STEM acronym. This raises the question of whether children must be aware of the STEM acronym in order to engage with related ideas. The acronym has been used in various forms (e.g. SMET, SET) since the 1990s – early 2000s (Roberts 2002; Lyons 2020, 225-6), and the intention to embed it within education was laid out by the UK Government in 2004 (HM Treasury 2004, 12). STEM engagement is a well-established concept in UK primary education, with numerous policies and initiatives in place to support teachers and learning (DoE 2011, 10-11; Morgan and Kirby 2016, 42; STEM Learning 2020). All teachers interviewed for this research (see Chapter 4) had a good understanding of the issues surrounding STEM and their impact on teaching, however, it appears that knowledge of the acronym was not passed onto the pupils who were interviewed.

Knowledge of the STEM acronym is not necessary for children to undertake science or maths lessons, so it is understandable that this may not be passed on via lesson content. However, learning STEM facts and skills are not all that is required to foster young people's STEM aspirations. Understanding wider social issues surrounding STEM is key to navigating the barriers that individuals may face in their pursuit of a future in STEM. Equipping young people with knowledge about STEM stereotypes and misconceptions empowers them to recognise and tackle these barriers, and to make fully informed decisions (Macdonald 2014, 29; Zecharia *et al.* 2014, 11; Finegold and Jones 2016, 31). The importance of primary years in stimulating and maintaining STEM enthusiasm is recognised (DoE 2009, 47; Archer *et al.* 2013), so it makes sense to begin raising awareness of and tackling social factors at this time too. While children begin to absorb stereotyped ideas from a young age (Bian *et al.* 2017), there is evidence that from the age of eight, children begin to identify stereotypes as separate from their own personal beliefs (Augoustinos and Rosewarne 2001, 153). Research carried out by the National Union of Teachers[37] into gender stereotyping in primary schools also showed that children were able to recognise and address gender stereotypes during guided discussion with their teachers (Jennett 2016, 20-22), and the Welsh Foundation Phase curriculum requires pupils to '*begin to question stereotyping'* (Welsh Government 2015, 10). Tackling stereotypes about STEM in primary education creates space for children to feel a sense of belonging in STEM from a young age, and to develop the STEM aligned identities that are crucial in future participation.

Anecdotally, guided discussions such as this were already happening in some of the schools that participated in this project: a BG teacher discussed gendered opportunities in science with her class (Excerpt 9.34), and a teacher at YP encouraged pupils to draw scientists and think about the range of careers within science (Figure 9.50). It appears that although some teachers are already taking steps to address wider issues surrounding STEM, knowledge of the STEM acronym may not necessarily be passed onto pupils by these interventions. There may be scope to formalise such conversations across all institutions, allowing all children to engage with these issues, regardless of their individual teachers' interests.

BG Teacher: *we spoke about opportunities for women in science and how they've changed over time. I told them I would have liked to be a scientist if I hadn't been a teacher. I think they're worried I'm going to run off and become a scientist now!*

Excerpt 9.34: Comments from a teacher at BG School about a recent class discussion.

[37] The National Union of Teachers (NUT) is now known as the National Education Union.

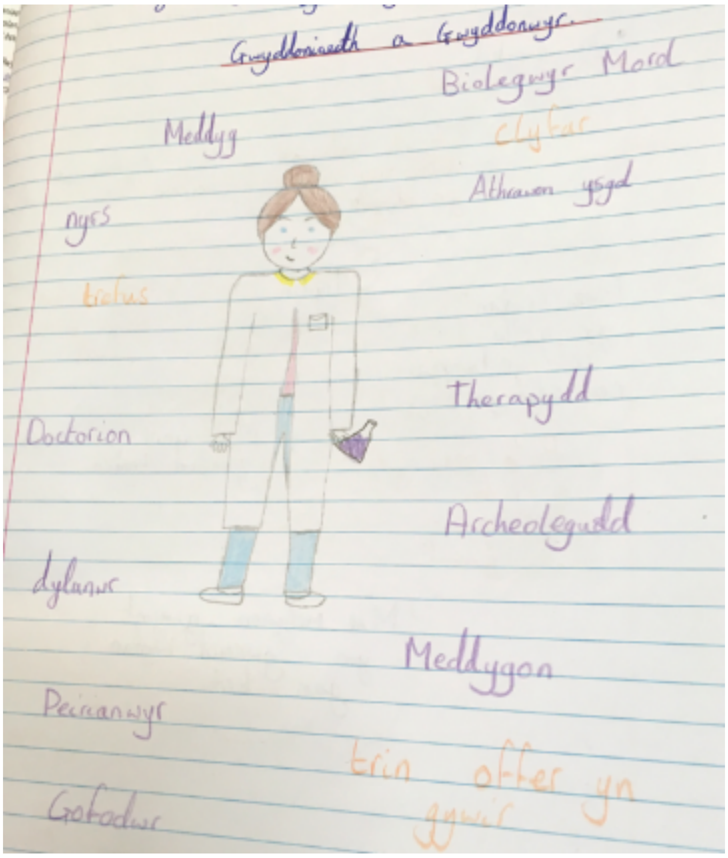


Figure 9.50: An example of an activity at YP where pupils thought about the range of jobs within science. This activity was not part of this research project.

Some participants reported other types of new knowledge or experience; building aqueducts and handling animal remains were frequently referenced, highlighting the importance of a novel experience in capturing children's attention. Broadening the range of access points is crucial to widening STEM participation, and this project provided participants with alternative ways of engaging with STEM content. References to 'learning new things' or finding the experience 'fun', indicate a generally positive outlook of the project and STEM, although they give no indication of whether this reflects a change in perception or what that prior perception may have been. One striking difference was reported by Molly, who claimed to have discovered a new 'like' of science; a promising example of how STEM content can be adapted to be relatable to children with 'non-STEM' interests.

While the intention of this project was to effect change in pupils' perceptions via a series of archaeological interventions, the interviews themselves were also sources of meaningful change. NJ and Apple explicitly referenced the interviews as part of their perception altering experience. Others were less direct, but still demonstrated evidence of perception changes derived from interview content. Numerous individuals found new ways to relate to STEM as specific links with their interests were highlighted (e.g. Cupcake: nursing, Buster: baking), and others identified non-traditional, non-simplistic ways to integrate their STEM skills into career aspirations (e.g. Cleo: sports presenter). For Olivia and Black Cat, the interviews represented a space where they felt comfortable discussing STEM; though their initial feeling towards interviews was anxiety, they built confidence through continued peer discussions and overcame their initial concerns. These findings demonstrate the value in discussing 'STEM' directly with young people when attempting to tackle the social issues surrounding STEM uptake and aspirations.

9.2.2 Participants' understanding of STEM industries

A primary focus of this research project was on the intersection between archaeology and STEM. It was not within the scope of the project to address participants' understanding of the entire breadth of possibility in STEM industries. However, participant misconceptions were apparent during the survey exercise, highlighting sources of influence on their perceptions, and the limitations of those influences in providing a realistic understanding of STEM. It also demonstrates the limited success of addressing stereotyped ideas about STEM in only a few engagements. Instead it is likely that a sustained and consistent effort is needed to provide young people with a broad and accurate understanding of STEM industries and those who work in them.

In many instances respondents drew on personal experience rather than genuine industry knowledge, which was most apparent in their discussion of maths and technology. Participants' comments reflected a shallow understanding of maths and technology, based on a level of experience expected for a primary level child. Depictions of 'maths' as a series of simple sums reflect the kind of maths encountered in primary school, as does Pepperoni's connection between maths and footballers' numbered shirts. In almost every instance where participants referred to technology, desktop or laptop computers were used as an example; a finding mirrored in other research studies (Hansen *et al.* 2017). 35% of 8-11 year olds have a smartphone and 47% have their own tablet (OECD 2019, 2), but laptops and desktop computers are used most often in school[38] (Promethean 2019), likely resulting in the overwhelming focus on them in these responses. Engineering was also discussed in a way that suggested participants filled knowledge gaps with concepts that were more familiar to them. Multiple participants drew houses to represent engineering, and these children are not alone in this misconception (Knight and Cunningham 2004; DiDonato *et al.* 2014, 35). Despite Videogame

[38] Up to date figures for 2020/21 show that tablets are now the most used technology in English primary schools (88%) over laptops (86%) and desktops (60%; DfE 2021, 68).

Guy's more nuanced understanding of the profession, his drawings initially conformed to major engineering misconceptions, highlighting the power that stereotypes have over STEM perceptions.

Though this project's interventions and interviews were successful in presenting new access points to STEM, they did little to tackle limited or inaccurate knowledge of broader STEM industries. The nature of this project required a focus on archaeology in classroom-based interventions, and interviews were intended to explore participants' perspectives, not to change them[39]. The previous section (9.2.1) highlighted the importance of facilitating peer discussions which tackle stereotyped misconceptions about STEM and those who participate in it. These discussions could be developed further to address limited understandings of STEM industries with appropriate consultation from people based in those industries. Engagements designed to explore the breadth of engineering or to draw out complex applications of maths and technology in modern life would provide children with a deeper understanding of these areas. This understanding would allow young people to develop an affinity with STEM, and improve their chances of orienting their identity with it.

Participants' observations of mundane elements of adult working life were also present in their responses. Videogame Guy's description of poly-pockets in a scientist's laboratory and Blossom's drawing of a coffee cup on someone's desk are examples of how children's impressions of the adult world are influenced by the things they see in everyday life. In contrast some responses used imagery aligned with magic or science fiction (e.g. explosions in laboratories), which demonstrate how gaps in knowledge can be bridged by informal sources (Epstein *et al.* 2010; Tan *et al.* 2017, 526). Videogame Guy's discussion about science and 'potions' appears particularly influenced by this kind of imagery, where scientific equipment (e.g. a conical flask) is conflated with imagery from TV, films or games. It is noteworthy that Minecraft – mentioned by Videogame Guy in his interview – features 'potions' which give players particular powers and are depicted as glass flasks. Blackjack also opted to draw flasks and test tubes in her survey response; the depiction of 'scientists' with this kind of equipment is common amongst young people and has remained consistent over time (Matthews 1996, 234; Finson 2002, 341; Fung 2002, 206; Tan *et al.* 2017, 524). The use of chemistry equipment does not reflect the work undertaken in any of their interventions, indicating that the interventions were unsuccessful in altering these individuals' mental image of science and scientists. A way to

[39] Though as discussed in section 9.2.1, some of discussions held in interviews did inadvertently result in broadening or changing some participants' perspectives.

address this in the future might be to incorporate an element of 'myth-busting' into interventions, where participants are asked to suggest equipment/skills they associate with STEM and then reflect whether their experience in the session matched those expectations.

9.2.3 Misgendered drawings

Three participants mixed their use of pronouns when referring to people in their drawings: Blackjack, Cupcake and Skull Trooper. In the case of Blackjack and Cupcake, they used male pronouns to refer to themselves, whereas Skull Trooper used the female pronoun to refer to a separate individual, but adjusted to the male pronoun. Blackjack's reference was to an image of herself 'as a scientist' whereas Cupcake's was to a drawing of herself thinking about a career in STEM. Blackjack's answer may have been influenced by stereotypes; scientists are more often depicted (or thought of) as male, causing her to also refer to an image of a scientist as male, even though the drawing was of herself. In Cupcake's case, the association of 'male' with 'STEM' is not quite so clear, though there is a tendency within social discourse to assume 'male' as the default (Bailey *et al.* 2019; Yang and Aggarwal 2019, 329), which may have influenced her response. It is important to note here that in Welsh the female pronoun is *hi* (pronounced the same way as 'he'), which may have led to some confusion in both cases. Skull Trooper's 'correction' may have stemmed from the fact that he initially imagined a female person when drawing a zooarchaeologist (perhaps based on the gender of the person who introduced zooarchaeology to him), but then decided he wanted his drawing to be male. He then used a gender non-specific pronoun to describe his drawing, so it may be that Skull Trooper did not hold a gendered image of zooarchaeologists.

These examples further evidence the reliance placed by participants on stereotypes, and highlight the power that stereotypes have over perceptions of who participates in STEM. It also raises a possible advantage that unusual disciplines (e.g. zooarchaeologist) may have over broader traditional ones (e.g. scientist), in that young people may be less likely to have formed opinions about these disciplines based upon societal norms. Presenting STEM via novel subject areas may allow young people to circumvent preconceptions about participation, therefore improving access to STEM.

9.2.4 Association of STEM specific skills with future STEM-related work

It was notable how many participants chose words that specifically relate to the STEM acronym (e.g. liking maths or science), rather than other skills (e.g. creativity, determination) that are equally relevant to a STEM career. 21 out of the 37 responses to this question were either directly linked to the STEM acronym or had been explicitly linked to it by participants during interviews. Other participants, like Pippin, identified creative skills in their project work, but did not highlight those skills as being useful for future pursuit of STEM. Only Blackjack and Buster explored how creative skills might be relevant in STEM, though these conversations were brief. A number of explanations for these findings are outlined here, though it is acknowledged that each participant will have had their own personal rationale, which may in fact be a blend of perspectives.

It may be that some participants took a literal interpretation of the question, where they identified things that they enjoy directly about STEM, such as science, maths or technology (mostly computers). These responses, combined with comments made elsewhere in the interview sessions (Excerpt 9.35) highlight participants' belief that enjoyment of STEM subjects is integral to achieving a happy future within it. As a result, pupils may have chosen to prioritise enjoying elements of STEM in their definition of what will '*help them to use STEM in the future*'. It is important to explore broader skillsets and aptitudes in STEM participation as research has shown, simple 'enjoyment' of STEM subjects is not enough to guarantee a future in it (Archer *et al.* 2013, 12). The results of Q2 indicate that the 'subtle' approach of highlighting other skills and traits in relation to STEM was not effective in altering participants' perspectives. Ultimately the participants in this study continued to consider the STEM acronym, rather than the wide range of skills or personality traits that complement a career in STEM. A more effective future approach may be to directly address the issue by asking questions such as "*People often think of x when they think about STEM, why is this? Is there anything else they could also consider?"*.

Responses also demonstrate how participants' limited understanding of the breadth of STEM reduced their ability to answer this question effectively. For example, limited awareness of how maths can be applied in STEM industries resulted in a simplistic understanding of the necessary skills to succeed in a maths-based career. Therefore a child may focus on simply enjoying maths, rather than considering other skills/aptitudes, such as curiosity, logical thinking, creativity, and perseverance. Current subject structures in Welsh and English education may have also impacted responses to this question. Maths, science, and technology are generally taught as 'siloed' subjects rather than broad areas of interest that encompass a range of skills and knowledge. Consequently, participants may be more likely to consider their future in STEM in terms of specific subjects, rather than transferrable skills and aptitudes. The reformed Welsh curriculum will go some way to addressing this issue, as it delivers knowledge and skill development across 'Areas of Learning' to encourage pupils to consider the wider context of their learning (Welsh Government 2020). This is an excellent opportunity for educators to emphasise skill and aptitude usage across the curriculum, which will encourage learners to think about STEM in broader terms than individual subject branches and to recognise how each subject (including those beyond STEM) is knitted together via the skills and aptitudes used.

Bumble: *I think it's important* [to enjoy maths] *because in STEM there's maths*

Blackjack: *if they don't* [enjoy maths], *they basically won't enjoy STEM because there's maths in STEM*

Apple: *for the mathematical* [part of STEM], *you might need to enjoy maths because then you would know what to do*

Videogame Guy: *to enjoy STEM you need to enjoy maths*
Interviewer: *how come?*
Videogame Guy: *because maths is a part of STEM, so to enjoy it all then you need to enjoy maths because that's a part of it*

Cupcake: *maths is in the STEM. You use it in your job, so if you want to enjoy your job, you need to enjoys maths, science, stuff about technology because that's the stuff that you're using in your job*

Pippin: *because STEM, the M stands for maths. And if you don't enjoy maths or don't really know anything about maths, you can't really join in with STEM*

NJ: *you need to enjoy science though to do it*

Pepperoni: *enjoy science because if you don't enjoy science and you work for a STEM company, one day you might have to do STEM and you might – well you don't have to enjoy science, but it would be better if you enjoy science to do science*

Olivia: *you need to enjoy science to be a scientist, because if you don't enjoy science –*
Bluebell: *what's the point of being a scientist?*
Olivia: *yeah, what's the point? Because you don't even want to do science, but you're doing a science job. So I think you need to be able to like it to be able to do your job*

Excerpt 9.35: Comments made by participants about the 'enjoys maths' and 'enjoys science' cards across all three interviews.

9.2.5 The importance of 'broadening what counts'

This survey and previous interviews (Chapter 8) revealed that the majority of participants regularly engage with STEM through entertainment and leisure pursuits. However, in numerous cases the children did not consider their actions to constitute STEM engagement. Godec *et al.* (2017, 19) highlight the importance of '*broadening what counts*' when tackling engagement with science; this concept can be applied across the whole STEM spectrum. Recognising the legitimacy of a wide range of STEM-related knowledge and experience is crucial to engaging children who may not otherwise identify with STEM. Drawing out relevant aspects of STEM in these areas of interest would empower children to pursue their interests within the world of STEM.

For example, Olivia expressed considerable interest in dancing, but felt that it did not align with a future in STEM, and Pepperoni equated her athletic aspirations with maths rather than sport science. An understanding of human physiology is relevant to professional dancers and athletes (Mehta and Choi 2017; Redding 2019), exploring this would present both children with a novel access point to STEM engagement. Similarly, Pippin and Molly believed that their aspirations to work in fashion precluded them from pursuing a STEM-related career, despite clear links between STEM and the fashion industry; from designing and making clothes, to marketing and distributing them (Hyllegard *et al.* 2016; Hong *et al.* 2019; Stewart *et al.* 2020).

Apple's assertion that his 'YouTuber' aspiration is incompatible with STEM represents an important opportunity to broaden his understanding of what 'counts' as a STEM career. YouTube is extremely popular amongst 5-15 year olds; in 2020 87% of this demographic used it to watch online content (Ofcom 2021, 13). The educational potential of YouTube as a tool for learning is well documented (Jones and Cuthrell 2011; Moghavvemi *et al.* 2018; Kohler and Dietrich 2021; Tadbier and Shoufan 2021), though less attention has been paid to the educational value of creating rather than consuming content. Creating content for YouTube requires digital literacy skills, in terms of capturing, editing and promoting content (Lange 2014), even if the content itself has no specific STEM focus (Choi and Behm-Morawitz 2017).

The belief that computer games are interesting, but not particularly useful to a person working in STEM was widespread amongst participants[40] throughout all three interviews (see Chapter 7). It is unsurprising that the majority of participants did not recognise the links between computer games and STEM, as they are often perceived as a form of entertainment (Bassiouni *et al.* 2019)

[40] An exception to this was NJ who identified the role of programming within game development.

rather than a learning opportunity (Girlguiding 2020, 18-19) or a route into STEM. Parental concerns about potential negative effects of computer games upon children (Bourgonjon *et al.* 2011, 1436; Airbe *et al.* 2019, 109) can shed doubt on their efficacy as educational tools (Williamson 2009, 35; Bourgonjon *et al.* 2011, 1440), which can be passed onto children themselves (Scharrer and Leone 2008, 229). It is clear that there is scope to build upon children's interests in computer games by exploring their use as a vehicle into STEM; both via the skills that are learned 'in-game' *and* skills relating to programming and game design.

Blackjack and Videogame Guy referenced Roblox (2006) and Minecraft (2015) on their final surveys. Both games are creative: Roblox allows users to program games and play those designed by other users (Meier *et al.* 2020, 271), while Minecraft requires users to build a world based around a complex system of building blocks with different properties and functions (Nebel *et al.* 2016, 356). The educational potential of both games has been emphasised by other researchers (Callaghan 2016; Ellison and Evans 2016); particularly Minecraft's applications in engineering (Shaw *et al.* 2014) and geometry (Foerster 2017), and the role of Roblox in programming and computer science (Long 2019). Games can also be used to explore archaeology in creative ways, such as reconstructing ancient monuments (Rice 2014, 36; Cadw 2020), or recreating quasi-historical food recipes that feature in gameplay (Reinhard 2018, 179). There is also great potential in the actual creation of games, as explored by Copplestone (2017, 92): '*Creating video games means engaging with archaeology not only as an art, a craft, and a science, but as design as well'*. Challenging young people to translate archaeological findings into a playable game facilitates their engagement with archaeology, and with computing and programming skills.

Providing educational experiences such as these empower young people to recognise the value of their personal skills and interests in STEM contexts. Feeling valued in STEM scenarios and communities is crucial to maintaining STEM participation throughout an individual's life, and should therefore form a substantial part of primary education.

9.3 Chapter 9 summary

This chapter examined the results of a survey instrument used to gauge perceptions of small-group interview participants at the end of the research period. Participants reported a positive change in attitude to science, changes to perceptions resulting from peer discussion, enjoyment of novel experiences, and demonstrated newfound access points to STEM via things that were already relevant to them (e.g. nursing). Though these changes are small, they indicate the potential impact of approaching STEM education in a new way, and hint at what might result from more sustained and consistent engagements. Delivering STEM content through the unusual, yet accessible medium of archaeology provided participants with a memorable and positive learning experience. This impact could be amplified through consistent use of engagements which explore less traditional (but more personally relevant) angles of STEM. Themes for future engagements were revealed in the responses of participants who did not always fully appreciate the relevance of STEM in their personal interests. Computer-based entertainment, fashion, sport and dance all have strong links with STEM, and opportunities to 'broaden what counts' are abundant, particularly in light of curriculum reform in Wales.

This project was successful in introducing participants to the STEM acronym. This is a crucial first step in raising awareness of the issues facing young people in their pursuit of STEM; by equipping individuals with this knowledge, they will be better placed to make informed decisions and navigate the issues effectively. Some responses suggested a continued reliance on stereotypes of STEM, highlighting the power of stereotypes and informal information sources, and the difficulty in influencing perceptions even after children have undertaken realistic STEM activities. Educators and policy makers must create space for young people to explore STEM more broadly: to challenge social factors of participation, and to examine the breadth of opportunity to engage in STEM education and careers. This can be achieved by holding frank discussions about STEM with young people, and is key to generating and sustaining engagement.

There was limited success in getting participants to consider their own aptitude for STEM beyond simply enjoying a subject. While these children had a good understanding of the things they like, they were less able to recognise personal skills and aptitudes and envisage how could they translate into future happiness or success. It is likely that children of this age require more consistent engagement with such concepts to fully incorporate this way of thinking into their day to day practice. Supporting young people to engage in this level of reflection may help them to better understand themselves and their suitability for a wide range of future careers, including – but not limited to – STEM.

These findings illustrate the complexity of STEM engagement, and demonstrate the issues that informal educators face in effecting change via limited interactions with young people. It is clear that a continuous and sustained approach is needed; such as one embedded in formal education. This approach would encourage learners to think about the wider issues surrounding STEM, and how they can recognise and tackle them in their own lives. It would also validate pupils' personal connections with STEM by 'broadening what counts', and support them to identify how their contributions to STEM contexts and communities can be valuable. Redefining who can participate and succeed in STEM will enable young people's development of a STEM identity and improve their chances of future participation. Implementing this however, may be beyond the scope of what individual educators can achieve. Instead a wide-scale approach is needed to support them to incorporate aptitude reflection and flexible learning content into their practice, which is explored in Chapter 10. Chapter 10 takes a broad view of the various data collection methods used throughout this project, and combines their findings to assess the project's impact on participants' understanding and engagement with archaeology and STEM.

10 Chapter 10: Discussion

This research project was devised in response to concerns about low STEM engagement across the UK; it sought to explore the potential of archaeology in addressing this, given the widespread popularity of archaeology and heritage across the UK (Historic England 2020b, 42-5; Society of Antiquaries of London 2020, 5) and their strong STEM themes. The issue of STEM engagement is relevant to both economic concerns, and those of social justice. Modern economies rely on a large pool of people working in STEM-based careers, which in turn relies on high numbers of people studying STEM after compulsory education. Despite the high demand for people with STEM qualifications, comparatively few people in the UK choose to pursue relevant subjects (NAO 2018, 8), resulting in large projected deficits in the future STEM workforce (HM Government 2017, 97), and substantial revenue losses (STEM Learning 2018). From a social justice perspective, advances in technology and science require STEM-literacy in populations to ensure individuals are socially mobile, informed and active citizens (Godec *et al.* 2017, 2).

Archaeology occupies a unique position at the nexus between humanities and STEM, providing a novel point of access to STEM education. Presenting STEM content through the lens of humanities demonstrates the multitude of ways to engage with STEM, and highlights an option individuals may not have considered before. Therefore, the aim of this thesis was to explore archaeology's potential in providing a novel access point to STEM, from which learner's STEM self-concepts and identity could develop. To achieve this, it was necessary to foster relationships with schools through local contacts and STEM Ambassador networks. A total of 233 pupils from five primary schools across Cardiff and Hampshire were recruited to the project. Welsh and English curricula were reviewed to identify opportunities for STEM and archaeology crossover, and preliminary research was carried out with teachers at each school to understand the major challenges faced in their STEM provision. Findings from these investigations informed the development of three STEM-themed archaeological interventions, which were delivered throughout one academic year. Links between archaeology and appropriate curriculum requirements were established and exploited in each intervention.

Potential changes to participants' STEM self-concepts in response to interventions were assessed through multi-modal data collection methods. Data collection methods focused on skills and aptitudes (Macdonald 2015; Godec *et al*. 2017, 56-8) due to the proven importance of identity and self-concepts in STEM participation (Stevens *et al.* 2008, 358; Archer *et al.* 2010; Macdonald 2014, 12). Qualitative and quantitative data was collected via multiple small-group interviews and class-wide questionnaires. Questionnaires examining participants' STEM enjoyment and aspirations, and understanding of STEM skills were administered to all 233 pupils before and after interventions. Qualitative data was collected via interviews, conducted with 20 pupils and comprised three major exercises: a word sort activity, a self-reflective exercise and a final survey instrument. This chapter considers the results of all data collection methods thematically, to establish participants' perceptions of archaeology and STEM, and their potential development over time. The chapter begins by exploring how the impact of common barriers to STEM participation appeared limited amongst project participants, and discusses alternative barriers that were raised in the findings of this thesis, such as curriculum structure, limitations of the STEM acronym, and consistency of engagement.

The chapter progresses from barriers to potential solutions arising from this research that could inform the future direction of STEM and archaeology in primary education. It argues the value of a learner-led approach to better provide personal and novel access points to STEM content which, as demonstrated by this thesis, are frequently underestimated by pupils. It also explores the historic opportunity presented by Welsh curriculum reform to embed the concepts of ability and identity via archaeological engagement championed by this project into primary education. Finally the chapter establishes the need for a consistent approach across formal and informal education to maximise the power of all learning engagements. The findings of this thesis reveal essential information about the practicalities of embedding a skill/aptitudes and identity-based approach into primary education. They highlight the potential of interdisciplinary subjects in presenting learners with opportunities to use skills/aptitudes across a range of contexts, and demonstrate the importance of consistently centring reflective and metacognitive practice in learning engagements to achieve this. This chapter is followed by a series of recommendations for educators and policy makers, to progress the issue of STEM participation based on the conclusions drawn here.

10.1 Challenges and barriers to STEM

STEM engagement literature is largely focused on the challenges and barriers that obstruct young people's participation (e.g. Macdonald 2014; Zecharia *et al.* 2014; Nugent *et al* 2015; Codiroli Mcmaster 2017). As discussed in Chapter 2, common challenges are: ethnicity, socio-economic status, gender, and perceptions of intelligence. However, evidence for such structural and socio-economic barriers amongst this sample was limited. Instead, the challenges that these young people faced in recognising their STEM-aligned identity were derived from limitations of curriculum structures, the STEM acronym, and of infrequent engagements. The following considers how barriers related to ethnicity, SES, gender and 'cleverness' manifested (or otherwise) amongst the project’s participants, and then moves on to explore issues relating to curriculum structure, acronym use, and ‘one off’ engagements.

10.1.1 Ethnicity, SES, gender and ‘cleverness’

Broad demographic data for participating schools and their local areas (see Chapter 3) makes it possible to infer how these may manifest amongst the pupil participants. Based on the assumption that people with an ethnic minority background or low SES have reduced access to STEM, we might expect to see low STEM expectations reflected in questionnaire and interview responses at schools with these indicators (SP, BG and NB). Questionnaires (Chapter 6) asked all project participants about their expectations for future STEM engagement, and data from the final questionnaire reveals the mindset of all interview pupils at the end of the research period. When these data are disaggregated according to participants’ potential ethnic or socio-economic barriers to STEM, there is little difference between responses of those facing challenges and those not (Table 10.1). Likewise, interview participants who were asked about their desire to pursue a STEM-related career on the final survey (Chapter 9) did not appear to be impacted by potential ethnic and socio-economic barriers (Table 10.2). It is notable that participants with theoretically few barriers demonstrated less uncertainty in their responses. If these children have previously engaged with STEM (via families’ science and cultural capital) to a greater extent, they may have more insight and a better understanding of how they could ‘fit’ into a STEM role, resulting in a definitive acceptance or rejection of a STEM future.

	No barrier (n= 38)			Barrier (n= 174)		
% Agreement with statements	**Yes**	**Maybe**	**No**	**Yes**	**Maybe**	**No**
I want to be a scientist when I grow up	13	47	39	8	53	39
I would like to learn more about STEM in the future	47	32	21	43	39	18
I would like to use STEM in my job when I’m older	26	34	39	21	58	21

Table 10.1: Responses to questions regarding STEM aspirations on the post-intervention 3 questionnaire. Responses are disaggregated by participants' potential barriers to STEM engagement, as distinguished by ethnicity and socio-economic status demographics of their school and local area.

Agreement with statements	No barrier (n=8)			Barrier (n=11)		
	Yes	**Maybe**	**No**	**Yes**	**Maybe**	**No**
Would you like a job that uses STEM in the future?	3	2	3	5	5	1
%	37.5	25	37.5	45	45	10

Table 10.2: Interview participant responses to final survey question of whether they'd like a job that uses STEM in the future. Responses are disaggregated by participants' potential barriers to STEM engagement, as distinguished by ethnicity and socio-economic status demographics of their school and local area.

Interview participants' conversations occasionally revealed how they perceived gender in relation to themselves and STEM[41]. Examples include: misgendered drawings of girls as scientists (see Chapter 9), reflecting the common association between maleness and science; one participants' perception of computer games as being inherent to maleness was mirrored in the ratio of boys and girls declaring an interest in computer games (see Chapter 8). There was also a clear division by gender amongst the sporting and dance activity of participants (see Chapter 8), demonstrating the impact of cultural norms on participant interests. There was a small difference in STEM aspiration by gender, with more female interview participants being certain that they did not want to use STEM in a future career (Table 10.3, and see Chapter 9). However, the number of participants who *did* wish to use STEM in future careers was the same regardless of gender. Gendered assumptions about 'cleverness' (Bian *et al.* 2017; Francis *et al.* 2017; Boston and Cimpian 2018) were not borne out in participant self-reflections either; the only participant to consistently identify as clever throughout was female[42] (Chapter 8). Additionally, the majority of participants who specifically aligned with STEM in self-reflections did not describe themselves as clever, indicating that identification with 'cleverness' was not a barrier to their current STEM participation.

	Female (n=10)			Male (n=9)		
	Yes	**Maybe**	**No**	**Yes**	**Maybe**	**No**
Would you like a job that uses STEM in the future?	4	3	3	4	4	1
%	40	30	30	44.5	44.5	11

Table 10.3: Interview participant responses to final survey question of whether they'd like a job that uses STEM in the future. Responses are disaggregated by gender.

[41] Gender identity of participants is assumed based upon names, gender presentation, and peers' pronoun use. Participants were not asked to confirm gender identity.

[42] Another female participant described herself as clever twice, though she was only present for two interviews.

Though the evidence for impact of ethnicity, SES, gender and 'cleverness' on the STEM expectations of this study's participants is limited, it is not guaranteed that these factors will never play a role in their engagement with STEM. The relatively low impact is likely due to participants' age; they have not yet been asked to make life choices under the pressure of societal expectations and limitations, and so are largely open to STEM participation. This finding supports the decision to undertake research amongst this age group, and also underlines the need for continued and consistent engagements that reinforce young people's STEM self-concepts and their knowledge of the wider social STEM context. The potential of archaeology as an engagement tool is pertinent here; as an engaging and accessible vehicle for STEM content, archaeology is well placed to capture the interest of young people who have not connected with STEM via traditional routes. However, it is worth considering the future which awaits young people who wish to pursue archaeology once their interest is piqued.

Current professional and academic archaeology is poorly placed to address factors of ethnicity and SES. As outlined in Chapter 2, archaeology is overwhelmingly comprised of white and (to a lesser extent) middle class individuals, making it is even less representative of the UK population than many STEM industries. In terms of gender, female students dominate archaeology degree courses, and just under half of UK professional archaeologists are female (47:53, see Aitchison *et al.* 2021e). Additionally, the majority of *young* people currently engaged in UK and European archaeology are female (Lazar *et al.* 2014; Aitchison *et al.* 2021e), meaning that women will likely be increasingly well represented in the future. Entry requirements for most archaeology degree programmes do not exceed average A level grades, making archaeology less exclusive than other STEM subjects with higher grade requirements.

It is clear then, that archaeology does not represent a straightforward alternative route into a STEM career. Despite being more accessible in terms of gender and grade attainment, current archaeological education and career pathways are subject to some of the same structural and institutional barriers that affect STEM participation. Young people who become enthused for archaeology and STEM via interventions such as those in this study may still face barriers in achieving their aspirations. This is particularly true for Welsh project participants, as only 3% of UK archaeology jobs are currently held in Wales; the majority of archaeologists are currently employed in Southern England and London (Aitchison *et al.* 2021b). When developing recommendations based on the findings of this thesis, it is important to also consider the situation beyond a primary school context. The use of archaeology as a tool in primary-level STEM engagement must be matched with changes to academic and professional archaeology, which address how they can become more accessible to non-traditional audiences (e.g.

Amgeuddfa Cymru n.d.b; Nevell 2013; Wyatt 2015; Pitt Rivers Museum 2017; Westwater 2021). Creating inclusive STEM environments is crucial to maintaining young people's interest and motivation as they move beyond compulsory education.

10.1.2 Curriculum structure

The word sort exercise (Chapter 7) revealed challenges participants faced when considering STEM practice in terms of skills and aptitudes. While they described a relationship between things like 'using computers', 'enjoying science or maths' and STEM practice, the skills which they related to these experiences were largely simplistic or absent altogether. For example, Pepperoni's suggestion for a footballer's application of maths was recognition of numbers on players' shirts, rather than broader skills like tactical thinking and problem solving. Despite having engaged with scientific and mathematical skills during interventions, participants largely did not extrapolate these archaeological experiences to interview-based discussions about STEM[43] (Chapter 7). Instead, they maintained perceptions of what constitutes 'doing STEM' that were closely aligned with school-based subject matter such as counting and simple arithmetic. Recognition of how 'non-acronym' skills/aptitudes, such as curiosity, imagination or enjoyment of sports and gaming might hold relevance in STEM was mixed (Chapter 7). For example, the process of peer discussion encouraged some participants to expand their perceptions of gaming's relevance in STEM practice, but only in relation to technology and computer usage. Things like the role of imagination in game development were not explored. For most participants, STEM remained most strongly associated with subject content of the acronym, with very few observations of how skills might transcend subject 'silos'.

A similar trend was apparent in participants' self-reflections (Chapter 8). Individuals identified relationships between multiple skills/aptitudes, such as Cleo's interest in sport being informed by her competitiveness and enjoyment of being outdoors, and Olivia's dance pursuits being supported by teamwork and hard work. However, very few participants linked their 'non-acronym' related skills/aptitudes with STEM practice, suggesting that although these children *were* able to consider skill usage across contexts, their perceptions were limited by pre-existing concepts of which situations particular skills/aptitudes can be used in (e.g. science or maths content is not applicable in a dance context). Key exceptions were Apple and Videogame Guy, who described creative skill usage in relation to computer games, and Pepperoni who highlighted a range of skills within her scientific practice: experimenting, problem solving, predicting and creativity. It is notable then, that these participants did not identify those skills

[43] A consistent exception to this was references to 'the bones' from the first intervention.

on their final surveys when asked which of their skills/aptitudes would help them use STEM in the future (Chapter 9). All three pupils reverted to acronym-specific responses focused on using computers and technology. The focus on acronym-based skills (e.g. computers, maths, science) was mirrored amongst the majority of responses to this question, further compounding the impression that participants found it challenging to identify how 'non-acronym' skillsets could be relevant to their future engagement with STEM.

This challenge is reinforced by current curriculum structures in Wales and England, where subjects are taught separate from one another. Researchers argue that subject compartmentalisation results in learners who cannot transfer skills and concepts between similar contexts (Billingsley *et al.* 2016, 466). Teaching in 'siloed' subjects, rather than broad areas of inquiry, encourages learners to focus on subject matter rather than applying skillsets across disciplines. It is clear that these children *are* able to consider skill/aptitude usage across a range of contexts, but require additional support to think beyond the confines of subject 'silos'. For example, Pepperoni's understanding of creativity in science practice was directly informed by a British Science Week activity, where she was challenged to engage with science creatively and gained a deeper understanding of science-relevant skillsets. Reframing everyday learning to emphasise cross-curricular knowledge and skill development is key to young people recognising their aptitude for STEM beyond simple 'enjoyment' of a subject. The 'STEM' acronym is in itself an acknowledgement of the interdisciplinarity of these subjects, and there are strong arguments for teaching school-based STEM accordingly (see Tytler *et al.* 2019; Millar 2020). However, interdisciplinarity across the entire curriculum is less common, particularly between STEM and humanities subjects (Murphy and Beggs 2005, 11; Billingsley *et al.* 2016, 460; Stylianidou *et al.* 2018).

Current primary curriculum structures pit foundation subjects (history, art, design technology) against core subjects (maths, English, science) via uneven assessments which prioritise Welsh, English, maths and science (Welsh Government 2018b, 10; STA 2020, 16). Foundation subjects are often deemed low priority and 'squeezed' off school timetables by core subjects (Ofsted 2011b, 32; Spielman 2018; Caldwell *et al.* 2021, 237), a phenomenon recounted by teachers interviewed for this project (Chapter 4). Part of this 'squeeze' is due to the volume of curriculum requirements for science, maths, English compared to other subjects (DfCELLS 2008a; DfE 2013a; DfES 2016a,b), which result in greater time allocation to core subjects. Content volume and timetable pressures could be alleviated through the use of cross-curricular teaching. Interdisciplinary subjects like archaeology encapsulate requirements across the entire curriculum, and are therefore capable of delivering multiple learning objectives within a single learning engagement. This project has demonstrated the impact of creating memorable and novel learning experiences, and the need to emphasise skill/aptitude usage throughout. While it may seem a lot to ask schools to overhaul their entire curriculum, this suggestion is made against the backdrop of historic curriculum reform in Wales. This revised curriculum, focuses on areas of learning (AoL) rather than subjects (Welsh Government 2020, 12), and presents an excellent opportunity to restructure learning around interdisciplinary subjects like archaeology (Appendix 38).

10.1.3 Limitations of the 'STEM' acronym

The STEM acronym is useful shorthand when discussing issues surrounding science, technology, engineering and mathematics; it saves time, and symbolises the interconnectedness of STEM disciplines and their associated skills. However, throughout this project it became clear that participants' focus on the acronym (and its associated school subjects) limited their in-depth exploration of STEM self-concepts, skillsets and aptitudes. Acronym related skills and aptitudes (e.g. enjoys maths and science, can use computers) were repeatedly cited as most important to a person working in STEM during word sort exercises (Chapter 7), and were most frequently identified as useful for participants' futures in STEM (Chapter 9). Learning 'what STEM means' was one of the most commonly reported changes in response to the project, demonstrating the priority placed on the acronym by participants. It is also possible that the process of reminding participants 'what STEM stands for' at the start of each session (to reduce confusion), inadvertently entrenched this further. Asking 7-9 year olds to reflect on an entire year of experience may have been asking too much of them, and these responses could reflect the difference in cognitive skill between recalling knowledge and articulating feelings.

Children develop the ability to identify and understand feelings – in themselves and in others – from a young age (Human 2018, 13), but this does not guarantee that they'd want to discuss those feelings in an interview context. Children are selective when discussing feelings and emotions, and are more likely to reference them in conversation with siblings than friends (Hughes *et al.* 2007, 345). Self-reflective practice also develops with age; as individuals' vocabulary and experience increases, so does their ability to describe themselves in complex ways (Mervielde and Fruyt 2000, 102; Markey *et al.* 2002, 175). These factors are likely contributors to participants' reliance on shallow descriptors of STEM practice, such as choosing 'enjoys science' over skills like 'logical', 'determined' or 'practical'. STEM self-concepts that are based solely upon 'liking' a subject may impact subject choices for GCSE and A level study. Not only does STEM enjoyment decrease between KS2 and KS4 (Brown *et al.* 2008; Gorad and See 2009, 107; AT Kearney 2016), but choices based upon enjoyment could result in drop out if it becomes diminished or compromised. There are a wealth of factors which might reduce enjoyment of a STEM subject (see Chapter 2), and pupils who might otherwise be successful in STEM become alienated from subjects based on dislike of those lessons (Nardi and Steward 2003).

Participants' focus on 'science, technology, engineering and maths' skills/aptitudes in potential future engagements with STEM, caused them to overlook broader skills that are essential to STEM practice, such as creativity and imagination. Despite interview participants recognition that creative-based skills *do* have relevance in STEM (Chapter 7), only two participants (Buster and Blackjack) who identified with creative practice (Chapter 8) highlighted its potential use in their future STEM practice (Chapter 9). In addition to this, questionnaire data revealed creativity to be one of the least commonly identified skills used in the workshops (with the exception of the aqueduct workshop, see Chapter 6). Imagination was even less well regarded in interviews for its relevance to STEM (Chapter 7), and one of the least frequently selected skills in pre and post-workshop questionnaires (Chapter 6). It is apparent that while participants understood some of the ways creative practice can be relevant to STEM, these are not the skills that they most readily associate with STEM or identify in their future pursuit of it.

The emphasis on 'STEM' skills infers a value of these above other skills; a likely consequence of which is that creatively aligned people may feel that they cannot contribute or succeed in STEM education and careers. To combat this, a broader public understanding is needed of how skills are relevant across STEM, as well as greater recognition of how STEM-based skills are applied throughout non-STEM disciplines and practices. Additionally, the 'STEM' acronym gives little indication of where archaeology fits into STEM practice, especially as archaeology is more traditionally located in the humanities. In summary, though the STEM acronym is a useful shorthand, it is evidenced throughout this research as having a constraining (rather than enabling) impact on learners, creating an inadvertent barrier to STEM which must be addressed.

Another acronym has been proposed to address this shortcoming of STEM: STEAM, where the 'A' represents artistic and creative practice (Maeda 2013), and broader 'liberal arts', including humanities and social sciences (Haesen 2019). However, this raises the question of how a carousel of changing acronyms (SET to STEM to STEAM) actually serves young people and their education. This thesis is rooted in the assumption that interdisciplinary education is necessary to meet the entire range of learners' needs and interests, and to ensure their skills and knowledge can be applied across contexts. It is clear that the STEM acronym becomes problematic when it is used in ways which limit this (e.g. via subject resource allocation, public discourse on subject value). Yet it is also clear that there are instances where a specific focus on STEM is necessary, such as the examination of specific barriers that people face when pursuing education or employment in those disciplines. The acronym itself does very little to inform young people about the broader issues surrounding STEM, or prepare them for potential barriers to future access. Enthusing pupils for a discipline where they may face challenges or discrimination must be accompanied by information about those possibilities, to ensure that young people make fully informed decisions about their futures. The power of peer discussion in influencing the perceptions of participants in this study demonstrates an avenue through which these issues could be explored in educational settings. Constructively challenging stereotypes and other STEM-related inequities in a safe classroom environment will empower pupils to recognise the socio-political issues surrounding STEM engagement. This is equally important for young people who are less likely to be impacted by common STEM barriers, as they must also be part of the solution to addressing these issues.

10.1.4 Impact of STEM-based interventions

Despite countless calls to action for STEM education (e.g. Finniston 1980; Roberts 2002; SBS 2002; Archer, Osborne *et al.* 2013; The Royal Society 2014b) and initiatives for engagement (e.g. Daly *et al.* 2009; ScienceGrrl 2012; Macdonald 2015; STEM Learning 2016; Stock Jones *et al.* 2016; Arad Research 2017; Bloodhound 2017) change has been slow (WISE 2020) and marginalised groups continue to be underrepresented in STEM education (see Chapter 2; IOP 2020) and careers (Engineering UK 2018a; Joice and Tetlow 2020, 5; STEM Women 2021). As discussed in Chapter 6, many other instances of STEM engagement intervention research have produced limited impacts on STEM participation. The most promising examples are those which were long term, and focused on fostering STEM identities and mindsets (van den Hurk *et al.* 2019, 161; Prieto-Rodriguez *et al.* 2020, 1157). Although this thesis also sought to explore STEM engagement from a perspective of identity and self-concept, there is limited evidence that participants experienced change in these areas.

Interventions aimed to demonstrate to participants how their STEM skills and broader skillsets could be used in a novel context. Questionnaire data revealed that participants believed the most important skills for STEM practitioners[44] were consistently reflected in their intervention practice (Chapter 6). This suggests that participants recognised STEM skill usage throughout interventions when explicitly prompted to reflect on that, but did not draw on those

[44] As defined by the skills most frequently identified as being the 'top three' most important skills for someone working in STEM.

experiences when considering STEM practice more generally in the following interviews (Chapters 7 and 8). Responses to other questions also indicated that these reflections did not impact participants' intentions to pursue STEM in the future, or their perception of STEM's current importance in their lives. The small decline in STEM aspirations and enthusiasm observed in questionnaire responses is mirrored in findings of previous research (Pell and Jarvis 2001, 857; Murphy and Beggs 2003, 111; Archer *et al.* 2013a) and may indicate an even earlier decline than previously identified; occurring in lower key stage 2 and across all of STEM (Turner and Ireson 2010, 129).

Interview exercises such as the word sort activities (Chapter 7) and final survey (Chapter 9) revealed limited change in the way participants perceived skills. Word sort discussions revealed largely positive perceptions of how skills and aptitudes are relevant to STEM practice, with participant conversations displaying greater nuance and detail in response to increased interaction with these concepts. This was reflected across most skills/aptitudes presented in the word sort selection, but was not translated into individuals' projections about their future STEM practice. For example, participants made strong arguments for the STEM relevance and use of computer gaming and creative skills (Chapter 7), which were also some of the most commonly identified in self-reflections (Chapter 8). However, only Buster and Blackjack identified creativity as being useful to their future pursuit of STEM and none suggested gaming. This indicates that interventions and interview discussions provided space for participants to develop their ideas about STEM skills/aptitudes, but did not demonstrate exactly how those skills/aptitudes could manifest in future STEM pursuits on an individual level. Achieving this would have required more time with participants than was possible in the context of an external project running alongside normal school timetabling, and highlights the need for this approach to be embedded within the curriculum rather than intermittent engagements.

Providing each participant with opportunities to experience how individual interests and skills (e.g. gaming and YouTube, fashion, sport and dance) align with STEM is beyond the scope of a single PhD project, but a crucial step in empowering young people to engage with STEM on their own terms. While the content of this project's interventions did not cover things like sport or gaming[45], there were many other attributes present which interview participants also overlooked in their future projections for STEM-based skills. In order to shift the focus from 'acronym specific' skills to more generally applicable skills/aptitudes, more time could have been spent reflecting on this practice *as* it was happening. Encouraging participants to

[45] Though the flexibility of archaeology is such that these areas could be covered in future efforts.

recognise their use of skills/aptitudes in 'real time', rather than a single exercise at the end of each session, would have more effectively highlighted their importance within STEM practice. Despite evidence that participating schools *do* encourage skill development and reflective practice[46], the requirement for pupils to demonstrate what they learn remains embedded in systems of assessment. Consequently, pupils may place a higher value on knowledge accumulation, as demonstrated by some participants' assertion that the volume of 'known things' might indicate 'cleverness' (see Chapter 7). To instil value in skill development alongside content knowledge, reflection on skill and aptitude usage must be explicitly and consistently embedded in learning. Interdisciplinary subjects like archaeology are particularly well suited to demonstrate skill/aptitude usage and value across contexts; adopting this approach in formal education will empower young people to make decisions about their futures based upon a deeper understanding of their own abilities and the contributions they can make across a broad range of disciplines.

10.2 Future directions for STEM engagement and archaeological education

Young people deserve the opportunity to imagine themselves in the world of STEM, to understand how they might 'fit in', and to make informed decisions based on a realistic understanding of themselves and of STEM. To achieve this, educators must identify ways to centre concepts of aptitude and identity within their practice. The remainder of this chapter will outline suggestions for future directions of STEM engagement that have arisen from the findings of this research project. This is done specifically through the lens of archaeological education, but with some consideration of how all in/formal educational experiences might take a united approach to STEM participation.

10.2.1 Curriculum changes

Welsh curriculum reform has been mentioned numerous times throughout this thesis. This section will briefly outline the major changes and discuss their implications for skill and aptitude perceptions in primary education. The revised Welsh curriculum will no longer distinguish between primary and secondary learning stages, and instead will focus on 'principles of progression' and 'descriptions of learning' that broadly relate to pupils' age (5, 8, 11, 14, 16; Welsh Government 2020, 8). Subjects are restructured into 'Areas of Learning' (AoL) and

[46] Discussions with pupils and teachers, and observations of displayed work on visits to schools anecdotally demonstrated how these schools encourage and facilitate deeper learning. NB, YP and SP pupils engaged with problem-based learning, BF pupils are taught within a Growth Mindset framework, and BG teachers make time for reflections following tasks.

underpinned by 'statements of what matters', which must be covered by schools (Welsh Government 2020, 12). AoL are designed to '*enable learners to build connections across their learning and combine different experiences, knowledge and skills'* (Welsh Government 2020, 6). Structuring the curriculum in this way is an unparalleled opportunity for interdisciplinary education, where subjects like archaeology teach key skills (critical thinking, data interpretation, collaboration, creativity) across many AoL. AoL position all lesson content on an equal level, theoretically removing traditional ideas about the status of particular subjects and their associated skills. A truly cross-curricular education will challenge pupils to use their skillsets in multiple contexts, and demonstrate the value of their aptitudes across all AoL.

This project demonstrated how reflecting on skills/aptitudes at the end of a learning engagement (Chapter 6) may have a low impact on individuals' projections for future STEM practice (Chapter 9). One suggested solution to this – 'metacognition' – is also embedded in the reformed Welsh curriculum (Welsh Government 2020, 51). Metacognition ('thinking about thinking') encourages learners to engage in consistent monitoring and evaluation of progress (Mevarech and Kramarski 2014, 35), and is widely understood to improve educational outcomes and motivation (Michalsky *et al.* 2009, 372; Hiller and Kitsantas 2015, 205; Avargil *et al.* 2018; Mevarech and Fan 2018, 268). Adopting a metacognitive approach would allow educators and learners to go one step further than the reflections of this study, by reflecting on skill and aptitude usage in 'real-time', and with a higher degree of consistency. Highlighting the application of 'non-STEM' skills in STEM settings could be particularly powerful for pupils who do not identify with STEM, but do recognise their 'non-STEM' skillsets. Additionally, pupils who *do* consider themselves to have an affinity for STEM will also benefit from observing how their STEM skills are relevant in other contexts, and reinforce their connection to arts and humanities. Young people who are practised in identifying their own skill usage will have a deeper understanding of how those skills might translate into future practice; archaeology and other interdisciplinary subjects are uniquely placed to facilitate this and to broaden learner's self-concepts. Welsh curriculum reform represents a key opportunity to embed these subjects into formal education.

Smaller scale changes are also proposed for English education, with Ofsted (2021) recommending greater focus on full curriculum teaching. This may help to address the imbalance between core and foundation subjects and their associated value judgements. However, increased scope for skill application across learning contexts may be undermined if these experiences are not made explicit, meaning that pupils continue to perceive certain skills to be aligned with specific subjects. Educators working within the English curriculum may find archaeology even more valuable in this case, thanks to its ability to produce cross-curricular learning in a system that remains divided by subject. There is provision in the English curriculum for teachers to draw upon subjects not specified in the curriculum (DfE 2013a, 5), though this may be limited by volume of requirements for other subjects (see teacher concerns in Chapter 4).

Including archaeology in primary education may be challenging for teachers, who can face difficultly in accessing archaeological knowledge and resources (Chapter 2). Integration of archaeology into education must be done with the support of archaeological specialists to ensure that pupils benefit from the full range of opportunity that the discipline presents. With appropriate resources and funding, archaeologists could form partnerships with education authorities to develop an archaeology curriculum. Under new Welsh regulations individual schools create their own curricula, however, to reduce replication of labour it may be more sensible to develop one broad but flexible programme of study. This could be adapted by institutions to reflect content relevant to their local area, such as specific heritage sites and objects or events of historical importance. Archaeologists have previously made contributions to formal education; before archaeology A level was discontinued, archaeologists prepared a support package to assist in the revision of the course (Heyworth 2016). Providing teachers with access to expert knowledge and skills would build upon this previous relationship, and could also benefit archaeologists by creating a direct link between their research and national education content.

10.2.2 Centring learners' interests

An important finding of this project was that while participants seemed to have a clear and largely consistent understanding of themselves, this was primarily based around the things they like to do rather specific skills or aptitudes. Self-concepts of ability play a crucial role in formation of identity (Carlone 2004, 409; Kyriacou and Goulding 2006, 17; Mendick 2006, 63), and it was apparent that the interests highlighted by participants in the reflective exercise (Chapter 8) were underpinned by feelings of success in those areas. This raises the question for educators of how to capitalise on those feelings and interests with regards to STEM engagement. Another major finding was that almost all participant interests intersected with STEM, but very few children fully appreciated this (Chapters 7 and 8). Sport (including dance), gaming, fashion and YouTube all have distinct links with STEM skills and knowledge, but almost none of the participants with interests in these areas identified them. Participant interests are mirrored amongst the wider population of children in Wales and England (Arts Council of Wales 2018; Sport Wales 2018; DCMS 2019; Ofcom 2021; Sport England 2021), meaning that these areas represent key opportunities for educators to explore STEM engagement in areas that many young people are already engaged with and confident in.

As outlined in Chapters 7 and 8, archaeology is well positioned to explore popular interests such as computer-based entertainment and creative practice. Existing computer games like Minecraft allow users to create archaeological structures and landscapes, but archaeological engagement through gaming can go further than this by challenging learners to develop their own games or digital experiences based upon archaeological knowledge. Digital preservation and dissemination of heritage may also appeal to learners who enjoy computer-based entertainment. As technologies like photogrammetry, geographical information systems (GIS), and film making software become more accessible, so do the opportunities to incorporate digital humanities into school-based education. Experimental archaeology provides a vehicle for creatively aligned learners to engage with artistic practice through a scientific method. Investigating things like clay composition, plant dyes and natural fibres, material manipulation and construction allows learners to make and test hypotheses based upon scientific knowledge in an accessible and personally relevant context. STEM engagements which tap into pupils' interests and identity in this way have the potential to create very powerful learning experiences.

Engaging young people with STEM through current areas of interest and enthusiasm presents them with novel access points to explore STEM, and also demonstrates the importance of their entire skillset and experience base. Those who do not identify with STEM can recognise the ways they currently engage with STEM practice, and the contributions they could make to STEM. Exploring STEM through archaeology opens up huge potential to engage with young people's interests via one unifying theme. Archaeology allows educators to create interdisciplinary learning experiences where creative and artistic skills, physical and outdoor activity, gaming and digital content creation are all valued equally to STEM content. Showcasing the breadth of possibility within STEM-based practice enables young people to understand where STEM 'fits' into their own identity, and empowers them to access the social and economic benefits of STEM. This section has focused on the interests of interview participants, which although broadly reflected in wider populations of primary children, may not reflect the interests of *all* young people. Godec *et al.* (2017, 30) outline how teachers can get to know their pupils' interests and lives outside of school to create personalised and relevant learning experiences. This approach could also be taken up by informal educators, though it is recognised that many informal educators have limited time with individual young people and may be unable to tailor all engagements accordingly.

10.2.3 Making use of peer discussions to explore STEM issues

An important finding from interview sessions was the development of discussion content throughout the research period. Participants' conversations progressed from vague and brief comments, to specific and nuanced descriptions and suggestions of skill usage in STEM contexts (Chapter 7). Individuals took the opportunity to debate each other (e.g. their perceptions of 'nerds'), and to use their expert knowledge to inform each other on issues (e.g. programming a computer game). Participants demonstrated increased confidence in discussing STEM after only three interview sessions. This progress could be developed further by embedding a 'personal, social, health and economic' (PSHE) approach in STEM education. With appropriate guidance from teaching staff, young people could explore topics such as those laid out in Chapter 2. Broaching issues surrounding STEM access would inform young people of potential future challenges, whilst providing constructive counterpoints, such as addressing stereotypes and common misconceptions about who can succeed in STEM, and what 'success' should look like. Research into 'stereotype threat'[47] has demonstrated that reinforcing harmful stereotypes has a negative impact on individuals' performance (Brown and Leaper 2010, 862), whereas challenging those stereotypes improves self-concepts and broadens perceptions of who can participate in STEM (Weisgram and Bigler 2007; Sharkawy 2012, 315; Finegold and Jones 2017b, 32; Shimwell *et al.* 2021). Therefore acknowledging and challenging barriers to STEM are a valuable part of STEM education, and ought to be integrated into learning.

Challenging social and structural barriers to STEM is a key element of widening STEM participation, which ought to begin as early as possible to better insulate young people from their impact. Participants of this project showed little impact of such barriers, and so introducing a PHSE element to key stage 2 (or earlier) STEM education would likely benefit learners. Facilitating peer discussions where individuals can explore STEM perceptions whilst sharing and accessing each other's' knowledge would broaden pupils' understanding of STEM practice and build confidence in occupying and critiquing STEM-related spaces. Positioning pupils as experts allows them to be 'recognised' and consulted by peers as having an aptitude for something (Champion *et al.* 2016, 1028), building their self-esteem and embedding that experience within their identity (Dou *et al.* 2019, 625). Delivering this goal on a national scale represents a significant challenge; schools and teachers already deal with an immense workload (Chapter 4), and it is unreasonable to expect individual institutions to develop and sustain

[47] The phenomenon where minorities who are reminded of a stigmatised status may feel compelled to conform to those stereotypes (Maass and Cadinu 2003).

programmes of STEM-based PSHE. Systematic change is needed to the way STEM is taught within schools; in addition to learning STEM skills and knowledge, pupils must be supported in their development of a STEM identity and feeling of belonging within the wider STEM community.

The reformed Welsh curriculum specifically references issues of challenging stereotypes and recognising pupil aptitude in the context of future careers (Welsh Government 2019a, 14). The draft curriculum makes provisions for schools to pursue this guidance in ways that are most suitable for their individual context; an important step in empowering teachers and institutions, though there is a danger that this may limit schools with access to fewer resources. Low cost resources, such as Godec *et al.*'s (2017) Science Capital Teaching Approach have proven effective in increasing STEM aspirations (Archer *et al.* 2018, 7). However, it is unclear how effectively resources like this reach schools, particularly in a context where individual reports can be lost in the sheer volume of 'STEM resources' that are published[48]. The argument for a nation-wide approach does not seek to undermine the work that is currently being done by the many hundreds of individuals and organisations in STEM engagement. Rather than viewing individual engagements as separate (and therefore low impact), it is helpful to consider them in terms of a learning ecosystem instead. Derived from the work of Bronfenbrenner (1979), and repurposed by Archer *et al.* (2021) under a STEM lens, the theory of learning ecologies acknowledges that learning occurs in a range of contexts and never in isolation; this will be explored further in the following section.

10.2.4 Taking a consistent approach across all learning engagements

As concluded in Chapter 6, the power of interventions may have been greater, had they been more consistent and more frequent. Though novel intervention content was retained by participants over an extended period, there was limited evidence that pupils' perceptions of their STEM self-concepts (Chapter 8) and future STEM use (Chapter 9) were altered via participation. However, even these small changes are promising if they are considered in the context of consistent engagement – such as what can be provided by mainstream education – where they may be magnified by repeated interaction with interdisciplinary, identity-based learning. This could be achieved with a curriculum that emphasises skill usage across multidisciplinary subjects, like archaeology, which can provide long term learning experiences, and incorporate aspects of STEM and non-STEM learning. Such a curriculum should also provide

[48] On the stem.org.uk website alone there are 2147 CPD courses and a further 14,182 educational resources (as of 6th October 2020).

pupils with space to explore wider STEM issues and to share their expertise with peers. This form of learning will encourage young people to consider the relevance of their skillsets in alternate contexts, building confidence and self-esteem, and allowing them to construct new STEM identities.

However, curriculum changes only impact formal education, and would not extend to the myriad other learning opportunities encountered by young people (e.g. after-school clubs, youth clubs, museum and community events, summer schools, university open days). This thesis is framed around archaeology, but fostering aptitude and identity is relevant across all educational opportunities. Formal and informal education both have a role to play in STEM engagement, and both can be applied with greater effect when approaching the issue from similar positions. The theory of learning ecologies is a useful device to address this. Many archaeological learning engagements take the form of 'one offs' (e.g. museum, community and university events) meaning that impact of interventions is limited. Under learning ecology theory, educators can collaborate to maximise the power of their engagements. Brofenbrenner's (1979, 22) work on learning ecologies describes the relationship between individual development and external factors in terms of ecosystems. These systems encompass every physical, social and cultural context that make learning possible. Contextualising all STEM interventions within a single ecosystem of learning ensures that each engagement (including 'one offs' like this study) has value and is related to all learning experiences that come before and after.

The relevance of learning ecology theory to this thesis is twofold: both its findings and recommendations are considered through this lens. Interventions had limited impact on participants, which might otherwise be considered a disappointing outcome. However, positioning the project as part of participants' wider learning ecology recognises its value as one of their many STEM experiences as they progress through the education system. Bevan (2016) argues that young people do not follow a linear path into a STEM career, instead their interest must be nurtured across a range of contexts in their learning ecology; this project represents just one of those engagements. Learning ecology theory establishes that educational institutions should form networks within their communities and collaborate to ensure relevance and consistency in their approach. A national STEM learning network does already exist in the UK, run by STEM Learning, however the majority of major named partners are private companies (STEM Learning 2020, 14), and it is unclear how educational institutions are involved on a local and national level.

While local learning partnerships undoubtedly exist across Wales and England, this thesis asks them to use concepts of aptitude and identity to support young people's exploration of STEM. Adopting a consistent approach between formal and informal learning will allow young people to recognise the relevance of their interests and skillsets in STEM, across a range of learning and social contexts. Supporting young people to build confidence and self-concepts as legitimate members of a STEM community is key to facilitating and maintaining aspirations and expectations for future STEM participation. In the event that archaeology was incorporated into the national curriculum through the lens of skills/aptitudes, it would be essential for archaeological educators to adopt this framework to ensure consistency between school-based and 'real world' archaeological engagement.

10.3 Chapter 10 summary

This thesis examined the value of archaeology in presenting primary level pupils with a novel access point to STEM education. It focused on skills and aptitudes to observe how participant identities were aligned with STEM, and how this could be influenced by archaeological interventions. Despite their experiences of interdisciplinary learning in the archaeological interventions, evidence of how participants felt their skill/aptitude usage could transcend subject silos was limited. Understanding of skills/aptitudes which would best serve personal future STEM practice was largely mediated via proximity to the STEM acronym rather than individuals' relationship with that particular skill/aptitude. These findings highlight the need for a new approach to primary education; one where learners consistently engage with skills/aptitudes across the whole curriculum and use metacognition to observe skill/aptitude usage in novel contexts. Adopting interdisciplinary subjects like archaeology will also encourage learners to shed preconceptions about which skills/aptitudes are valuable to STEM, and open up access points for those who have not connected with STEM via traditional means. Taking an interdisciplinary approach to education presents an opportunity to incorporate PHSE into STEM, allowing learners to explore and challenge common social and economic barriers to STEM. Despite little evidence for their impact amongst these participants, such factors are likely to become more influential as they progress through compulsory education.

This thesis demonstrated participants' limited appreciation for the vast overlap between their personal interests and STEM content or practice. An interdisciplinary curriculum would enable educators to expand upon learners' interests to create personally meaningful learning engagements. These kinds of engagements position pupils as 'experts' and create opportunities for individuals to embed learning experiences within their identity. Current curriculum reform in Wales is a golden opportunity to capitalise on the findings of this thesis; proposed flexibility to the curriculum allows educators to take an interdisciplinary approach, resulting in a cohort of learners who understand their abilities and the value of their contributions across a range of educational contexts. However, curriculum reform only addresses compulsory education. To fully maximise the potential of this approach, a level of consistency must be maintained across all learning opportunities (e.g. extra-curricular and youth clubs, museums and other community-based learning). Recommendations for achieving these objectives are outlined in the next chapter.

11 Chapter 11: Recommendations

This thesis has demonstrated the need for a new approach to primary education, one that is guided by concepts of ability and identity across all learning engagements. The role of archaeology in this is clear: its interdisciplinarity can support learning across the whole curriculum and present learners with consistent and frequent opportunities to recognise the relevance of personal skills/aptitudes in multiple contexts. Total curriculum overhaul is a considerable undertaking, but this proposal is made in a period of substantial curriculum reform in Wales, and smaller – but still important – changes to Ofsted guidance in England. This new approach will empower young people to recognise the value they bring to STEM contexts and envision themselves as legitimate members of a STEM community. The following recommendations are intended to guide educators and policy makers in capitalising on these changes for the benefit of learners and their ongoing STEM participation.

11.1 Frame education around skills, aptitudes and identity

Developing an identity which the individual perceives as being compatible with and valued in STEM is crucial to young people's participation. Self-concepts of skills and aptitudes are key contributors to identity development, and emphasising their application across the STEM curriculum can empower young people to connect with content in a personally meaningful way. Reflecting on skill and aptitude usage provides insight into the relevance of those which are less commonly associated with STEM (e.g. artistic, imaginative); young people who identify in this way would be better placed to understand the contributions and value they bring to STEM contexts. Widening reflective practice beyond STEM subjects to the entire curriculum would emphasise the relevance of STEM in numerous aspects of life, and its accessibility across contexts. Encouraging learners to observe 'traditional STEM' skill usage in 'non-STEM' contexts (e.g. mathematics of music, engineering in art) would strengthen their understanding of how their skills and contributions are valuable across the whole curriculum. Interdisciplinary subjects demonstrate skill/aptitude use across the curriculum, and should therefore take a more central role in formal education. Reconfiguring self-concepts in this way will allow young people to integrate STEM alignment into their identity, which is essential for maintaining STEM participation. Appreciation of cross-curricular skillsets would also benefit young people who *do* align with 'traditional' STEM skills, presenting them with connections to disciplines (e.g. fine and performing arts) which may have previously felt inaccessible, and allowing them to take advantage of associated benefits (e.g. mental wellbeing, confidence). This framing of education may produce a future where skills and subjects are not pitted against each other, and instead are recognised for the ways they complement and add value to each other.

For individuals to recognise broader skill use in STEM, they must deploy those skills across a truly open curriculum, such as that which will come into practice in Wales from 2022. This is where cross-curricular subjects like archaeology are invaluable. The interdisciplinarity of archaeology is a perfect vehicle for cross-curricular teaching where learners can appreciate skill and aptitude usage across a range of disciplines, but with the understanding that all of their actions contribute to an overall 'STEM practice'. Appendix 38 demonstrates how general archaeological practice meets learning requirements of the 2022 Welsh STEM curriculum. Metacognitive reflection is also encouraged by this new curriculum, which establishes an excellent opportunity to embed skill and aptitude usage into learning. Reflecting on skills as they are used will encourage young people to think more deeply about themselves, going beyond the topics they 'like' to consider the ways of working and learning that they connect with most. Metacognitive practice could take a central place in each learning engagement; similar to learning objectives being outlined at the beginning of each session, learners could be made aware of the skills they might use. This could even be developed further, with learners predicting which skills they think will be useful in the session, and reflecting on how their expectations were met or challenged at the end. Skills and aptitudes could be selected from a 'bank' (such as that presented in Macdonald 2015), which is then adapted and added to by learners as they gain confidence in examining and categorising their practice.

11.2 Collaborate with archaeologists and other interdisciplinary specialists to develop an open curriculum

Providing a truly cross-curricular educational experience for learners requires consultation of interdisciplinary subject specialists, such as archaeologists, engineers and social scientists. Curriculum reform currently underway in Wales makes this recommendation especially relevant to schools preparing for a new education system. Under this system schools will have the freedom to develop individual curricula which best meet the needs of learners. Appendix 38 demonstrates the relevance of archaeology[49] across the new Welsh curriculum. Archaeological excavation and other fieldwork provide excellent opportunities for pupils to engage in physical investigations using practical, spatial and temporal skills. Other types of archaeological investigation (e.g. zooarchaeological, botanical, small finds analysis) also allow young people to develop observation and classification skills, data collection, analysis and interpretation skills, followed by synthesis and communication (e.g. verbal, written, visual, digital) skills. Experimental archaeology combines aforementioned investigative and data-related skills with

[49] In progression step 2, which approximately correlate with what was previously known as key stage 2; the level of participants in this research.

creative design, allowing pupils to explore ideas about the past through practical investigation (e.g. crafting objects, digital or physical re/construction of built or natural environments, food processing and cooking). Collaboration and interpersonal skills can also be developed via the group work scenarios likely required by large scale investigations or experimental construction tasks. However, teachers wishing to develop such learning engagements would benefit from additional support and specialist knowledge.

Two major forms of support exist for Welsh schools in the process of developing their own curricula to meet new requirements: a National Network for curriculum development, and curriculum reform funding. These supportive resources are outlined here with suggestions for how they can be adapted to facilitate schools' consultation of interdisciplinary subject specialists in their curriculum development. The National Network aims to connect '*teaching professionals, experts, stakeholders, policy makers and enabling partners… to identify and address the barriers to, and opportunities for, the implementation of Curriculum for Wales*' (Welsh Government 2021a). Schools will be provided with funding to send representatives to National Network events and contribute to 'Conversations' about curriculum development, which will result in future curriculum guidance and resources. In Autumn 2021, a 'Conversation' topic was: *'how can those outside schools and settings (e.g. third sector) support the development of Curriculum for Wales resources and supporting materials?'* (Welsh Government 2021a). This acknowledges the importance of consulting with external specialists to develop robust and relevant learning experiences. Archaeological representatives (and those of other interdisciplinary subjects) must attend pertinent National Network 'Conversations' to provide perspectives on cross-curricular education and promote the unique opportunities presented by these subjects.

Archaeologists' presence in 'Conversations' must then be followed up with consultation on curriculum content. Though archaeology represents a valuable opportunity to pursue cross-curricular learning, anecdotally teachers have found it challenging in terms of subject knowledge and resource access. These concerns should be addressed via collaboration with archaeological educators to create appropriate learning engagements and resources. It is essential that archaeologists (and other interdisciplinary subject specialists) receive financial support for their time and expertise, and that schools are able to fund this. Curriculum reform funding is currently available to schools, which they may use to consult external experts. However, this funding is not intended to produce a third party 'off the shelf' curriculum, and must be used to develop schools' capacity to produce curricula. Supporting schools to create sustainable curriculum development practices is key to the success of the revised Welsh education system, and so this funding restriction is understandable. It is recommended here that once curriculum production skills are established in schools, future funding must provide flexibility for institutions to consult with external partners and specialists. Current curriculum reform funding guidance emphasises the importance of schools pooling resources to maximise funding outputs (Welsh Government 2021b). Using interdisciplinary subjects to teach skills across the curriculum represents another cost-saving measure, as it will potentially reduce the number of specialists being consulted. The principle of co-construction underpins curriculum reform guidance; specialist consultations must mirror this, where archaeologists (and others) present expert knowledge and resources for teachers to embed within their own pedagogical frameworks. This relationship could also present external specialists with an opportunity to broaden their own pedagogies, and to develop closer links between formal and informal education.

The updated English Ofsted school inspection framework states that learners should engage with the full curriculum *'for as long as possible, 'specialising' only when necessary'* and *'develop detailed knowledge and skills across the curriculum'* (Ofsted 2021). Interdisciplinary subjects like archaeology are an excellent solution to this, as they introduce cross-curricular engagements into an education system that remains divided by subject. Funding should also be made available to educators in England to exploit the potential of interdisciplinary subjects, which could be spent on expert consultations, resources and materials. A great deal of information and resources currently exist to support Welsh and English educators access subjects like archaeology (e.g. Council for British Archaeology and English Heritage) engineering (e.g. Engineering UK and EESW STEM Cymru), but much of this is focused on pre-existing and/or 'one off' engagements. Bursaries are also available through some external institutions, though these are often small (e.g. Engineering UK) or granted to individual students to support their continued study (e.g. Royal Academy of Engineering). Government level investment has the scope to provide much more substantial funding, and to demonstrate policy makers' commitment to cross-curricular education. Such funding would empower schools to pursue interdisciplinary subjects consistently and on a long-term basis, while tailoring content to the needs and interests of their learners. Funding strategies for Wales and England ought to be carefully considered to ensure that schools with additional funding priorities (such as those covered by the pupil deprivation grant and pupil premium) are able to access the full benefits of interdisciplinary learning, and are not obliged to spend this funding elsewhere.

11.3 Centre learners’ interests and abilities in educational engagements

All formal and informal education ought to involve an element of collaboration with young people, where STEM is explored via their current interests and abilities. This approach complements the first recommendation: by ‘broadening what counts’ educators challenge concepts of what is valued in STEM, and support young people to see themselves as legitimate members of a STEM community. Enthusiasm for common interests highlighted by participants in this study (e.g. gaming, sport, arts and crafts) is mirrored amongst the primary population of Wales and England, and resources exist to support STEM education in these areas. Many teachers (including participants in this study) already practise pupil-led pedagogy, but informal educators (including archaeologists) are less familiar with attendees and often prepare materials in advance of meeting them. Extra-curricular learning experiences are learner-led to some extent, as individuals attend voluntarily, whereas, formal education relies on teachers identifying experiences that meet their pupils’ interests. Both formal and informal educators would benefit from a deeper understanding of the their learners’ interests. School teachers could tailor lesson content throughout the academic year, engineer opportunities for individuals to share expertise with the class, and invite relevant external partners to work with pupils. In/formal educators would benefit from interest profiles, which provide insight into learners prior to engagements, enabling them to select their most appropriate content (though this approach would be of less use in ‘drop-in’ learning environments).

Interest profiles could follow a similar process to the self-reflections in Chapter 8, where individuals record skills and interests (e.g. two interests and three skills) that they most identify with. This could be done with the support of a central ‘skill bank’ such as that presented by Macdonald (2015, 22-3), but with clearly signposted opportunities for young people to adapt responses to represent themselves appropriately. Profiles would then be revisited at regular intervals to allow individuals to reflect on their development and update interests and skills accordingly. Pupils should understand that these profiles are working documents: flexible and subject to change as frequently as an individual might change themselves. To prevent individuals from feeling ‘pigeonholed’ by their profile, it must be generated with the understanding of how skills and interests are relevant across the whole curriculum. A child who identifies with creative practice must be equally encouraged to recognise and utilise creativity in maths and science, as with art materials.

11.4 A STEM curriculum which challenges and addresses barriers faced by pupils

STEM education must encompass more than knowledge and skill development by embedding an element of PHSE to prepare young people for barriers they may encounter when pursuing

STEM. Disassociation with STEM in later adolescence is a widely reported phenomenon linked to a number of social and institutional factors. An absence of comprehensive STEM career advice, preconceptions about who is suited to STEM, and alienating learning or working environments, all serve to reduce the number of young people persisting with STEM. Welsh and English curricula require that pupils learn about the impact of science and technology on society (DfE 2014, 5; Welsh Government 2020, 215), and it is sensible for them to also consider how society impacts people's access to science and technology. A STEM curriculum that acknowledges and challenges access issues would allow young people to make fully informed decisions about their futures. Findings from this project demonstrate the efficacy of peer discussion in altering pupils' perceptions and understanding of STEM concepts, and this must be extrapolated into mainstream education. Content would address and challenge misconceptions about who can participate in STEM, which skills and experiences are valued, and what opportunities are available to those who persevere with STEM education. Responsibility for making access to STEM equitable lies with everyone and learning about potential barriers to STEM is essential, even for those less likely to be affected by them. Understanding challenges faced by peers and colleagues is a crucial step in creating inclusive STEM spaces. Such interventions must begin before adolescence: prior to GCSE and A level decisions, which influence individuals' future options, and before children internalise social messages about what is 'appropriate' for them.

11.5 Exploit learning ecologies

The above recommendations are not designed to be used in isolation by individual institutions; to have the greatest impact, they must be implemented across entire learning ecologies. A robust learning ecology comprises multiple, complimentary STEM learning opportunities. Learning networks are a powerful tool in this, allowing educators to take a unified approach to STEM engagement and increase the impact of each learning experience a child encounters. Adopting learner centred, interdisciplinary and identity focused approaches throughout informal education in addition to mainstream schooling will ensure even greater consistency and frequency of engagement with these concepts. Collaboration across learning networks will allow educators to frame each learning opportunity around this approach, and to support learners in developing a STEM identity which translates across many formal and informal educational contexts. Reforms to the Welsh curriculum call for collaboration between schools and external experts to develop curriculum content. These relationships could be expanded to include educators outside of school-based contexts, and be extended beyond curriculum development, eventually representing a local network of educators and other stakeholders who co-produce consistent educational opportunities across pupils' learning ecologies.

Communicating young people's interests and abilities as they move between engagements is key to helping educators create effective and relevant experiences; the interest profiles of section 11.3 would serve this purpose. These profiles would bridge the gap between formal and informal educators, allowing facilitators of new learning experiences to adapt content for each cohort of learners. Developing these profiles would ensure that young people reflect on personal progress, and provide additional insight into learners for formal educators. For example, in the case of a child finding new inspiration in an extra-curricular engagement, this newly favoured way of working could be communicated back to the individual's school teacher.

11.6 Chapter 11 summary

The above recommendations pave the way for a new approach to primary education and STEM engagement, where learners recognise their abilities and interests across a range of learning contexts and are confident in the contributions they can make to STEM knowledge and communities. Archaeology and other interdisciplinary subjects sit at the centre of this vision by facilitating engagements across the entire curriculum. In the current climate of historic education reform in Wales, the findings and recommendations of this thesis highlight an unparalleled opportunity for archaeology to contribute to the future of primary education and STEM participation.

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13 Appendix 1: Pilot teacher interview findings

The following outlines findings from pilot teacher interviews, undertaken with three teachers (PT1, PT2 and PT3) from an external primary school. Responses covered a range of themes, including: factors which impact pupils' engagement with STEM at school and at home; experiences and approaches of teachers when tackling STEM; suggestions for how these challenges might be addressed.

Pupil engagement with STEM

All three teachers agreed that their pupils enjoy engaging with STEM. PT1 noted that pupils particularly enjoy the 'hands on' and practical aspect of STEM learning, that allows "*children who are poorer academically,* [to] *shine* [during] *STEM activities'*. She highlighted how the 'trial and error' nature of STEM learning, creates an environment in which pupils can engage without fear of wrong answers. She felt that this learning environment helps to build the self-esteem and confidence of her pupils. PT2 noticed a difference in pupils' behaviour during STEM activities, noting that the level of conversation between the boys in his class was at a much higher standard than had been observed in other lessons. PT2 expanded upon the concept of pupil enthusiasm for STEM, stating that in his experience, pupil interest in a subject is proportional to the enthusiasm of its delivery. He had noticed that "*if you come across really interested… then their engagement goes up and up and up"*.

When it came to the likelihood that their pupils engage with STEM at home, the responses were more conflicted. PT2 did not think that his pupils engage with STEM outside of school, and noted a possible parental influence. He suggested that parents may not be aware of STEM, or of its value, meaning that pupils are not encouraged to engage with it at home. PT1 disagreed with this opinion, she felt that her pupils are often exposed to outdoor play, which develops their creativity and exploration in construction. However, she also cited an absence of parental influence in these activities, suggesting that *'lots of the children are left to engage and entertain themselves'*. The difference between PT2 and PT1's views on this, may be partly explained by the age of their pupils. Much of Foundation Stage (FS) teaching is based around child initiated learning, and learning through play, in contrast to Key Stage 1 (KS1) teaching, which is more formalised and teacher-led. It is understandable then, that PT1 (FS) considered playing in one's garden to be a learning experience, while PT2 (KS1) felt that a clearer focus, and perhaps an element of adult guidance is required for learning to take place. It is also fair that PT2 expected a more complex level of engagement from his pupils, who are two academic years ahead of PT1's.

PT3 did not give a definitive answer, as to whether she believes her pupils engage with STEM at home, but she did highlight the importance of parental involvement. She drew the same links as PT2, between the value placed on a subject by one's parents, and the likelihood of a child pursuing it as an interest. Additionally, she felt that while many parents of her pupils do want to help their children with maths, specifically the homework that is set for them, they often feel ill equipped to provide maths support. She suggested that the wide variety methods available for teaching maths skills was a key reason for this uncertainty, and the fear of teaching their child the wrong method, hinders parental maths support.

All participants agreed that they engage with STEM in their own lives outside of school. However, there was a clear difference between PT3, who pursues STEM via her own personal interests, and the other two teachers, who engage with it through their children. PT3 outlined an interest in neuroscience, as well her resolution for personal improvement in higher level maths. PT2 described engaging in 'fairy tale inspired' outdoor exploration with his daughter: building bridges and creating 'tracks' in a local area of woodland. It is likely that PT2 and PT1 do engage with STEM on a personal level, but were unable to think of examples when put under the pressures of an interview. This issue will be addressed in the 'Reflections and Modifications' section of this report.

STEM resources

When it comes to gathering ideas and resources for STEM lessons, all three participants said that they made use of the internet. PT1 and PT3 both mentioned the use of books, but PT3 found them of limited use, as many more ideas were available to her on the internet. PT3 also described the ideas she found on the internet as '*far more up to date'* than those in books, citing a recent Year 1 experiment where pupils made slime. PT2 agreed that the internet was a useful source of ideas, particularly the STEM Learning website (www.stem.org.uk). However, he raised the issue that many of the activities available to 'Primary' teachers are pitched too high for Infants, and that further modification of them is often required to make them accessible to his pupils. PT1 stated that her preferred website for STEM lesson ideas was Pinterest, stating that the highly visual format of the website was useful when gathering ideas. All three participants also mentioned that they often gathered ideas from their colleagues and peers.

When asked about the ease of gathering resources for STEM activities, PT2 felt that they were easy to come by *'if you look'*. It is not clear however, from his answer, whether he was referring to finding ideas, or acquiring actual physical resources. PT1 and PT3 were united in their opinion that obtaining resources was sometimes problematic. Both teachers mentioned that the expense of buying resources was a concern, as was the importance of time management, when planning activities. They both recalled how in the run up to STEM Weeks, it is necessary for each teacher to make a list of their required resources, so that they might be ordered in time. According to PT3, these lists are sometimes provided too late, making the acquisition of resources more difficult. PT3 also highlighted the issue of storage space within the school, and the concern that teachers must always have more resources than they anticipate they will need, to give pupil's a choice of materials to use. Additionally, she noted that re-use of equipment was a problem, with many resources being used only once if teachers fail to repeat activities from year to year.

Making STEM inter-disciplinary

All three participants agreed that STEM teaching and learning ought to be inter-disciplinary. PT3 and PT1 pointed out that STEM was already a mixture of disciplines, and when asked, PT1 said she had not tried to link STEM with arts or humanities. She did, however, say that she thought linking STEM and humanities could be beneficial, although did not elaborate further. PT2 stressed that he always tries to link learning topics to multiple subject areas for his pupils, although he sometimes finds that this can be *'tedious'* if the activities are only *'faintly related'*. He described a 'Healthy Eating' topic, during which pupils created their own healthy pizzas and then made boxes to take them home in. He felt that these activities were an effective combination of maths, (weighing and measuring ingredients), design and construction skills. PT2 also mentioned that he had supported pupil exploration of materials that are 'fit for purpose' while making Christmas cards; pupils were encouraged to trial different ways of attaching decorations to their cards. He believed that primary teachers have more scope to be creative when making these cross-curricular links, than those who teach in secondary schools, although he emphasised that this takes careful planning and support from colleagues. PT2 also felt that their efforts to make these cross-curricular connections have improved each year, as their own experience and confidence in STEM delivery increases.

Influences on pupil engagement with STEM

PT2 thought that the biggest influence on pupils' long term engagement with STEM subjects and careers, was confidence. He recalled that during STEM week, pupils were able to engage with maths activities much more effectively because they were not labelled as such. He said: '*some of the children aren't confident in maths, so if you gave them a maths task, and said it was a maths task, they would immediately put their barriers up, saying they can't do it. Whereas,* [with] *STEM, they're not quite sure they're doing maths on some of the activities so they're confident'*. PT1 proposed that an influence on pupil engagement with STEM may be the fact that the way they are taught changes as they progress from the Foundation Stage upwards. She felt that pupils have fewer opportunities to engage with *'child initiated'* STEM exploration as they move up through school, and that this may impact their enthusiasm for it. She noted that KS1 pupils respond particularly well to engineering-based activities, and suspected that this is because they were reminiscent of the explorative, child-led style lessons seen in the Foundation Stage.

PT1 and PT3 suggested that gender may play a part in pupil STEM engagement. They both noted that girls' interest in STEM appears to be limited once they reach secondary school. PT3 elaborated on this, questioning how the views of society may negatively influence girls' interactions with STEM subjects and careers. She also considered how many of these views go unchallenged, as pupils do not have access to role models who might realign their perceptions to the reality of STEM careers. She opined that many of her pupils are not aware of the breadth of STEM career options in the modern UK job market, and consequently, these careers are unattainable for them. PT3 also noted that the knowledge of primary teachers is influential on pupil engagement with STEM. She suggested that they are not always equipped to pass on correct scientific information, such as *'why a rainbow is arched, or why the sky is blue, or why a ship doesn't sink'*.

Challenges to teachers when teaching STEM

All three participants mentioned that the personal knowledge of teachers was a key factor in STEM teaching. PT1 found that she is often asked by her colleagues to remind them what 'STEM' stands for. She felt that this is linked to a lack of understanding of the importance and value of STEM. PT3 expanded on this point by criticising the length of teachers' training courses. She believed that nine months is not long enough to train a teacher effectively, and suggested that insufficient training is a major contributor to the high attrition rate of newly qualified teachers. Both PT3 and PT2 stated that having confidence in a subject was crucial, and that in the absence of confidence in STEM, teachers will often revert to subjects that they feel more comfortable delivering. This was particularly well illustrated by the question of which area of STEM the participants enjoyed most; when asked, all selected their own discipline.

PT3 and PT2 noted that time restrictions are a further hindrance to STEM teaching. PT2 felt that the time spent preparing for SATs exams prevents him from considering STEM as much as he'd like to: *'I feel like the constraints of curriculum content we've got to get covered, really hold back on the amount of STEM that we can put in'*. PT3 also highlighted that pressure on teachers differs from school to school, and that concerns with things like pupils' reading levels can lead to a lack of focus on STEM. Additionally, PT2 stated that with all of these other pressures in mind, teachers sometimes struggle to keep STEM at the forefront of their minds when planning lessons. He felt that STEM Weeks each term are a good way to overcome this, as it serves as a reminder to consider STEM.

Finally, PT1 raised the issue of funding. She suggested that the difficulty in attaining and paying for resources could be a challenge in delivering STEM lessons. PT3 had also found that funding could be a barrier to STEM participation. She outlined a scheme provided by the car manufacturer Jaguar, aimed at connecting children with engineering. However, she was not able to continue with it, as the cost exceeded what the school could afford to pay.

Personal challenges when teaching STEM

PT2 and PT3 both stated that time was an important factor in their own experience of STEM teaching. PT2 and PT1 also mentioned their confidence in a subject was sometimes an issue. PT1 mentioned that she did not always feel as confident with maths, as with other subjects, especially when planning work to challenge her most able pupils. PT2 explained that while his confidence in Technology was very high, he felt he was still developing in other areas. He felt that the more experience he has of STEM teaching, the more confident he feels delivering it to pupils in new ways. He described how he reflects upon his teaching to identify areas where he might improve his STEM content and create links across the curriculum.

Most important challenge in STEM teaching and learning

PT1 stated that she felt the biggest influence on pupil engagement with STEM was their own enthusiasm for the subjects. She suggested that the biggest challenge was *'the barriers to children themselves'*, indicating that a child's personal experiences are what shapes their world view, and ultimately decides whether they participate in STEM. PT2 believed that the biggest barrier to STEM engagement is the time available to teachers. He suggested that finding the time to plan, and teach STEM content amongst all the other requirements of the curriculum can be challenging.

To address this issue, PT2 recommended the utilisation of STEM practitioners from outside of school. He has found that inviting experts in to speak to his pupils can go some way to eliminate concerns about time for lesson planning and whether he possesses adequate knowledge of a subject. He also noted that pupil enthusiasm for a topic is increased when it is taught by someone who can display a passion for it. However, PT2 did note that the follow-up resources provided by external practitioners are sometimes in the form of an internet based activity. He explained that many of his pupils do not have access to the internet, preventing them from using these resources.

PT3 thought that the most important factor in STEM participation is whether a child has appropriate roles models in their life. She felt the presence of role models would enable a child to see the wide variety of STEM careers and challenge the misconceptions that are placed upon them. PT3 suggested that teachers can begin to tackle these issues by visiting places where STEM careers are displayed, such as Jaguar. She also highlighted the need for a shift in the way society perceives and discusses people in those careers, citing the use of *'geek'* as an abusive term.

Finally, PT3 mentioned the importance of having an inspirational teacher to foster a life-long interest in a subject. As an example, she described an experience that her husband had as a child: one of his teachers had an interest in bird watching and set up bird feeders outside of the classroom. Each day, pupils would be encouraged to observe the birds and to ask questions about their physiology, habits and habitats. This experience stayed with him, and he is now a keen bird watcher. While this example did not lead to a career in STEM, it is nonetheless an excellent example of how a passionate and inspirational teacher can have a positive influence on a pupil, lasting into adulthood.

Discussion

All three participants were united in their belief that their pupils enjoy STEM learning, and engage with it well during school. However, there was a suggestion that pupil interactions with STEM outside of school hours may be subject to parental influence. Participants indicated that some parents do not feel comfortable facilitating STEM activities with their children, meaning that pupil engagement outside of school is limited. All participants stated that they themselves engage with STEM outside of school, although only one of the three implied that this was due to a personal interest in a STEM subject. Evidently, these teachers feel parental encouragement is important in a child's STEM interactions, as is shown via the support of their own children's STEM learning.

When gathering ideas for STEM lessons, all participants said they use the internet and fellow members of staff for inspiration. Books were found to be less useful, as they have limited content and are not always up to date with pupil interests. The primary concern of these teachers, when acquiring resources for STEM activities, appears to be the expense. It was suggested that ideal resources are often 'everyday' items, that can be reused from year to year.

Teachers also highlighted the importance of planning and time management, to ensure that all resources are obtained in time for lessons. While it was claimed by one teacher that these factors do not affect her lessons, it seems likely that a school's budget will have some impact on the activities and opportunities available to its pupils.

The major influences on a pupil's long-term engagement with STEM, as highlighted by the participants were confidence and role models. They believed that pupils lacking either of these things were less likely to engage with STEM throughout their lives. The issue of confidence in STEM subjects was not restricted to the pupils themselves, but also included their parents and teachers. It was suggested that pupils' exposure to STEM might be affected by the confidence of influential adults; by engaging only within their own 'comfort zones', these adults could be indirectly reducing a child's opportunities to participate in STEM. Additionally, without role models in their lives to promote the breadth and variety of STEM careers, many children will not be aware of the opportunities available to them. Children cannot aspire to something if they do not know it exists, and therefore pupils without STEM role models are less likely to pursue STEM careers.

Some participants felt that a key challenge faced by teachers in their approach to STEM teaching was that other pressures and requirements of the curriculum leave very little time for them to address STEM. The KS1 SATs exams were flagged as a concern, as some teachers may feel that other areas of learning, are neglected until SATs are completed. It was also suggested that the pressures placed on teachers differ between schools, depending on the focus for improvement in each one. Therefore, it is possible that pupils' STEM engagement might be affected by the specific concerns of the school they attend. Additionally, while all children attend school from the same age, there is some discrepancy between their relative stages of development by that age. Some schools find it necessary to provide a high level of support to their pupils, for example developing fine motor skills to enable a child to hold a pencil. It is reasonable to assume that in schools where this is the case, there is limited time available for STEM exploration, compared to those where pupils display more advanced stages of development.

To conclude, the challenges to STEM engagement are complex and multi-faceted. Both internal and external factors can influence a child's experiences with STEM, from their own confidence, to the visibility and availability of STEM opportunities around them. Although teachers and schools may strive to provide a comprehensive STEM experience to their pupils, they are in turn affected by the resources available to them, as well as their personal subject knowledge.

Implications for this research project

Any archaeological interventions proposed by this PhD project must consider these factors. While an external STEM practitioner may free up a teacher's time, space must still be found in the school's timetable for their visit. As a result, external practitioners must ensure they maximise the output of their visits appropriately. Additionally, this project must achieve its aims at no financial cost to participating schools. The results of this study have also highlighted the importance of ensuring that the follow-up resources provided to pupils are accessible. Activities that require an internet connection, or complex equipment may not be appropriate for all pupils. PT1's assertion that pupils respond well to the practical element of STEM teaching, ought to be explored further. Identifying and utilising the most effective styles of teaching will be important in ensuring the success of this project.

In a more positive light, the results of this study have compounded some of the ways in which this project may be beneficial. Issues of planning time, and teachers' confidence in a subject can be negated somewhat by utilising an external practitioner. This person takes the burden of responsibility for organising a lesson, and provides the 'expert' knowledge and resources that teachers may feel they lack. By presenting STEM content through the medium of an enthusiastic female practitioner, this project can attempt to address some of the negative misconceptions that pupils may have about STEM careers.

Reflections and modifications to question schedule

The phrasing of the introduction to the questions was found to be problematic in the first interview, conducted with PT2. By stating that *'I would like to ask you about your experiences as a primary school teacher delivering STEM content'*, the interviewer gave the impression that they wanted the respondent to begin speaking before a question had been asked. In consequent interviews, this statement was rephrased to: *'I would like to ask you some questions about your experiences as a primary school teacher delivering STEM content'* to indicate that the respondent ought to wait for a specific question before speaking. Additionally, the length of the introduction was slightly too long, and will be shortened to reduce the time spent by participants listening to the interviewer.

The question *'In your opinion, what is the level of pupil engagement with STEM subjects in your class?'* may also be subject to rephrasing, due to the unclear meaning of the word 'engagement'. Here, it was supposed to identify whether teachers think their pupils enjoy STEM lessons. However, the alternate meaning of the word ‘engagement’ within teaching to mean ‘focused’, meant that this question was not understood in the way it was intended. It will be necessary to replace the word ‘engagement’ with ‘enthusiasm’, in further iterations of this question.

The question asking whether teachers felt the level of STEM engagement in their pupils was reflected in the rest of school, was designed to recognise teachers who hold a special interest in STEM. It was suspected that teachers who are particularly interested in STEM might find that their pupils engage with it more often than those in other classes. None of the teachers who were asked this question believed that their pupils were more engaged with STEM than any others. It is possible that this was due to a lack of personal interest in STEM amongst the participants, or it may be that this question requires further clarification. It may be of benefit to combine this question with the later query about teachers’ personal STEM engagement outside school.

On this note, it is worth highlighting that the phase ‘outside school’ was also found to cause confusion, as to whether the interviewer was asking about activities ‘at home’ or ‘outdoors’. The question regarding pupils’ STEM engagement outside of school, will be modified to: ‘*Do you think your pupils engage with STEM at home?*’. When asked about their own STEM engagement outside of school, most participants described their interactions in relation to their children. This question was intended to pinpoint how teachers engage with STEM on a personal level, and to identify teachers with a clear interest in an area of STEM. However, it is likely that when put upon the spot, participants were unable to specify exactly how they engage with STEM in day to day life. It may be necessary to change the format of this question from an open-ended question to multiple choice. Presenting participants with examples of possible STEM interactions might produce more comprehensive and accurate answers. This multiple-choice question could then be followed up by asking whether the participant has a personal interest in STEM, and how this might influence their teaching.

It was hoped that the question ‘*which aspect of STEM teaching do you feel pupils respond to best?*’ would provide insight into the teaching methods and styles that were deemed most effective in STEM lessons. However, there is potential for this question to be interpreted as enquiring which STEM subject pupils respond to best, e.g. maths, science or technology. To prevent this misunderstanding, the question will be rephrased to *‘what do you think pupils enjoy about STEM lessons?’*. The follow up question of which aspect teachers enjoy most about STEM lessons will also be modified accordingly: *‘what do you most enjoy about teaching STEM lessons?*’.

It may be necessary to amend the question of STEM lesson preparation further, to enquire about the names of specific websites and other sources that teachers prefer to use. In this study, it was noted that the official STEM website was not always appropriate for primary level teaching. It would be useful to know whether other teachers have had similar experiences. A further point of interest was one teacher's use of Pinterest, which may not be associated with STEM by those who are unfamiliar with it. It may be the case that other websites are being used as unlikely sources of inspiration for teachers, and if so, would represent a point of interest to this research.

The question '*do you find that resources for STEM lessons are easy to come by?*' may also require clarification, in that it is referring to the acquisition of physical objects, rather than ideas. It would also be beneficial to expand the question of whether difficulty in gathering resources affects lessons. While teachers may feel that they are able to provide STEM lessons with the resources available to them, it is likely that those with a wider range of resources are able to explore STEM further in their lessons. Pressing teachers on this topic might be achieved by asking '*would you do anything differently if you had access to more resources?*'.

Questions about 'interdisciplinary' teaching will be altered to 'cross-curricular', to better reflect the language used by teachers rather than academics. Provision will also be made to enquire more effectively about how teachers can attempt to make STEM cross-curricular with other areas of learning, such as humanities and arts. Finally, the interviewer must remember to ask for examples of how teachers have attempted cross-curricular teaching in the past. It is also important to ask teachers their opinions on how practitioners might go about tackling the issues we have discussed.

These alterations will be considered and applied to further iterations of this interview schedule.

14 Appendix 2: Pilot teacher interview transcript, PT1

Title: STEM Teaching Experiences (Pilot)

Date: 18th January 2018

Speakers: Poppy Hodkinson (interviewer) and PT1

File Duration: 10 Minutes

Interviewer: I'm interested in some of the reasons why the UK has such low levels of engagement in Science, Technology, Engineering & Mathematics (STEM) careers. A lot of research has shown that people's attitudes towards STEM careers are formed at a really young age, and so I want to find out what can be done at primary school level to try and encourage and enhance the enthusiasm of pupils for later life. So, I'd like to ask you a few questions about your experiences as a primary school teacher delivering STEM content. So first, may I ask how many years you've been a teacher?

PT1: Nearly 12 years, I think

Interviewer: Okay cool, and what is your current position at [School]?

PT1: Year 1 teacher and science coordinator

Interviewer: Awesome, okay. In your opinion, what is the level of pupil engagement with STEM subjects in your class?

PT1: Quite low level, I would say. I do find that when we do STEM activities, I notice that the children who are poorer academically, with literacy and numeracy, shine when we do STEM activities

Interviewer: Really? That's really interesting. Would you say that they're keen for them? That they enjoy them?

PT1: Yeah, because I think it's very hands-on, it's very practical, so they can express themselves. It involves a lot of trial and error, so they can test things without worrying about getting it wrong. So, I think, for them, that really helps them with their self-esteem and their confidence

Interviewer: Yeah, I suppose that's what science is about, it's about making mistakes

PT1: That's it yeah

Interviewer: That's really interesting. So do you think that the level of engagement that you see with pupils in your class is reflected across the rest of the school?

PT1: I would say it's very similar, I wouldn't say there's anything that stands out

Interviewer: Fair, do you think that your pupils engage with STEM at all outside of school?

PT1: Yes, I think they probably do. Because they are very hands on children. A lot of them are probably left to, I'm not saying this is actually the case, but I imagine lots of the children are left to engage themselves, and entertain themselves. That might be playing in the garden, or out playing, you know. And I think then they're using resources around them, whatever that they can find to build, to make, to be creative with. So, I think they do

Interviewer: Okay, that's cool. Do *you* ever engage with STEM outside of school?

PT1: Probably with my children? I don't know that I would personally

Interviewer: So I just mean things like: do you go to museums, read…

PT1: Well yeah! Yeah I suppose so, things like that yes

Interviewer: Okay cool, which aspect of STEM teaching do you think that pupils respond to best? I think you might have touched on that a little bit already

PT1: Yeah, probably the science. Just because it's very exploratory, isn't it? Exploring and testing ideas, that sort of thing. And as well, the engineering, I think Key Stage 1, when we've done STEM weeks in the past, KS1 have really responded well to the engineering. Because they haven't had as much opportunity to build and to construct with different materials, as they probably have done in Foundation Stage. So that's been quite nice for them

Interviewer: Which aspect of STEM teaching do *you* enjoy teaching the most?

PT1: Probably the science, I have to say that really don't I? But no, I think science yeah. Science is probably my fave

Interviewer: So, when you're preparing for your lessons, where do you look for ideas and resources?

PT1: So, I use the internet, I've used a lot of ideas off 'Pintrest'

Interviewer: Oh really?

PT1: Yeah, there's a lot of stuff on there. Talking amongst staff, I've got a few books and things that I've referred to in the past. But mainly internet for ideas, yeah

Interviewer: Okay, are there any websites in particular that are really helpful?

PT1: I'm not sure off the top of my head, again Pinterest I've just found useful because you've got the images straight away, you've got the pictures, so you've got the visual straight away

Interviewer: Okay, and would you say that the resources for your STEM lessons are easy to come by?

PT1: Not always, and it can be expensive, so it's not always easily resourced, I don't think. Because when we've had STEM weeks, we've had to come up with lists of things that we need. Because some of them are everyday resources, but not necessarily things that we'd have to put our hands on straight away. You know, like pegs and spaghetti, and those sorts of things. A lot of it is mainly supermarket stuff that we've bought and then sent the receipts in

Interviewer: Has this ever affected how you plan and carry out your lessons?

PT1: No, because we've always made sure we've got the resources we need

Interviewer: You make it work?

PT1: Yeah

Interviewer: Would you say that you are satisfied or dissatisfied with the amount of STEM content you are able to cover in your lessons?

PT1: I'd probably say satisfied? Yeah, I think so because we do a lot of STEM, probably without realising, throughout school anyway. And then having those STEM weeks as well, we've done a couple – I think we've done two in this year actually, I'm not sure. But that's been nice, and it's nice to have a real focus on it for a whole week

Interviewer: Have you ever tried to make your STEM lessons interdisciplinary, or cross curricular?

PT1: I think it's quite cross-curricular, in itself isn't it? So, yeah, cross-curricular within the Science, Technology, Maths I would say. I can't say that I've made it cross-curricular with across any other subjects like arts and humanities and things

Interviewer: Do you think that maybe it could be of potential benefit, linking STEM with arts and humanities?

PT1: Yeah, definitely

[Pause]

Interviewer: Archaeology maybe…?

PT1: Yeah, I've heard of STEAM!

Interviewer: So, the next question is a bit of a long one. It's in three parts, so we can just discuss each part separately. I'm interested to know, when it comes to STEM engagement, which barriers, if any, you feel are in place for pupils, teachers as a group, and then yourself as a teacher?

PT1: Okay

Interviewer: So firstly, what do you feel is the biggest influence on pupil's long term engagement with STEM subjects and careers?

PT1: I would say girls not really continuing to enjoy maths and science, when they go to high school. I'd say that's probably one of the barriers. I would say that the Foundation Stage, we put so much into child initiated learning and the play-based stuff, that actually when they go further through school, it just gets less and less and they have less opportunity to engage with those sorts of activities. I'm not saying they don't have any, but they just have less

Interviewer: And what do you feel is the key challenge faced by teachers as a whole, when it comes to teaching STEM content?

PT1: Probably knowledge, knowledge of what STEM is. A lot of people say to me "what is it? What does it stand for again?". So, it's knowing "what's the point?" and "what is it?". And funding, I suppose, funding resources. If you've got your hands on the resources and the money to get stuff straight away, it can be fab. But if you haven't got it, then it's not going to work

Interviewer: It's a bit more tricky? That's fair. So, the answer to this next question, might be the same as your previous one, but what do you feel is a key challenge faced by yourself when trying to teach STEM content?

PT1: Yeah, I'd probably say the same. Maths isn't my strongest point, so I wouldn't say I avoid doing the maths, but I do find that a little bit more difficult to incorporate, probably for the more able children, to challenge them

Interviewer: I think it's fair that people are more enthusiastic about what they're more confident with

PT1: Yeah, yeah

Interviewer: So, of these three factors that we discussed, what do you think is the most important influence on pupils taking up STEM careers in the future?

PT1: Could you say that again, please?

Interviewer: Sorry! So, of the three things we discussed, which of those do you think is the biggest influence on pupils attaining STEM careers?

PT1: I would probably say the barriers to pupils themselves. So, their enthusiasm for those subjects. And I like the fact that STEM is what it is, because it makes it more fun. It's a more holistic approach to everything, rather than just having maths and science and technology and engineering. It does make it a lot more fun and a lot more hands on

Interviewer: That is actually all of my questions, so thank you very much for answering them for me!

PT1: That's okay!

15 Appendix 3: Pilot teacher interview transcript, PT2

Title: STEM Teaching Experiences (Pilot)

Date: 18th January 2018

Speakers: Poppy Hodkinson (interviewer) and PT2

File Duration: 13 Minutes

Interviewer: I'm interested in the reasons why the UK has such low levels of engagement in Science, Technology, Engineering & Mathematics (STEM) careers. Research has shown that people's attitudes towards STEM careers are formed at a very young age, and so I want to find out what can be done at primary school level to enhance pupils' enthusiasm in later life for STEM subjects. So, I'd like to ask you about your experiences as a primary school teacher delivering STEM content

PT2: Okay. Right, well we had a week dedicated to STEM, which I wasn't there for. Which was unfortunate, but I was there for the planning of it, so I was there the week before. So that went really well, and obviously that kick-started us off into having STEM and including STEM in as many areas as we can. I'd say the biggest, the constraint that we have is just time, just doing as many things as you can. I think the curriculum seems to be filled with other things, but I think you can get STEM into it. It's just, we're just not really sure the best way of putting STEM to the different areas though. I think the more experience we have of it, and the more we see of it the better we are at it. But I think because we haven't done so much of it, we're not very confident to put it in there

Interviewer: Okay, sure. So, can I ask you, what do you think is the level of pupil engagement with STEM subjects in your class?

PT2: What do you mean by that?

Interviewer: So, are the kids interested in science? Do they sort of... how do they react..?

PT2: Okay, I see what you mean. They are, they're really interested in it, especially if you're subject knowledge is really good on whatever you're doing. If you are, well if you come across really interested and up for it, and into it, then obviously, their engagement, it just goes up and up and up. I'd say the biggest thing I've noticed is the boys, how interested they are, and the biggest, those have been the biggest things I've noticed, how, just how interested they are, how engaged they are. The level of conversation that goes on between the boys is much better than what you would normally see in some of the activities we've done

Interviewer: Okay, that's interesting and do you think that level of enthusiasm that you see in your class is reflected in the rest of the school

PT2: Yeah, I think it is. We've had some good CPD [*Continuing Professional Development*] on STEM, which helped us out. Because I think we were all a bit… just not had a lot of experience. So, if you're like "I don't know what it is how to implement it", the training we had really helped. We had quite a few banks of resources, the STEM website was quite good and helpful

Interviewer: Okay

PT2: But I think, the subject knowledge is a big thing. So, if you got more subject knowledge on a certain thing, it helps out a lot

Interviewer: Okay, cool. So, you're the technology lead, is that right?

PT2: Yeah, yes

Interviewer: So, do you find it's easier for you?

PT2: I find it easier for the computing side of things, I've found that easier in delivering it and more, what's the word? Enthusiastic about it

Interviewer: Sure

PT2: So, I found that easier than say, when I was doing other things to do with geography, which we still did our best with, but I wasn't as comfortable with that, as I was with the computing side of things

Interviewer: Okay, sure. So do you think that your pupils engage with STEM outside of school at all?

PT2: Outside of school? Outside of school when they go home or things that we do?

Interviewer: When they go home

PT2: Probably not as much. I don't think they have, the school where we're at, I don't think they have the experiences

Interviewer: Okay, sure. And what do you think might be the reason for that?

PT2: I'm not sure the parents are aware of STEM, to be honest. I'm not sure that they have the interest in STEM either, to pass on. Like I say, in school, when you're enthusiastic about something, it's easier when you want to push that onto others. But I don't think the parents, not all, but most, majority, they're not really interested in as many STEM activities. So, they don't do, there are some that do, but I think the lack of interest, they don't see the interest and the point of putting their children, putting it onto their children

Interviewer: Yeah, so they don't pass it on essentially?

PT2: Yeah

Interviewer: Would you say that *you* engage with STEM outside of school?

PT2: [*pause*] …yeah, I'd say we do as much as we possibly, as much as I can at home. And I try and do it, I mean, more now it's in school, I've tried to do more things at home with my children especially. So, yeah I do, but not as much as I probably should. But I do a lot, like I say, I do a lot of the computing things at home. And I do building things at home and making things. But there are other areas, maths and things like that I could probably do more with. But I don't feel as comfortable

Interviewer: Fair enough. What kind of things do you build? That sounds interesting

PT2: We build, well we spend a lot of time at the [local forest], so we build bridges, we hide things and make tracks to find stuff. We link it a lot to fairy tales, and stuff like that. But again, these are ideas that I've seen and things that I got off the STEM website that I thought "my daughter will really like that when we go". It makes it more fun when we go up there, rather than just walking around

Interviewer: That sounds really nice, that sounds lovely! So, you have actually mentioned this quite a lot, but the question is: when you're preparing for STEM lessons where do you look for your ideas and resources?

PT2: We've got a list of resources that we had through training at school, which are really good. If not, I would speak to L[M], she's got some really good ideas, she gave us a lot, but she's also got a lot if those aren't really in mind for what you want to do. The STEM website is good but sometimes you kind of have to dull it down a little bit

Interviewer: Oh really?

PT2: I know it is aimed at Primary, but Infants is just another step lower

Interviewer: Okay, so would you say it was easy to come by these resources?

PT2: Yeah, if you look

Interviewer: Are you satisfied or dissatisfied with the amount of STEM content you are able to cover in your lessons?

PT2: That's a good question. It depends on what it is, but I don't think I do it enough. And I feel like I don't do it enough because I always feel like there's something else that I've got to get covered by May [SATs examinations]

Interviewer: Sure

PT2: I think once May's out of the way I could put a lot more STEM activities in and go outdoors a lot more but I feel like the constraints of curriculum content we've got to get covered, really hold back on the amount of STEM that we can put in

Interviewer: Okay, so you feel like it's the time that you…

PT2: Yeah

Interviewer: And you've mentioned this as well a little bit, but do you try to make your STEM lessons, so you do with your daughters, but with your pupils do you try to make STEM interdisciplinary? Like linking in the fairy tales, things like that?

PT2: Yeah. Yeah, we always try and do that, if possible. Sometimes those links can be tedious, so we're just doing this to make an activity that is really faintly related, but I think in Primary you've got more scope to make it, it's easier to do so. So, we do try and do that

Interviewer: Can you give an example of this?

PT2: So last year, it was in September, we did pizza boxes. We were doing, we were focusing on healthy eating. Our topic was 'health', so we did lots of cooking and measuring, making things. Then we had to design a pizza box to hold our pizza, our healthy pizza that we made, that kind of thing. So that was quite good. We've done other things, like making Christmas cards and finding how to attach certain things and trialling all different ways of attaching and those kind of things. Those are two really good ways. We've done those two years running you get more confident with doing it and the resources that you've used last year, you can see which ones don't work as well, so you build up on. So that was quite good, those are two good ways

Interviewer: That sounds cool! So, the next question is in three parts, so we can address each bit separately. I'm interested to know, when it comes to STEM engagement, which barriers, if any, you feel are in place for pupils, teachers, as a group, and then yourself personally. So if we want to look at: What do you think is the biggest influence on pupil's long term engagement with STEM subjects?

PT2: The biggest thing, I think, perhaps for all three would be confidence. Even for teachers, for myself and for children. Some of their maths activities, the good thing about STEM is, they don't always realise that it's a maths thing. So, some of the children aren't confident in maths so if you gave them a maths task, and said it was a maths task, they would immediately put their barriers up, saying they can't do it. Whereas, I think STEM, they're not quite sure they're doing maths on some of the activities so they're confident. Other than that, other barriers I would think are maybe resources, but then again, they're there, it's just taking the time to either make them or find them. What else did you ask me?

Interviewer: Well that was just the first part, so then what do you feel is the key challenge face by teachers, as a whole, when teaching STEM content?

PT2: Okay, definitely time. Making the time to do it. It's just prioritising and fitting it in where you can. The other barriers might be, making sure that you're making the links. They're there, you've just got to make sure that you've got the time to plan how you can link this into STEM. So sometimes it seems more difficult, but if you actually have time to think with other people and get together, you can make the links that are not so tedious. Time is definitely the biggest one. Maybe subject knowledge would be another one? So if you can get different groups in. When we've had archaeology, the guy who came in, he knew a lot more than I knew. And so that was a really good starter point for him, because I was learning as well as the children and we could go on from there and do activities that were linked to that

Interviewer: Okay, and did he leave any activities for you guys to do?

PT2: He left a website that they could use. Which immediately rules out 60% of the class, because they don't have the internet at home. Or they're not allowed to use it or they don't have a device they can go onto. That was one of the things that was a problem

Interviewer: That's interesting.

PT2: The one's that do have it, a lot of them did use it. But then again, once they'd done it once or twice, the interest has gone then. You've got to keep refreshing that interest

Interviewer: Okay, just the last one is: what do you feel is the key challenge faced by yourself when teaching STEM? This can be the same as an answer that you've already given

PT2: Okay, well time is definitely one of the problems. Knowledge as well. I think the more involved with STEM that I am, the more experience that I have of it, the more confident I get and think "oh yeah, I could do that here or I could do that there". And we did that week on it, which was really good and I found that once we'd done that week, even though I wasn't part of it, I'd planned it. So, we did that, two or three, four, five weeks afterwards, but then after that because you didn't do that STEM week again, it slips off your mind that you could perhaps link things to STEM. So, I think if we refreshed it every term, every half term and just reminded ourselves where we could put it in, when we're doing our planning. That would probably overcome that barrier

Interviewer: So that's cool, you've basically answered the next question for me as well, with what you think you can do to try and approach it. So, which of those factors: the time, the confidence and the knowledge, which would you say is the most important thing?

PT2: I think probably the time. But that could be overcome when someone comes in, that automatically frees you up, you get the knowledge, you get the time, because you're watching someone else deliver it. And you can step back. But I'd say that was probably the biggest thing is fitting it in and implementing it

Interviewer: Okay, so would you say then that it's actually really helpful when people do come in and put on these things?

PT2: Yeah, it's really helpful to either kick-start something off or to tie it up as an everything day. You might be teaching different things, but if you get a really good STEM activity to finish it off, they [the pupils] realise what they've been doing

Interviewer: Okay, sure. Which area of the curriculum or your lessons do you think would be best suited to focus the STEM and archaeology?

PT2: Which lessons?

Interviewer: Yeah, so is there anything at the moment that you do that you think could link quite nicely?

PT2: History would link really well, things we've had in the past, when they've [external experts] brought things in. It's the resources that we can't get, but when they [pupils] get actual resources, they seem to remember a lot more than when you just talk about it or when you just show them. When they've [external experts] brought things in, they've [pupils] have been able to remember dates, sizes, those kind of thing, because they've [pupils] actually, physically seen and held them. We can make a lot of resources, but things from the past, we don't really tend to get our hands on so much, but they are the things that make a big difference

Interviewer: Fair enough! That's everything, thank you

16 Appendix 4: Pilot teacher interview transcript, PT3

Title: STEM Teaching Experiences (Pilot)

Date: 18th January 2018

Speakers: Poppy Hodkinson (interviewer) and PT3

File Duration: 30 Minutes

Interviewer: I'm interested in the reasons why the UK has such low levels of engagement in Science, Technology, Engineering & Mathematics (STEM) careers. Research has shown that people's attitudes towards STEM careers are formed from a very young age, and so I want to find out what can be done at primary school level to try and tackle this, and to try and enhance pupil enthusiasm in later life for STEM subjects. So, I'd like to ask you a few questions about your experiences as a primary school teacher delivering STEM content. Firstly, may I ask how many years you've been a teacher?

PT3: 26

Interviewer: That's a long time!

PT3: Thank you, thanks for pointing that out! Yes, 26 years

Interviewer: And what is your position in this school?

PT3: Deputy Head Teacher

Interviewer: And you are the lead on maths? Is that correct?

PT3: Yeah

Interviewer: Okay, so. In your opinion, what is the level of pupil engagement with STEM subjects in your class?

PT3: Well hopefully, as I teach maths on a daily basis, I would hope 100%. I hope they're all engaged with maths! I have, perhaps an issue with 'STEM', in that for me, when you teach maths it should be CPA. It should be 'Concrete, Pictorial, Abstract'. It should follow those three and it should be fun, and there should be a variety of styles of engagement, and styles of learning. My problem is, that if you say that something is a separate subject, that it's part of

STEM, that this is a 'STEM week' – it's like saying: "we do these important subjects, English and maths all the time", but then we make a week every so often to do STEM. And so therefore, I'm not sure if it gives it enough focus, as it were

Interviewer: Sure

PT3: I would hope, that when they're doing maths, then I have 100% participation. For me, STEM is about the original purpose, which is girls going into jobs within engineering, technology. And I understand that maths is a part of that engineering and science, and all those bits and pieces that are needed within it. When at infant stage, we get quite a lot of girls, who are quite bright at maths. And then when we have to do application for that maths, that's when they begin to swap over. We get boys who are better at the application stage then the girls

Interviewer: Okay, sure. That's interesting. Do you find that your pupils enjoy STEM, so science or technology?

PT3: Yeah, they do. And we try to encourage them with the forest school bits and pieces, with the resilience, with the BLP, the Building Learning Power, to try and overcome those obstacles. Part of it, just in terms of maths, is it being valued. And whether, if I'm sending out homework, whether it's something that's valued, and should be done. I mean, we often get compared to, I don't know, Singapore, and "why is the Singapore method better than our method?". But they're completely different cultures, it's a completely different mind-set. We're here, teaching all day, teaching a range of subjects, there you have a maths teacher, who's teaching that maths subject and taking children at the end of the day, for interventions. The parent will be paying for various bits and pieces. And things like Sudoku are infant children puzzles! I give some of the staff a Sudoku and they would look at me as if to say: "well I'm not doing this!"

Interviewer: Do you think that your pupils engage with STEM at all outside of school? So, at home at all? This probably links a bit to what you were saying before

PT3: I think that people are happy to help their children with reading, it's something they feel confident with, doing the more early stages of reading. I think that people are more likely to pass on skills that they feel confident with themselves. When I take parents evening, parents will often say to me: if their child is good at maths, they'll say "oh, her dad's good at maths, that's where they get it from". If it's someone who's not so good at maths, they say "oh I'm rubbish at maths too!". Now we would never say to an outsider, "actually, you know what? I can't read!". You just wouldn't! But it's socially acceptable to say that with maths, and it's not with literacy. And so, if I make the maths homework something that is suitable for the children to do on their own, if it's just something that we've done in the lesson and I put in big letters at the top: "please let your child have a go on their own", I get a much greater receipt. I get far more back, than I do if I follow what is supposed to happen, which is I'm supposed to further their learning

Interviewer: Okay

PT3: I'm supposed to give them something which moves the learning on. But actually, when I've done that, I don't get any back! So, you know, what's the point of that?

Interviewer: Sure!

PT3: When parents ask if there's any help that they can give, they will often buy the books from WHSmiths, or whatever. And one of the criticisms that we get, is they don't know the methods. They feel that they may be teaching them inappropriately. Whereas with reading, here's a reading book, they don't get much coaching, do they? The end criteria is: "can you read those words, and do you know what they mean?". "Can you answer a question on it?". Whereas, if you taught a particular method for adding, and you did a written formal method, and the children have had no experience of that. Like if you ask a group of adults, "how do you add 25 and 25?". Some will say the see a problem in their head, some will say they do 20 and 20, and 5 and 5 and they combine it. Some will say "I just know!". And so how do you know which is the best method. And I think parents worry that they don't

Interviewer: That they've got it wrong? Okay, I think that's probably fair. My next question is whether *you* ever engage with STEM outside of school?

PT3: Yeah, I suppose I do really. I do a lot of reading, to do with science. I did physics when I was at O level stage, but in those days, there were only two girls who did [physics] over a whole year group. All the other girls did biology, but it was a long time ago. At the minute, I'm reading a book called 'Spark', which is the science of exercise

Interviewer: Oh okay?

PT3: And how it may further achievement in various subjects, and how there is a link, but we don't quite know what it is yet. So, I would say, yes, I do a bit of science reading, I quite like neuroscience, if I were to pin it down, I suppose. I'm trying at the moment – the problem with being maths coordinator is that people send you a picture of their child's homework, right? A GCSE piece of homework, and say "[PT3], do you know what I should do with this?". And I, [*whisper*] "no". So, I've bought myself some books and I'm doing 15 minutes a day, just to go over it. Because I haven't had to use a quadratic equation, and maths has changed. Maths is more now, "can you work out the compound interest of something?". And we didn't have to do that

Interviewer: Sure!

PT3: Might have had a trigonometry table or a log book, to work it out with. But, I didn't have any of those kinds of things. So, it's important to keep up to date. Do I do any engineering? I don't know, if it's an IKEA bit of furniture, I might do! And technology I probably encourage Martin [*her husband*] *not* to go anywhere near it and get a professional in! But I find it interesting to read about and we get the Teach Primary magazine that comes through. But sometimes the articles are quite… it's just to get people in and it doesn't really go into much depth. And as I'm still not sure about the concept of whether it should be a STEM week, because when we did some Inset [In Service Training] on it, and I was giving people ideas for STEM, I just thought "these are ideas we use every day!". We should be doing this all the time! This is not something that's 'suitable for girls' or something that should just be done for that one week, it's things that should be done every time

Interviewer: Yeah, I completely agree. STEM week? STEM year! So, which aspect of STEM teaching do you feel pupils respond to best?

PT3: That's a really difficult question, because they feed into each other. If you're doing science, yes you can easily *notice* things. You know, I could *notice* a beautiful rainbow, could I explain the science of it? And keep the children with me? Then you're going to get [noises to suggest uncertainty]. There's a fine line. And then maths skills are so important for science skills. So, if we're going to talk about, I don't know, a car going down a ramp and then measuring. Well yes, the less able children can tell you that one's gone 'a long way' and one's gone 'not very far'. Or if you've got larger tyres, 'how much larger?'. You need those maths skills, and we teach maths far more than we teach the other subjects because of the testing arrangements. When I first did SATs science was included. And I've noticed that because it was tested, it was taught more!

Interviewer: Sure, so you think that…

PT3: There's a link between what's tested and what's taught. It's the same as a driving test, people are taught the things that go with the driving test. And in the same way as teaching, people are now teaching to the test. And so, it all goes around full circle

Interviewer: Yeah, sure. Which aspect of STEM teaching do you yourself most enjoy?

PT3: Well, maths because I'm Maths Coordinator. I mean, I like teaching science. And I set up links with Jaguar, to do engineering with. It was called Technology Tree, and I set up a programme at Jaguar for Infant children, so that they could go around the factory, have a feely bag with all the different bits in it. And it was great! It was lovely, but we couldn't afford it any more. Because it was £1000 for a trip.

Interviewer: For one trip?

PT3: For one trip! Each time we went.

Interviewer: That's a shame

PT3: And it was a great experience, but we didn't have £1000. We couldn't justify £1000 for that trip. And the first couple of years we went, they were able to subsidise part of it, but then that was it. And actually they weren't as interested in us [Infant school pupils], because we're not future workers.

Interviewer: Yeah?

PT3: There's a long space, they wanted secondary children.

Interviewer: Oh okay

PT3: Because they can easily train them up. They can look for potential, and then get them onto schemes to then make them future employees. But Infants, it's a long way, isn't it?

Interviewer: That's a shame, because I think, young minds can be moulded

PT3: Yeah, it's whether though, you can mould them in that direction, over such a long period of time

Interviewer: Yeah

PT3: You might put all of that effort into them as Jaguar, the company and they go and work for Aston Martin or they go and work, you know. If they're altruistic about it, then fine, but I don't think they will be!

Interviewer: So, when you're preparing for STEM lessons, where do you look for ideas and resources?

PT3: If we're doing a STEM week, then I might, it depends, because I've often done the CPD [Continued Professional Development] on it and so I've done it beforehand. I'll go around and ask everyone what their subject is, what their chosen vehicle, as it were, STEM to go with. So, if it was, I don't know, Goldilocks and the Three Bears, then I will look that up on the internet beforehand. I used to be a lover of books, and I used to buy *actual* books, but these days, I've stopped. Because, what's the point? You get so many better ideas on the internet, and they're just far more up to date. So, Year 1 did some stuff on slime

Interviewer: I saw it! [Wall displays of children's work, featuring bags of slime that they had made] in the bags?

PT3: Yeah, I had no idea about it! And that's the problem, when you get older, you don't know what's interesting on Facebook for that next generation that's coming through!

Interviewer: Slime, apparently!

PT3: And it's slime, yeah! But actually, those younger members of staff *did* know and so it taught me and it taught them [pupils]. So actually, I learn from other members of staff as well as the children giving their ideas to how something's going to go forward. Or the internet, well there's loads isn't there? There's loads of ways around it.

Interviewer: Okay, fab. So, would you say that finding resources for STEM lessons is easy to come by?

PT3: No!

Interviewer: No?

PT3: No, because there's no money! And where are you going to store it all? And it's fine if every year, people do exactly the same STEM. But they're not going to do exactly the same STEM. And some of those resources aren't finite resources. If you're doing technology and you're *making* something, you've got to have more resources than you actually need. Because you're giving them [pupils] a choice. If you put lots of resources on a table for them to use, some of them may not, so I don't know, cotton reels, you might put them out on the table and not use them again for ages. And so, we have a good DT medium term policy. So, the resources that are bought for that DT medium term policy, we use those things. But we are a small school

Interviewer: Of course

PT3: And you know, there's only so much we can keep. And so most staff will use Amazon.

Interviewer: Oh really?

PT3: Yes. So, there is a budget for it. It's nowhere near enough. And it depends when staff plan for it. So, we make sure the staff meeting is about a month before [STEM week], which gives us time, for them to plan, us to order the resources, them to do the STEM week. Right, so they do that kind of plan, then they forget about it. Then about two days before they're due to do it, they do their planning and say "oh, I just need 500 kitchen rolls and some sticky back plastic please!" and I... [head in hands] right

Interviewer: Sure, okay! Would you say that you are satisfied or dissatisfied with the amount of STEM content you are able to cover in your lessons?

PT3: I think if you teach *well* then there is plenty of maths in the curriculum. Because maths can be cross curricular

Interviewer: Of course

PT3: I think that there's not enough science and I think if you talk to staff, I don't think they'd know what engineering was

Interviewer: Sure

PT3: I think they would know what DT is, and they'd know what it is because of the National Curriculum. But as an Infants school, there is very little push towards engineering, and that's why the link to Jaguar was so good. Because you're saying "look at this bottle, look at this cup, someone has designed this. Someone has made it, what's it made it from?". And so, we would call a lot of the things that you would probably call 'engineering', so "what's the material?", we would call it 'science'

Interviewer: Okay, sure

PT3: And so, I would say probably in an Infants school you're going to do 'STM': science, technology and maths!

Interviewer: Yeah. So, you've touched on it a little bit before actually, have you ever tried to make your STEM lessons interdisciplinary?

PT3: You mean like cross-curricular?

Interviewer: Sure

PT3: Ah right, 'interdisciplinary'? Look at you! Right, okay. Well, yes. Because those lessons aren't discrete, they're not separate subjects. It's a bit like if I was doing A-levels, if I was doing physics, I would try to take maths with it

Interviewer: Yep

PT3: They *are* cross-curricular and you would try to get the children to see the links. And that with the BLP [Building Learning Power], is one of the characters is about seeing the links between the things you do. But it is something that many schools are criticised for at Ofsted is whether they bring maths into other subjects in the curriculum. And often people think, and I think it's to do with how people have been expected to do planning: they've got a 'success criteria' and must quote at the top, what that particular success criteria is from a national curriculum statement. And nobody's going to go through and write *all* of them, and say "well in literacy we're going to do a bit of this and then we'll do a bit of maths and a bit of geography". And actually, all you're doing is 'The Great Wall of China'. And so, it's how you… Yes, it should be cross-curricula

Interviewer: Okay, cool. So, my next question is kind of in three parts, so we can talk about each bit separately

PT3: Okay, go on then

Interviewer: I would like to know, when it comes to STEM engagement, which barriers, if any, you feel are in place for pupils, teachers as a group and yourself personally. So, the first part would be: What do you feel is the biggest influence on pupil's long term engagement with STEM?

PT3: Okay, so do you mean why I think they're not going to get a job in that, or why do I think a *girl* isn't going to get a job in that, or why do I think that girls don't do as well, when they get to secondary, in STEM subjects?

Interviewer: Kind of all three… So just in general, what sort of things do you think could influence a 'run of the mill' student from the school?

PT3: There are *still* perceptions of girls not doing science. There are still those ridiculous images of the 'sexy scientist' in the white coat, that actually, their white coats are probably quite grubby! And also there are more science programs on now. But when I talk to younger teachers that come through, they don't watch them! We've got members of staff that don't have a TV licence. They can't watch the iPlayer, so they can't watch BBC Four, they can't watch BBC 2 or BBC 1, they only watch things from the internet. A lot of staff who don't watch the news

Interviewer: Yeah?

PT3: And if you watch programs like University Challenge, they're nearly all literacy, classics based questions. They're rarely science based questions, and they just have to hope that one of their members of their team is a science expert. And so, for pupils, they don't see role models around them. They don't have those conversations, they won't be exposed to things on the television that will help them, to push them further. It's not given much of a focus. And actually, I'm not sure that the primary school teachers, that they have, have the ability to explain it in the way it should be explained

Interviewer: Okay?

PT3: So, they [primary school teachers] might have a vague idea of why a rainbow is arched, or why the sky is blue, or why a ship doesn't sink. You know, how floating and sinking works. But it's a criticism that's often levelled at primary school teachers that they don't really understand, so that when they [pupils] go to secondary, they have to relearn

Interviewer: Okay, that's interesting. So, would you say that the support for the pupils isn't there?

PT3: I just don't think they're given… it's more than just the role model, I don't think they even know it exists as a job. We have days in which we ask the children "what would you like to be when you grow up?", it's a rarity to see someone putting themselves down as a 'scientist' or a 'mathematician', or any of those things. They're jobs that they see in their environment. We get people dressed up as a 'Teacher', 'Scuba-diver Instructor'. All kinds of things that are quite elaborate, but they might have seen on the television. But Lab Technician is not necessarily something that they…

Interviewer: It doesn't sound as glamourous, does it?

PT3: No, no

Interviewer: Okay, cool. So, what do you think is maybe the key challenge faced by teachers as a group, when they're teaching STEM?

PT3: One, is their own knowledge

Interviewer: Sure

PT3: Two is their training course is not long enough

Interviewer: Oh really?

PT3: If you train as a teacher, from October through to June the next year, and you're on three placements. So, you might have taken your degree, then you've got this tiny little course, and in that you've got to know that, you might be given Reception children, or you might have Year 6 children. And you've got to know the maths and the English and all the other subjects to go with that. And there's only so much training time. For me, teachers should be trained over a five-year period. So that some depth can be got from it, but people want things quick don't they? They want to take their degree, and then have a quick course in how to be a teacher. And then they leave after three years because it's too much. Suddenly they're having to teach things that they have no understanding of. And I think that people are going to resort to things that they know

Interviewer: Yeah?

PT3: So, they'll teach something, so if before they were… because the profession is filled with women, if they like art, they're more likely to teach art, if they like doing a certain subject they're more likely to…

Interviewer: Do you think that maybe that could have an influence on the STEM itself? So if the women coming to the profession prefer art, or a language or something, do you think that could have an influence on how the pupils then see those subjects as well?

PT3: Yes, I think

[*interruption of another staff member, short conversation follows before they leave*]

PT3: I've forgotten what I was going to say now! Say it again?

Interviewer: I said that the fact that the teachers themselves are maybe more interested in one thing

PT3: Yes, by freeing up the curriculum, by saying that teachers can choose the vehicle on which those objectives are delivered, then they're more likely to teach something they enjoy

Interviewer: Sure

PT3: And it works the other way, I know teachers who *don't* like art and don't like music and don't feel comfortable teaching it. Because they feel they can't sing themselves, or they just don't like it, they don't like the kind of, lack of control part of it. Some of it is confidence, and it depends on the school you're in. If you're in a school with a lot of pressure that says, "you must get your English and maths scores to a particular level" it's alright me saying "where's your DT? Why aren't you doing a nice bit of that?". Well if you can't read and write, and you haven't got basic mathematic skills, then some things have to take priority

Interviewer: Yeah, that's fair. What do you feel is the key challenge faced by yourself personally when tackling STEM?

PT3: My own personal views on it. Because each of us is going to have a completely different view and my view will be different to [PT2's} view, different to [PT1's] and so just because I believe that these things should be happening in maths all of the time, doesn't mean people have the same priorities that I do. So, for me, it's the barriers I put up myself

Interviewer: Interesting answer

PT3: Probably, I don't know. I could quite easily do all kinds of things but then there's the restrictions of the timetable and all that malarkey

Interviewer: Of course. Of these three things that we've discussed, which do you think is the most important in terms of pupils choosing STEM careers?

PT3: I think having a role model is important

Interviewer: Yeah?

PT3: I think if you see someone, if you're in a particularly middle class family and your mum is a doctor, your uncle's a doctor, your cousin twice removed is something else, a lab technician! You see those people and you know that those jobs exist. We are in an area where those jobs do not exist

Interviewer: Sure

PT3: And so, whether that is a role model who is a teacher, that can say "look at all these other things!", but sometimes teachers have a tendency to make it [STEM week] a bit 'arty', rather than bringing the science into it. And yeah great, you can get lots of art and things from those things, but that's *not* what it's meant to be about. If I went and did a job in a science lab and said "look! I've done this lovely picture!" I don't think I'd get the same response, or the sack perhaps! So yes, I think it's role models, either within the family, or role models within school.

And so, it's good to see that there are more female secondary science teachers, but I also know from reading the press there's an issue with how many science teachers they're getting in. And maths teachers

Interviewer: Just in general?

PT3: Yeah, just in general, they can't keep them. Because why would you? Why would you put up with that stress? Why would you do that for a living, when there are very few other people doing the actual science and maths? And then, you come into the fact that the science and maths that's going on is often being paid for by a company. And that brings up all kinds of other issues. And so, it isn't, I don't think, science isn't the job that people think it is

Interviewer: Yeah?

PT3: You're often being asked to prove something because your benefactor who's paying your way, is the 'Sugar Company' or someone who's trying to say that "you must have these results". So, yeah…

Interviewer: So, do you think there is anything that practitioners, so teachers, can do to address this lack of role models?

PT3: Well, in theory we can go to somewhere like Jaguar or we could go and visit places. I think it gets increasingly important when they're [pupils] not so ego-centric. I think it's lovely to do a topic, which is 'jobs for people who are around us' and that kind of thing, but they're quite ego-centric at that stage. And if I said, "there's a job where you can design those things", yeah, it's a start, but if it's not going to be carried on, it's forgotten in the mists of time. It needs to be a coordinated approach, that goes all the way through [*school*]. In which, you're giving people those role models and you've got to make it appetising, you've got to make it a profession that you actually want to go and do! At the minute, people *don't* want to be maths and science teachers and I think we need to consider why

Interviewer: Yeah?

PT3: And why do those children believe it's okay to behave in those ways, and why do we as a society believe that it's okay to say "maths and science are for geeks"? Why is that okay?

Because it shouldn't be okay. We don't say the same, I mean we do, we say a 'bookworm', that's becoming more of an abusive term. Perhaps we need to consider why we say those things. But how you go about root and branch changing things? I don't know. That's way out of my remit! I don't know, you can make small changes around the edges, but the press has a big…

Interviewer: Influence, yeah. Well, I don't know. I think you that the little changes that teachers can make, I think they can have a big influence

PT3: I'd love to think you were right. For example, in Reception, there's a student teacher who I taught for a year. She doesn't remember any of us, she doesn't remember any of our names. She knows she came here, and she remembers it being a nice time, but that's all she remembers

Interviewer: Oh really?

PT3: And sometimes I see Reception and Nursery staff getting really disheartened because the Year 2 staff say they [pupils] can't remember anything prior to Year 1. And that's at a push! They just don't remember!

Interviewer: Really?

PT3: And so, I take your point that you can do lots of little changes to things. And you can show them people. So, sometimes we've had a 'scientist' in, but they kind of do a 'comedy science'. It's like, you know "wheee". And we get the planetarium obviously in to do the science bit and a colour rainbow show, and they're all lovely things, but if I were to ask them [pupils], five years later whether they could remember them [science visits] … I think you're right, it has to be a 'drip drip', but I think having an inspirational teacher when you're at primary, who every day had bird feeders and talked to you about those birds that are there: why they have those bits, how the different finches have different beaks and *why* they do, and how their feathers are made, and who has a passion for something. I think that's more likely to lead those children to do something else. So, if you had a teacher who did the same, but with some other part of science, then they're more likely to go with it.

Interviewer: Okay, I like the bird idea!

PT3: It's lovely! That happened to my husband, funnily enough. He had a teacher, and now he absolutely loves bird watching

Interviewer: Oh, there you go! Objective achieved!

PT3: But he wouldn't do that for a living, because it doesn't earn any money! You know, he's not Chris Packham!

Interviewer: Fair enough!

PT3: Yeah, go on, sorry.

Interviewer: No that's fine! That's all my questions. So, thank you!

17 Appendix 5: Pilot pupil task based interview findings

The following outlines a child-friendly interview method that was piloted with BF pupils in the Summer 2018 term, prior to the main research period.

Method

Four children were selected by their class teacher; two girls and two boys. All pupils were between the ages of 8-9. The children were given the opportunity to select their own pseudonyms, and will be referred to as such throughout this discussion. The pseudonyms are: Mad M, Pizza, Football and Orange O. The session ran for 1 hour and 40 minutes, and was audio recorded in its entirety. Recording was paused during occasional disruptions to the session, e.g. break times. Throughout the session, pupils were invited to join in with two activities. The first was an introduction to the concept of STEM: pupils were presented with the word 'STEM', and given the opportunity to discuss the meaning of each branch: science, technology, engineering and mathematics. They were then encouraged to suggest jobs that a person might do in each of the branches. Ideas were recorded by pupils on one central sheet of paper. The second activity was intended to build upon the knowledge learned in the first part of the session. Pupils were given a selection of print media (e.g. newspapers and magazines), and asked to create a collage to answer the question "*what does STEM mean to you?".* Attempts were made to ensure the range of print media offered to the children was relevant to the question they had been asked.

Magazines and newspapers with an obvious STEM theme (such as *Focus*) were included, as were those covering current affairs (e.g. *The i* and *The Week*), education (*Education Magazine*), and cultural engagement (*The National Trust Magazine*). A number of home, clothing (*House Beautiful* and *The White Stuff)* and gardening (*Sarah Raven*) catalogues were also included. Images of: people engaging in STEM activities, technological products, medical equipment, vehicles, plants and animals, and objects relating to finance were all present within the sample. It was hoped that the sources would be broadly representative of modern life, although it must be noted that many of these titles are likely to have a left-wing, middle class readership. Once their collages were complete, the children were asked to discuss their work, and explain the rationale behind their selection decisions.

Results

Activity One: Introducing STEM

Pupils were able to understand the concept of STEM; they understood that it was an acronym, and that each of the letters in the word stood for something else. They were able to relay the ideas that they had discussed to their class teacher towards the end of the session. However, they were limited in the number of STEM-related careers that they were able to suggest (Figure 17.1). Ideas put forward for 'science' jobs included: 'working in a laboratory', 'finding out new creatures/ wild life', 'finding out new stuff', 'museum staff' and 'learning about plants'. Only one technological career was suggested: 'YouTuber', but the children agreed that people might use technology in their job, such as using a laptop to "*look up stuff*".

They believed that an engineer might use a computer in their work. Orange O suggested that an engineer is responsible for 'building' and 'designing' things. Football asserted that engineers might build cars. Following this, it was highlighted that an engineer might provide roadside assistance to broken down cars on the motorway. The discussion that followed this idea expanded upon the different places that an engineer might fix a car, and agreed that cars might not necessarily have broken down for an engineer to take a look at them. Ideas of other things that might need fixing were limited, with only 'tractors' and a 'Lamborghini' suggested by Orange O. From the discussion, it also emerged that Mad M's dad had been a car mechanic. A number of careers involving mathematics were discussed by the group, including being in the police (although it was not made clear exactly how the two connect), 'finding out how old something is', shop owners, park keepers, and 'weighing pizza dough'.

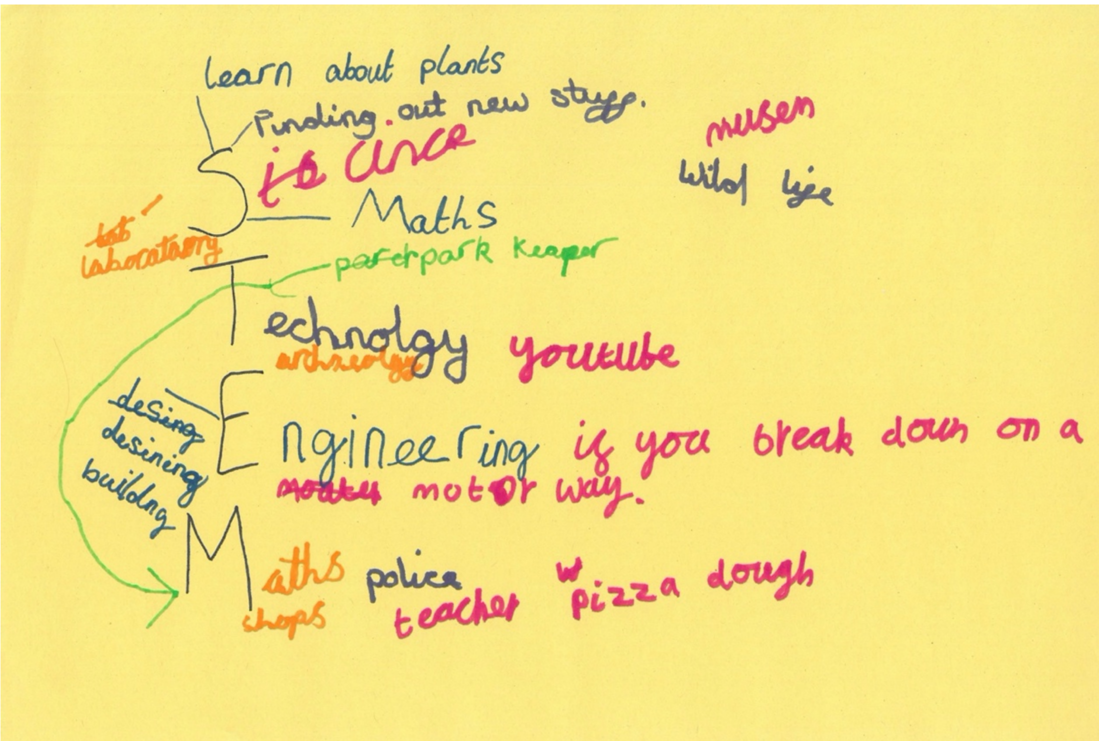

Figure 17.1: Pupil suggestions for careers associated with STEM branches.

The children also recognised that someone might use both maths and science simultaneously in their job. Orange O states that "*for science you need to use maths as well"*, and Football developed this with the assertion that you "*measure how high stuff is in science, that relates to maths"*. Football also mentioned that *"paramedics have to use maths when someone faints"*, although his understanding of this appeared to relate to the fact that one might count chest compressions, rather than use of maths skills to interpret medical equipment such as an electrocardiogram (ECG). It was suggested by Pizza, that teachers are another group of people who might be required to use STEM skills in their job.

Activity Two: "What does STEM mean to you?" Collage Creation

Using the print media resources provided, each child was able to create a collage to answer the question "*What does STEM mean to you*?". The content and rationale behind each child's collage is outlined below.

Football

This pupil expressed a particular interest in technology, which he used as the primary inspiration for his collage (Figure 17.2). He described his work as being *"more technology and maths than science and engineering"*, and sourced most of his images from the *Focus* publication. The images of robots, computers, phones, a telescope, a TV and iPads present on the collage reflect this. Football had also linked maths to his work via the price tag on an image of a computer, stating that "*I thought money goes with maths, so I made a flappy bit on the computer, so it lifts up. And underneath* [is] *the price*". He made use of the banner across the front page of his preferred magazine by repurposing it as the title of his work. The banner reads "*science, technology, health*", and Football has included three images of healthcare-related technology in accordance with this. These images are: a watch that can monitor heartrate, representations of neuroimaging brain scans, and what Football perceives to be an x-ray on an iPad (this image appears to actually be a close up of a beetle). With regards to the neuroimaging, Football suggested that the coloured parts of the brain may be of particular importance, but did not state his reasoning for this.

Football explained his attempt to demonstrate engineering in his work through the depiction of a phone, laptop, iPad and TV. Football appeared to understand that these devices require "*technology to make* [them] *work*", and suggested that the engineers who develop the products are "*like scientist engineers*". His discussion of these technological devices centred mostly around their use as an entertainment tool, suggesting that one might look up World Cup scores, or use a phone in the same way as using a TV.

Figure 17.2: Football's collage. Drawn arrow indicates a movable part of the collage: the computer screen flaps down to reveal its price.

Pizza

Pizza's work displayed a much broader spectrum covering all of the STEM branches, with no particular emphasis on any one area (Figure 17.3 and Figure 17.4). She chose to depict phones and a robot to denote technology, and a shoe to represent engineering *"because it's like designing*". She also included an image that she described as a stack of coins, and a price tag of £750,000, to denote maths on her collage. Pizza also chose to use the heading from the front page of a publication as a title for her piece: the word 'education', although it is not clear how she believed that this related to STEM. Another image shows a girl wearing goggles who appears to be engaged in an activity with a Bunsen burner. When asked, Pizza stated that this picture was selected because it "*looked science-y*", elaborating that "*she's wearing goggles…you normally wear those goggles in science*". This image led to some open discussion over whether the girl was "*a real person carrying out an experiment*" or "*advertising in the newspaper*". Finally, Pizza explained that she chose images of plants to represent *"science, for gardening and stuff"*.

Figure 17.3: Front view of Pizza's collage.

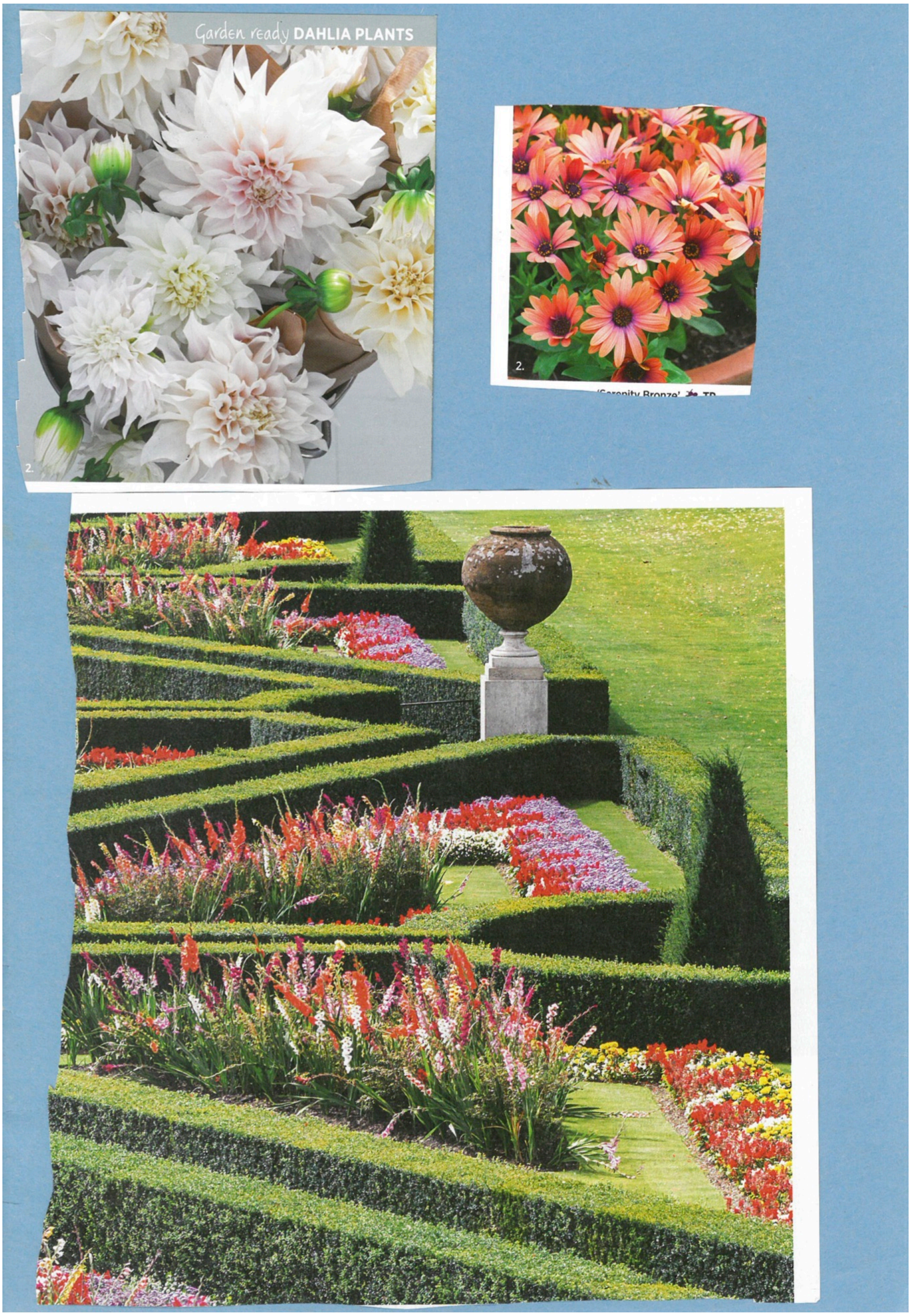

Figure 17.4: Back view of Pizza's collage.

Mad M

Mad M described her work as having *"a little bit of everything"*, reflecting her interests in "*baking and making stuff, and plants and planting…and maths"*. Photos of people baking and a plate of food were used to demonstrate an interest in cooking and baking (Figure 17.5). Mad M explained that baking requires STEM skills such as weighing and measuring. A further image chosen to signify maths on her collage was a picture of three people stood on stacks of money at differing heights (Figure 17.6). She understood that the number of coins a person was stood on was likely to relate to how much money each individual had. She drew a link between money and maths, and was also able to suggest that the stacks of money could also signify a bar chart. When asked about her inclusion of a pair of glasses, Mad M asserted that they were related to science because *"somehow glasses make people see"*.

When questioned about a picture of people digging up potatoes, Mad M described her personal experience of growing produce: "*because in our garden, we usually do gardening because we grow strawberries and gooseberries and raspberries and potatoes*". This, along with multiple images of flowers on her collage, indicate that Mad M had taken the idea that plants/ flowers were related to STEM on board. However, when asked about an image of a dog in a field of flowers, she did not recall our earlier discussion about biology as the study of plants and animals. Instead Mad M said that her decision to include the image was *"because I like flowers… and the dog!"*. Finally, technology and *"electronic*[s]" were denoted by an image of an 'Alexa style' electronic device.

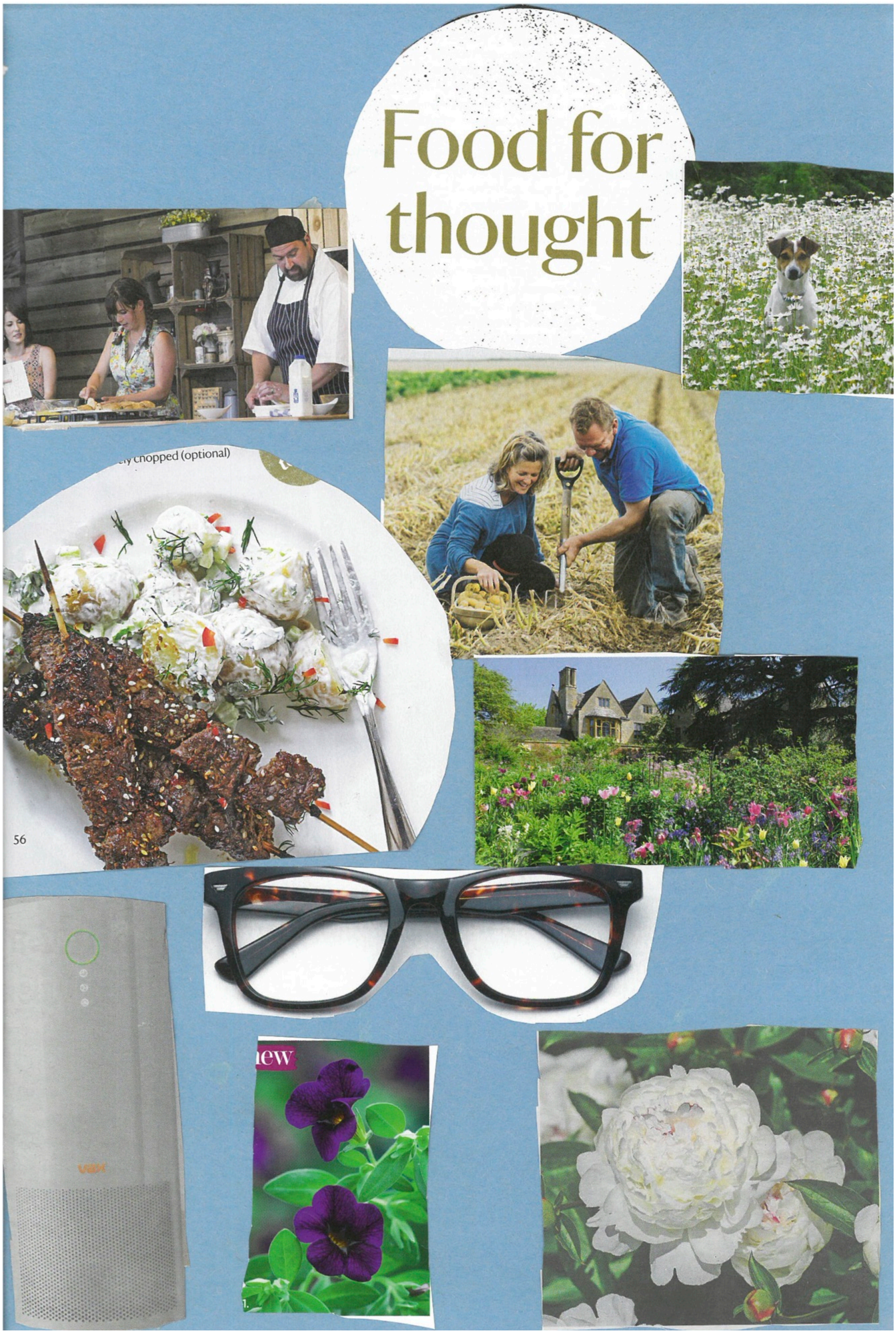

Figure 17.5: Front view of Mad M's collage.

Figure 17.6: Back view of Mad M's collage.

Orange O

This pupil's collage was dominated by images of flowers (Figure 17.8), a decision he made *"because* [his] *mum likes gardening and so do*[es he]*".* When prompted by the other children, Orange O recalled that plants were related to the science branch of STEM. He had also elected to include an image of a maze (Figure 17.7), which led to a discussion about how mazes are designed and created. During the discussion, none of the children made a link between mazes and STEM in terms of geometry, measurements etc. Instead they explored different ideas for how mazes are actually built; the general consensus being that they are cut out of a pre-existing mass of shrubbery. On the second page of his collage, Orange O mostly focused on technology (Figure 17.9). He requested to use one of the school's laptops to research more about technology, and came up with a timeline of when different technologies (Google, Facebook, iPhones etc.) were invented. This timeline, was paired with a picture of a laptop to represent 'technology'.

Figure 17.8: Front view of page 1 of Orange O's collage

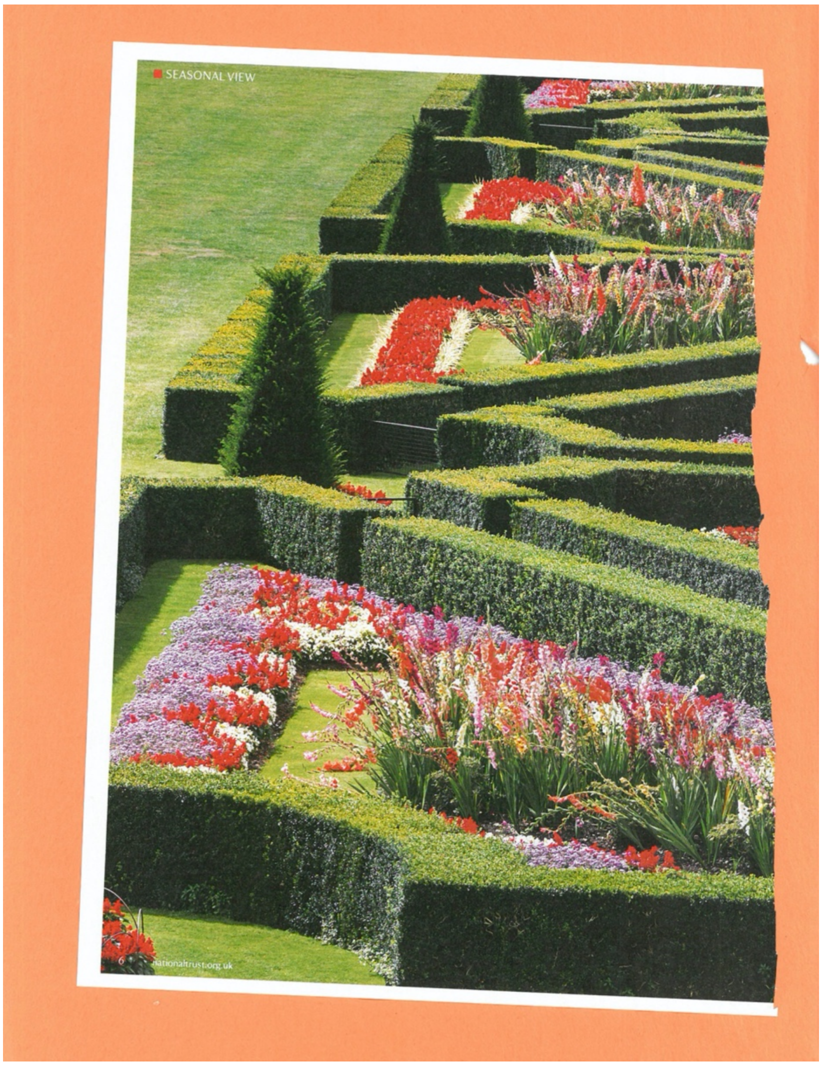

Figure 17.7: Back view of page 1 of Orange O's collage.

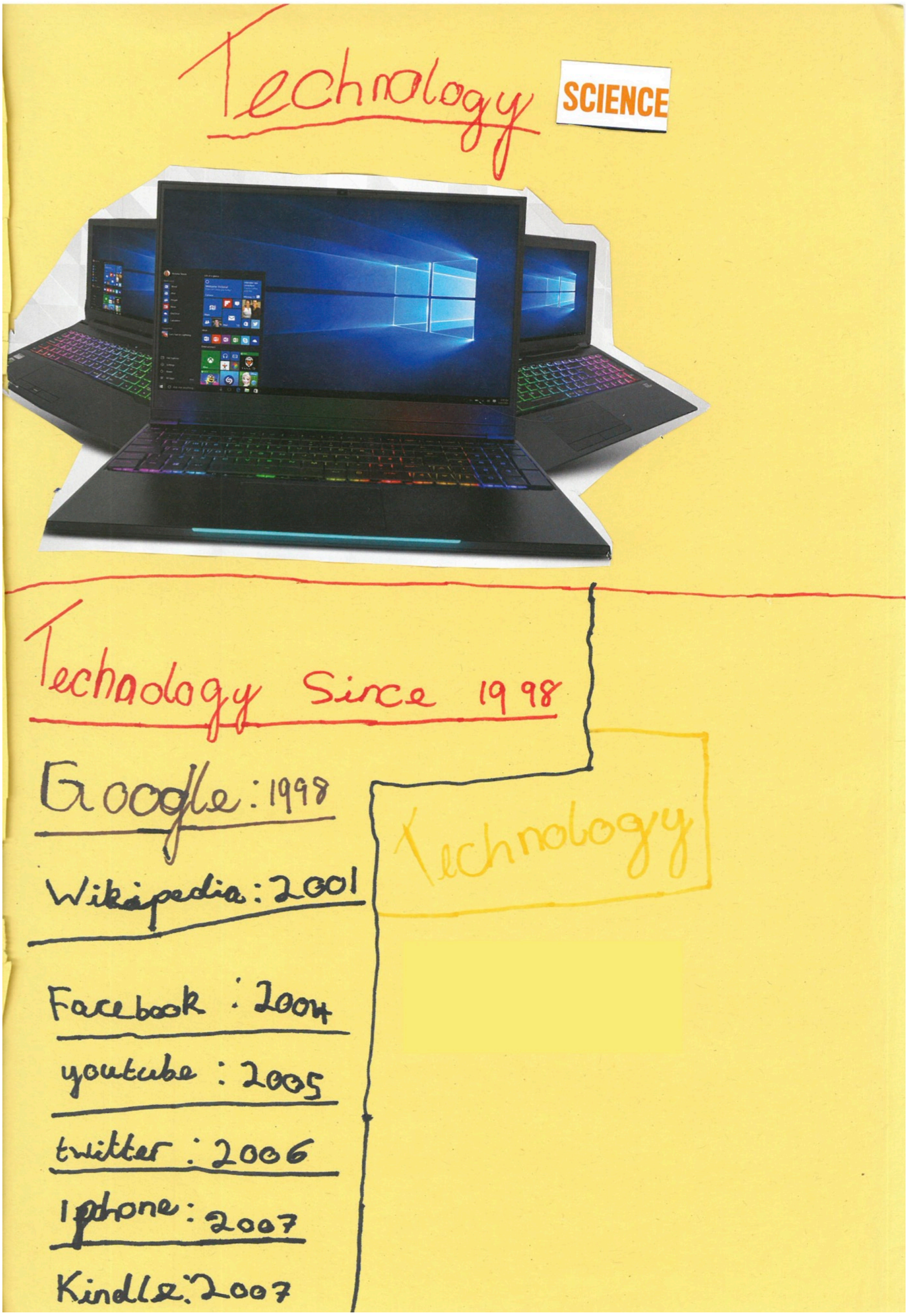

Figure 17.9: Page 2 of Orange O's collage.

Discussion

The conversation between pupils as they worked, and their subsequent summary and discussion of their final piece, revealed multiple points of interest. The children often drew upon examples of their own experiences with STEM, suggesting that their understanding is facilitated through events in their own lives. Overall, pupils had limited knowledge of the different STEM branches; with the most well recognised subjects being science and maths. This is unsurprising, as these are the two areas they are most likely to have engaged with, via lessons at school. Discussion of plants in particular, made up a large proportion of the conversation surrounding science. Technology was mostly discussed from the perspective of a consumer of entertainment, and engineering was only understood in the basic sense of 'designing and building'. Pupils identified that the branches of STEM link together, specifically those of maths and science, although it is unclear whether they fully appreciate the links with technology and engineering. Additionally, there appears to be a disconnect between the children's perception of technology, and the people who design and build it. Much of their conversation surrounding technology, focused on finished products rather than the process of creating those devices. Finally, some of the children's perceptions of stereotypes were revealed; specifically regarding the 'appearance' of scientists.

Personal Experience

The importance of personal experience in the children's understanding of STEM was very clear throughout the whole session. Pupils made frequent references to relevant examples from their lives during their discussion of STEM. The importance of personal experience in learning is widely recognised (Boud *et al.* 1994; Dewey 1997; Wood 1998; Sawyer 2006), and teachers are often advised to tailor subject matter to reflect its relevance to pupils' own lives (Bransford *et al*. 2000; Walqui 2006; Moyles 2011; Kang *et al.* 2014). It is not surprising then, that the children in this session drew their own comparisons between the topics of conversation and events in their lives. The experiences discussed here can be broadly split into: experiences of pupils themselves, and the observed experiences of others (often a parent).

Football referenced a school 'Italian Day', when describing his understanding of the mathematical skills required to make pizza dough, and Orange O was able to take this further by relating his experience of making pizzas at home. Mad M also highlights the importance of maths skills (weighing/ measuring and timing) in baking, and discusses her interest in this at length. She later uses this as justification for the images she selects for her collage. Football's personal interest in video games and technology is drawn upon throughout the session, and forms the main inspiration for his final collage. This affinity with technology was later confirmed by his class teacher when she was invited by the children to look at their work. Mad M references a personal experience with technology to justify her image of a ‘personal assistant’ style device, as it reminded her of the ‘Alexa’ in her family home. Orange O does this also, by linking an image of a laptop in a magazine to the one that he owns.

Examples of how the children had observed STEM experiences in others include: Orange O’s discussion of his mother’s interest in gardening, and his great-grandfather’s career as a *“moon and star kind of scientist*”, while Mad M revealed her father’s career as a mechanic. Both Football and Mad M mentioned the fact that their fathers wear glasses in a discussion about the *“science to make people see”*. Football was also able to describe how a “*shopkeeper”* might utilise maths skills, when working out prices and counting out change. He had previously observed this behaviour in the owners of the “*shop at the top of the rec”*. Finally, both Football and Orange O linked images of smartphones to the ones that their mothers own. By describing examples of conversation topics that they recognised in their own lives, the children were able to place new information into their current framework for understanding the world. This was clearly demonstrated when the word ‘biology’ was introduced as the science of “*how our bodies work and how plants work*”. Orange O immediately linked this to his existing knowledge, stating that “*my mum uses biology”* in her work as a gardener.

Understanding of STEM branches

The extent to which the children in this study understood the different branches of STEM was varied. They understood the concepts of maths and science well, as is to be expected in the English education system, where both of these subjects are given high priority within the curriculum. Pupils’ understanding of technology and engineering was much more limited, apparently due to the restricted ways in which they interact with these branches.

Many topics of discussion throughout the interview can be identified on the Lower Key Stage 2 science and maths curriculum. For example, the conversation covered plants and magnetic poles, both of which are learning requirements of the Year 3 science curriculum (DfE 2013a). The majority of discussion regarding maths centred around the concept of money, and recording lengths of time, which also feature on the Year 3 maths curriculum (DfE 2013a). Conversely, it is not unexpected that the children were unfamiliar with the concept of biology, chemistry and physics, as science is not taught under these titles until Key Stage 3 (DfE 2013b).

The link in the children's minds between plants and science appears to have been particularly strong. It was agreed very early on in the conversation that plants might be used to represent science, and all but one of the final collages depicted multiple images of plants and flowers. Football's was the only collage without images of flowers, but even made verbal reference to the link between science and plants. This is a good demonstration of the importance of personal experience in how children incorporate new information into their current understanding of the world. These pupils applied what they had learned in science lessons (and in Orange O's case, observations of his mother gardening), to provide "*learn about plants*" as an example of something that a STEM practitioner might do as part of their job. However, it should also be noted that because collages might be viewed as an artistic endeavour, it is possible that the preference for botanical imagery was due to the fact that they provided visually striking pictures for the children's artwork.

Pupils had a good understanding of technology, but this appears to have been mostly restricted to their interaction with it as consumers. This was reflected in multiple references to devices (laptops, smartphones, personal assistants) that the children interact with at home, and Football's specific description of his use of technology as entertainment. In addition to this, when asked about the kind of jobs that might relate to technology, the children's suggestions were limited to the ways in which people might use technological products in their jobs: "*YouTubers, they use loads of technology*" and using a laptop to "*look up stuff*". Excerpt 17.1 and Excerpt 17.2 were intended to encourage the group to think about the human work behind technological inventions.

Interviewer: *so with the technology, you mentioned my computer. And you said that using the computer was working with technology, but who made my computer?*
Football: *Apple*
Interviewer: *yeah, so who works for Apple?*
Mad M: *scientists*
Football: *it's not just Apple, you've got Windows and -*
Orange O: *Samsung*
Football: *- and Dell and all of that stuff*
Interviewer: *so, all of those people who are making computers – what kind of job do you think they're doing?*
Football: *they're technology scientists! …If that's even a thing*

Excerpt 17.1: Conversation between pilot participants and the researcher about the people behind technological products.

Interviewer: [using an image of a smartphone as a prompt] *who was responsible for making* [it]*?*

Mad M: *but that phone was advertising*

Football: *yeah, because it was next to these two phones*

Pizza: *it's probably made by Samsung, and then they just took a picture of it and stuck it in the paper*

Interviewer: *okay, and who are Samsung?*

Football: *they're a phone company, no not phone – they do phones, TVs – all of them*

Excerpt 17.2: Conversation between pilot participants and the researcher about the makers of a smart phone.

These responses suggest that the children did not immediately consider the individuals who work for technology companies, but were able to do so when prompted. This is likely linked to the issue of personal experience. If the children have no experience, or way of relating to this field of work, it is unlikely that they would think to mention it here. Once the existence of 'technologists' had been highlighted, Football was able to refer back to them in a discussion about using Google on a smartphone; declaring that "*the engineers that made it are like scientist engineers*". Participants' initial perspective of technology as consumers may have resulted from the source material, as the majority of 'technology' images were derived from adverts. It is clear from Excerpt 17.2 that the children were aware that they were viewing adverts, and they made frequent references to brand names: Samsung, Apple, Windows, Dell. It is possible that this presentation of technology, as a consumer product led the children to consider them on these terms. This, combined with a lack of personal experience or awareness of technological industry, may have reduced their capacity to explore the full extent of career opportunities in this branch of STEM.

Engineering was the area where participants demonstrated the least knowledge and understanding, which is likely due to the relative absence of it from school education in the UK (Finegold *et al.* 2011; IMechE 2016). Orange O defined engineering as '*building, designing*' (Excerpt 17.4). This conversation is a good demonstration of the limited way in which engineering is perceived by groups of people who do not work directly in the industry. One of the biggest misconceptions surrounding engineering careers is that they are restricted to tasks like fixing boilers and other home appliances, or constructing and mending cars (Silver and Rushton 2008; IMechE 2016). Further discussion of the work an engineer might engage in, did expand upon this original assumption, where it was suggested that engineers might be responsible for designing buildings and tools (Excerpt 17.3).

Interviewer: *are there any engineering jobs* [you can think of]*?*

Orange O: *engineering, building, designing*

Football: *yeah, building cars*

Mad M: *my dad used to be an engineer*

Football: *can't engineers fix cars?*

Pizza: *when they break down on the motorway*

Football: *fixing broken parts of the car as well, it doesn't have to be when they break down.*

Excerpt 17.4: Discussion with pilot participants about engineering job roles.

Interviewer: *so* [Orange O] *said one thing about engineering: designing buildings is part of engineering. Is there anything else that you think, as well as designing buildings*

Football: *I've got a cousin who studies archaeology at Cambridge University, and he's really good at drawing, and he's drawn all these pictures of everything*

Interviewer: *so what else might you design if you're an engineer?*

Football: *couldn't you design tools? Like new tools? Like hammers and stuff, or chainsaws?*

Excerpt 17.3: Further pilot participant discussion about engineering roles.

The concept of engineering as 'building and designing' was taken up by all participants, although it was sometimes assumed to mean any kind of design, including fashion. The children suggested that engineers may also play a role in technological industry (Excerpt 17.5). Overall it appeared that while the children had some awareness of engineering, and were able to suggest some examples of how it might be applied in a job, their understanding was much more limited than that of the other STEM branches.

Interviewer: *so which bit of STEM* [does Samsung] *relate to?*

Pizza: *Technology*

Interviewer: *yeah?*

Mad M: *and engineering*

Orange O: *because they had to design it and make it*

Pizza: *yeah because it's their company*

Interviewer: *okay, so would you say Samsung are a technology company?*

Pizza: *yeah, and engineering*

Excerpt 17.5: Pilot participant's discussed the overlap between technology and engineering.

The pupils displayed some understanding of how the different branches fit together, but this was not extensive. They identified that maths skills were often applicable to science, and identified that people often make use of technology in a range of careers. Football in particular, appeared to recognise how science, technology and engineering might overlap, with his suggestions that people could be "*scientist engineers*" or "*technology scientists*". Participants also appeared to comprehend that a range of STEM skills are required in some jobs, including their suggestion of a '*rocket engineer'* (Excerpt 17.6). However, when Football was asked about his decision to include 'health' on his collage, he did not make a connection between healthcare, science and technology (Excerpt 17.7). Football's explanation suggests that he did not fully appreciate the ways in which science and technology inform and support healthcare. This example highlights the limited way in which the participants perceive STEM skills and industries as being interconnected, something which is likely due to the absence of experience or familiarity with the full range of STEM careers. Pizza's suggestion that teaching is a career in which one might use a range of STEM skills, demonstrates that the group were able to comprehend the idea of combining STEM skills, but were prevented from widening their discussion by a relative lack of experience in this area.

Interviewer: *so if you're an engineer – does that mean that you never use science, and you never use maths and you never use technology?*
Pupils: *no*
Interviewer: *so if you're a rocket engineer, what kind of* [skills] *do you use?*
Pizza: *you use science and also technology. So if there's an engine*
Interviewer: *yeah?*
Pizza: *you'd have to do technology stuff – like making electronics*

Excerpt 17.6: Pupils explored the use of STEM skills across the acronym.

Interviewer: *what made you choose 'health' as part of science and technology?*
Football: *well, I just found this* [magazine] *title and I just thought I'd just do health if it was on the title*

Excerpt 17.7: Footballer explained why he included 'health' on his collage.

Linking STEM and people

One line of questioning pursued by the researcher, was raised by the absence of images of people from Orange O and Football's collages (Excerpt 17.8). While Pizza and Mad M selected two images depicting people for each of their collages, they were still favoured less than images of food, objects, plants and animals. It is possible that this was due to the type of publication that was most favoured by each child. For example, Orange O decided to get the majority of his images from the *Sarah Raven* gardening catalogue. As there are no images of people in this publication, it is likely that he would have had fewer opportunities to include them than a child who made use of a different magazine. Pizza made extensive use of the *Education Magazine*, which featured multiple photos of people, and this is reflected in her collage. Football *had* selected an image depicting a person (with a robot), but had ultimately decided to remove the person, leaving just the robot present on his collage. When asked about this decision, he stated that it was "*Because I thought I wouldn't really need it, because I could just describe it instead of actually showing* [the person in] *the pictures*". This may indicate that he perceived the robot to be most relevant to his understanding of STEM.

Interviewer: *how come you choose not to include people – or not many people?*
Pizza: *because they don't, well they're not really –*
Mad M: *they don't fit in*
Pizza: *- yeah, they're don't really fit in because –*
Mad M: *it's not the objects*
Pizza: *Yeah, well sometimes it is – if it's a mathematician or a scientist*
Mad M: *I think that you sometimes need people because – say on* [Pizza's collage] *– it's showing that people set* [the scientific process] *off, not that it just magically sets off – they did it*

Excerpt 17.8: Pilot participants discuss their rationale for including very few people on their collages.

From Excerpt 17.8, it is clear that Mad M recognised the importance of people in "*setting off*" scientific processes, with specific reference to an image on Pizza's collage, of a girl creating sparks using a Bunsen burner. Mad M understands that people *do* science, and she thinks that they can be important when understanding the context of a photo; in this case, to help someone understand *why* the sparks are occurring in the image. However, the assertion that people *"don't really fit in*[to]*"* these collages, suggests that Pizza and Mad M identified more closely with the "*objects*" associated with STEM, than the people who create them. This further compounds the suggestion that these children rely on their personal experiences to make sense of STEM: perhaps they are more used to consuming the products of STEM, than *doing* it themselves.

Stereotypes

One point of interest throughout the whole interview, was the way in which the children perceived the stereotypes surrounding STEM and its associated careers. It has already been noted that some of the pupils' discussion of engineers touched upon the common assumption that engineering is associated with 'fixing cars'. This stereotype is thought to derive from the limited public understanding of the true scope of engineering and the range of career opportunity available within that area. Pupils were, however, also able to suggest some other engineering job roles; such as "*building* [and] *designing*".

What was most notable about the children's consideration of stereotypes, was that they were not present in a few cases, where one would assume they might. Specifically, with regards to the perception of women and girls in science, and also the probable appearance of a 'scientist'. The image of a girl wearing goggles, depicted on Pizza's collage was the stimulant for Excerpt 17.9.

Interviewer: *what about this person here?*
Football: *isn't she a scientist?*
Interviewer: *do you think she's a scientist?*
Pizza: *I do*
Football: *or she could be a child from secondary school. You know at secondary school they have laboratories, she could be – they've made it all dark, so they could see the sparks they've been making?*
Interviewer: *so do you think she's in a laboratory?*
Football: *at a secondary school*
Interviewer: *okay and* [Mad M] *what were you saying as well?*
Mad M: *I was going to say that the newspaper – or something like that – they normally have real people, because they tell you about stuff. So that might be a real person, carrying out an experiment*
Interviewer: *so you think that she's a 'real' scientist, rather than someone just pretending to be a scientist? Okay.* [To Pizza:] *What did you want to say about her as well?*
Pizza: *I think she's just advertising, in the newspaper*
Interviewer: *oh okay, so* [Mad M] *thinks she's a real scientist – do you think she's a real scientist?*
Football: *I think she's in a secondary school*

Excerpt 17.9: Pilot participants' discussion about an image of a person wearing goggles.

From this interaction, it is clear that the children do not agree on 'what kind' of scientist the girl in the picture might be. Football thinks that she is a secondary school pupil, Mad M thinks she is a 'real' scientist, and Pizza believes that she is just a person playing the part of a scientist in an advert. While there is some question amongst the children as to the *type* of scientist the girl is, it appears that they are all happy to accept the idea of a female scientist. This might be seen to contrast with some public opinion that science is 'not for girls' (Archer *et al.* 2013; Macdonald, 2014; Zecharia *et al.* 2014). The most recent Girlguiding Girls' Attitudes Survey suggests that there has been a rise in girls' interest in science careers since 2009 (Girlguiding, 2018), and this may be reflected here. In recent years, representation of female scientists has developed away from depicting them as 'tokenistic' wives and mothers (Nelkin, 1995; Shachar 2000) or as "*babe scientists"* (Chimba and Kitzinger 2010, 615). There is some suggestion that films and television have begun to portray women in a range of professional science roles that challenge these gendered stereotypes (Long *et al*. 2010; Steinke 2013; Haynes 2016). Additionally, organisations like the WISE Campaign, Science Grrl and Stemettes have all strived to promote women in STEM. It is likely that a combination of this and other factors has caused the perception that girls can't 'do' science to decrease; a message that has clearly been transmitted to the pupils in this interview.

Another common stereotype of scientists is that of the 'mad scientist' or 'boffin'. This person is often represented in films and the media as a white man, with messy hair and glasses (Pansegrau, 2008; Chimba and Kitzinger 2010), and is an image appears to pervade public perception of how a scientist 'ought' to look (Matthews, 1996; Fung 2002). It would have been reasonable then, to assume that the inclusion of a pair of black, thick rimmed glasses on Mad M's collage (Figure 17.5) may have been a reflection of this stereotype. However, Excerpt 17.10 demonstrates that this was not the case. While this is not evidence that Mad M does not hold *any* stereotypical views of scientists in her head, it suggests that she is able to understand the scientific relevance of the ophthalmology, and believes it to be more significant here than media influenced imagery of a 'mad scientist' or 'boffin'.

Football: [Mad M] *what's the glasses to do with?*
Interviewer: *of course, good question*
Mad M: *so I did that as science because you know people with bad eyesight, somehow glasses make people see*
Football: *that's science. Scientists made that so you can see*

Excerpt 17.10: Football and Mad M discuss the image of glasses on Mad M's collage.

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18 Appendix 6: Pilot pupil task based interview transcript

Title: What does STEM mean to you? (Pilot)

Date: 3rd July 2018

Speakers: Poppy Hodkinson (interviewer), Pizza, Mad M, Football and Orange O

File Duration: 1 Hour and 35 Minutes

Interview location: BF

Interviewer: Okay guys, we're going to be talking about something called 'STEM' today. We've had a little bit of a chat already about what we think that might mean. And we've all *heard* of the word, but we're not really sure what it means at the moment, in this context. So I'm going to write [it] out for you guys. The word STEM is something called an 'acronym', have you heard of an 'acronym'?

Pupils: No

Interviewer: So an acronym is when instead of having one long sentence with lots of different words, you just take the first letter of each of those words. And you shorten it, and you call it something shorter. So for instance: the United Kingdom, we would call the UK

Pizza: The UK

Interviewer: So do you see how UK is an acronym for 'United Kingdom'?

Football: Couldn't you do that with really long names?

Interviewer: You could do! So 'STEM' stands for something. Each of these letters stand for something. Have you guys done 'across-stick poetry' in school?

Pupils: Yeah!

Interviewer: So it's kind of like that. So if you think of it as an across-stick poem. So our first word is – could you write that on for us E? The first word is 'Science'

[Children are spelling out the word to themselves]

Interviewer: Fab, thank you. The next word is a little bit longer than that – could you write that one out M please? It's 'Technology'. How do you think we spell that one?

[Children spell out word to each other]

Interviewer: And then the next word – could *you* do that one for us? – is 'Engineering'. How do you reckon you spell that?

Mad M: Whoa, that's hard!

[Children discuss spelling of word]

Interviewer: You all have lovely handwriting! I love all these swirly letters! And then the last word – what do you think the last word might be? So we've got science, technology, engineering – what word begins with 'm' that sounds…

Mad M: Maths

Interviewer: Brilliant! Yeah the last one is 'maths'. So do you see now that when I talk about 'STEM', instead of saying 'science, technology, engineering, maths' *every* single time, I just say 'STEM'. And when I'm talking about STEM, I mean *all* of those things

Football: All together

Interviewer: All together, yeah

Football: So is English not involved in any of this then?

Interviewer: Not on this one, no. So English is a couple of different things: it's reading and writing, but it's also the language that we're talking to each other in, isn't it? But at the moment, we're just thinking about Science, technology, engineering and maths. And the first thing I want us to have a think about is 'What jobs do you think you could do if were a scientist, someone working in technology, an engineer or a mathematician? So shall we do scientists first?

Pizza: Yeah

Interviewer: What jobs could you do if you were a scientist?

Football: You work in laboratories

Interviewer: Yeah, pop that on!

[Children spell out word]

Interviewer: Fab, so you could work in a laboratory – what other jobs might you have if you're a scientist?

[pause]

Interviewer: If you can't think of any more, that's fine, we can move onto the next one

Mad M: What kind of job does a scientist do?

Interviewer: Yeah – what does a scientist do

Football: Don't they find out –

Mad M: They can find out new creatures

Football: - They find out new stuff?

Interviewer: 'Finding out new stuff' – yeah awesome! Would you like to write that one down?

[chat about recording – Football has been put in charge of the recording equipment, and checks it throughout the session]

Interviewer: So what other jobs use science?

Football: I've got one for technology

Interviewer: You've got one for technology? What's your one for technology?

Football: Can't you be like – YouTubers – they use loads of technology

Interviewer: Yeah, they use technology!

Mad M: You could learn about plants

Interviewer: You *could* learn about plants! Which one is that for?

Orange O: I learn about plants but also play games

Interviewer: What job do you think you might call that if you learn about plants?

Football: Gardener?

Mad M: No!

Orange O: Horticulturalist

Interviewer: Ooh, good word! It that because you're interested in gardening?

Orange O: Yeah, my mum is

Interviewer: You could also learn about plants in a laboratory couldn't you? As well as in a garden

Football: You could just join this and that together

Mad M: Experiment!

Interviewer: Experiment, yeah. And you said 'learn about plants', so we could just write 'learn about plants' – are you going to write that one?

Mad M: Yeah

Football: is that for…?

Interviewer: Which one shall we put that for?

Mad M: Science, and also for the laboratory

Interviewer: Well you could learn about plants *in* a laboratory, or you could learn about them in a garden like [Orange O] said

Orange O: Or in a school

Interviewer: Yeah, you could learn about them at school

[pupil writes word]

Interviewer: Thank you, did we have another one as well?

Football: Technology, could you also do that [point at interviewer's laptop] type of stuff?

Interviewer: So you're pointing to my computer?

Football: Yeah

Interviewer: So what jobs do you think you could do with a computer?

Football: You could be – like what you do? You could look up archaeology stuff, when you do archaeology you have to look up pictures of animals and stuff you have to do

Interviewer: Yeah, absolutely! Do you want to write that one? And what was it you were going to say [Pizza]?

Pizza: Engineering

Interviewer: Ah what was your one for engineering?

Pizza: I was going to say the same

Interviewer: Oh okay

Football: Shall we write it in the middle here?

Interviewer: Where there's space, yeah

Mad M: Wait, can you do any of them?

Interviewer: Yeah! We were just going through them at first, but we can do any of them now

Football: How do you spell 'archaeology'?

Interviewer: Oh that's a tricky one isn't it? [spell out word]

Orange O: I've got one for maths! For Science you also need to use maths as well!

Interviewer: That was a really good thing you just said [Orange O], can you say it for us again?

Orange O: So in science, you also need to use maths to calculate – so like – how long, what the distance is

Football: Couldn't you also do sometimes when you have to do a line, you have to measure all of them with maths. Measure how high stuff is in science, and that relates to maths

Interviewer: Yeah perfect. So that's a really good point guys, that some of the things that you do for your job in science, you might also use maths to be a scientist. Are there any engineering jobs you think?

Orange O: Engineering, building, designing

Football: Yeah building cars

Mad M: My dad used to be an engineer

Football: Can't engineers fix cars?

Pizza: When they break down on the motorway

Football: Yeah, if there's a problem underneath the car they can go under the car, on a skateboard and then they go under and they fix all the stuff

Mad M: My dad used to fix cars

Interviewer: So that was some really good ideas guys, you said engineering was designing buildings – I like that! You said engineering was:

Pizza: If they break down on the motorway

Interviewer: If cars break down on the motorway. You said your dad was an engineer! What did he do?

Mad M: He fixed cars on the street

Interviewer: On the street rather than on the motorway? Do you reckon it was different?

Mad M: [shake head]

Interviewer: [laugh] no? Okay. So you guys both said fixing cars, and then you said engineering could be…?

Football: Fixing broken parts of the car as well. It doesn't have to be when they break down

Interviewer: What else needs fixing?

Orange O: Tractors?

Interviewer: Yeah! There's loads of other things that you might fix

Football: Any car has to be fixed sometimes

Orange O: Lamborghini!

Interviewer: Even a Lamborghini yeah! [laugh] Okay, what about maths? What jobs do you think – as well as being a scientist – uses maths? What other jobs do you think you might do where you need to use maths?

Pizza: How do you spell motorway?

[Children discuss spelling on 'motorway', and confusing spellings]

Football: We're on 13 minutes

Interviewer: 13 minutes? Brilliant, thank you. So what jobs use maths?

Mad M: If you were a police, you would need to know maths.

Football: Me and [Mad M] have [unclear word] police

Mad M: Or you find something out and you want to find out how old it is –

Football: You need to use maths

Mad M: You might find a number written in an olden day, and then you'd have to use your maths to find out

Orange O: Yeah, just like an archaeologist

Interviewer: So you could put Police on there

Football: Shop keepers need to use [maths], to add up all the stuff the customers want to buy

Interviewer: Yeah, definitely. You need to use maths in a shop

Football: Cause we have a shop at the top of the rec and when we buy stuff they have to add it up on a calculator

Interviewer: Ah okay

Football: Or in their head

Interviewer: Okay, so can we think of *any* other jobs that we might use any of those skills in?

Pizza: You could be a teacher

Football: Yeah you could be

Interviewer: Yeah you need to use *all* of those things to be a teacher!

Mad M: Teachers learn from other people, because they need to know, they need to learn how to be a teacher

Football: Teachers learn from other teachers

Pizza: Children need to learn as well

Orange O: Park keeper?

Interviewer: Park keeper? What kind of skills do you need to be a park keeper?

Orange O: They would use technology or maths

Interviewer: You could put 'park keeper' and then put an arrow to both, couldn't you?

Mad M: You can weigh out how heavy stuff is

Interviewer: Yeah?

Football: Sweet shops have to count all the sweets, or like [Mad M] said – the weighing of them. Some shops judge by the weighing of the [sweets], so they'll pay that. And they also need that as well, because they need to add up the money, or the change to give them. So say they gave them a £20 note, and [it was] £15, they would have to work out £5. Or they would give them a £5 note

Interviewer: [to Mad M] and what kind of things do they weigh?

Mad M: Sweets

Interviewer: Sweets, what other things might you weigh?

Football: Grams

Interviewer: Yeah, you weigh in grams possibly. What other things might you weigh out?

Orange O: Kilograms

Football: The dough! The dough for pizzas and stuff

Interviewer: Yeah! Do you want to write that one on? Which skill do you think that was [Pizza]? If you're weighing out your dough, which one does that come under?

Football: [whisper] maths

Pizza: Shall I write 'pizza dough'?

Interviewer: It could be anything

Orange O: We make homemade pizzas

Interviewer: Do you? Wow

Football: We made pizza on our Italian day at school. We got in our four groups and we made them

Orange O: When I make my dough at home for pizza –

Football: Some pizza people spin in on their fingers!

Orange O: When we get it to dry, or something –

Football: And they throw it in the air. And then it will go on their head! [laughs]

Orange O: - to make it rise. It rises – so here's the top of the bowl [gestures], and then – wait no. The bottom of the bowl is here

Interviewer: Yeah?

Orange O: And the top of the bowl is up here somewhere, then it goes from the bottom of the bowl to up here

Interviewer: It rises that much? Wow!

Football: That would be a big pizza

Interviewer: You need all that air in your dough, don't you?

Orange O: Yeah

Interviewer: Okay, so we've got some really good things on here guys. Let's just come back to science for a second – what kind of people who use science, might you have met in your life?

Pizza: Museum. If they do finding stuff out

Interviewer: Yeah, so people who work in a museum

Orange O: One of my great-grandfathers was a scientist

Interviewer: One of your grandfathers was a scientist? Fab! [to Pizza] write on the museum one

Orange O: He wasn't a very famous one

Interviewer: What kind of scientist was he?

Orange O: A moon and star kind of scientist

Interviewer: Ooh, so an [astronomer]?

Football: Albert Einstein had to use science

[children chant 'Albert Einstein' a few times]

Interviewer: He was a researcher wasn't he?

Orange O: He was a German

Interviewer: What about if you're feeling a bit poorly? Who do you go and see?

Football: The doctor

Interviewer: What kind of skills do doctors use?

Pizza: Science

Interviewer: Yeah!

Football: They need to know, say you had something wrong with your skin – they need to know

Orange O: They would have gone to university

Mad M: They have to learn about it before

Football: Because if you go up to them and say "I've got a problem with my arm", they say "Oh let's just put some Calpol all over it!" – and they won't know what to do!

Interviewer: [laugh] You said 'medicine' didn't you?

Mad M: No, I said 'medic'

Interviewer: Ah medic, so what is a 'medic?

Football: Paramedic

Orange O: [Friend's] dad's a paramedic

Mad M: Is that one of those things people cut people open with?

Interviewer: If you're a surgeon you might cut someone open with a scalpel?

Orange O: Do you know

Interviewer: But if you're a 'medic', you're someone who practices medicine – does that make sense? So you might say "This person practices medicine, they are a medic". So they're a doctor, what kind of knowledge is that? What kind of knowledge does medicine relate to?

Pizza: Science?

Interviewer: Yeah, do you know which part of science?

[pause]

Interviewer: So there are three different parts of science: there's biology, chemistry and physics

Pizza: Chemistry?

Interviewer: Yeah! It relates to chemistry quite a lot – knowing which medicines to give people

Orange O: Physics?

Interviewer: What's biology?

Orange O: Biology? Is like archaeology

[laughs]

Interviewer: Not quite! Biology is plants and animals

Orange O: Ooh plants!

Interviewer: Biology is how our bodies work and how plants work. So if you're a medic, you might use biology to understand how bodies work

Orange O: My mum uses biology

Interviewer: Yeah she does! And you need to know chemistry, because you need to know how tablets and medicine will work

Football: Don't paramedics have to use maths when someone faints, they get those taser things and put them on their chests, and then the numbers will come up on the thing. And that will make them come back

Interviewer: Yeah, so that's

Orange O: My friend fainted once

Interviewer: Did they?

Orange O: He fainted in the toilet and his head went down

Interviewer: So if someone's heart stops working, they'll use an electric shock to try and start it again. Okay, have we talked about all the jobs that we can think of now guys?

Football: We could do more about technology

Interviewer: So with the technology, you mentioned my computer. And you said that *using* the computer was working with technology, but who made my computer?

Football: Apple

Interviewer: Yeah, so who works for Apple?

Mad M: Scientists

Football: It's not just Apple, you've got Windows and -

Orange O: Samsung

Football: - and Dell and all of that stuff

Interviewer: So, all of those people who are making computers – what kind of job do you think they're doing?

Football: They're technology scientists!

Interviewer: Yeah

Football: If that's even a thing

Orange O: HP

Interviewer: Yeah so they work in technology

[chat about Orange O's wonky chair]

Interviewer: So [Orange O] said one thing about engineering: designing buildings is part of engineering. Is there anything else that you think, as well as designing buildings

Football: I've got a cousin who studies archaeology at Cambridge university, and he's really good at drawing, and he's drawn all these pictures of everything

Interviewer: Brilliant, so what else might you design if you're an engineer?

Football: Couldn't you design tools? Like new tools? Like hammers and stuff, or chainsaws?

Mad M: Or you could go to an old place and try to find stuff

Football: Doesn't archaeology people – you know old buildings? Don't they look at them and they draw pictures of it, all broken up and stuff?

Orange O: They look inside the buildings and dig to try and find any clues

Football: Sometimes they go, some have a big – it's like a picture – a setting, say a field with trees and stuff like that – they won't just go there to draw a single thing, they'll probably go further back

Orange O: Yeah, they'll draw all sorts

Football: They'll draw the whole field

Interviewer: Yeah, they do. How long have we been talking now guys?

Football: 23 minutes

Orange O: Can we pause it and listen to it?

Interviewer: You can if you want to, but it would take us *23* minutes to listen to back – we can listen to it later, because if we listened to it right now, then it would be *40* minutes!

Mad M: Are we doing this after the break?

Interviewer: Sorry?

Mad M: Are we doing this after the break?

Interviewer: I don't think so, I think you're going back into normal lessons afterwards

Orange O: Awwwh

Football: Are we doing it up to break?

Mad M: Are we doing it after lunch?

Football: Are you coming in after lunch?

Interviewer: Yeah, I'm going to do some archaeology with you guys after lunch

Football: So can we go outside and draw stuff?

[chat about coloured paper, which colours people want to use]

Interviewer: Okay guys, so what I want us to do now. Remembering all the things that we've talked about. Of what people do in their jobs if they're a scientist, if they work in technology, if they're an engineer or if they're a mathematician – I was wondering if you guys could make a collage now –

Orange O: My mum makes flower collages

Interviewer: That sounds beautiful! Does she make them out of the actual flowers?

Orange O: Yeah

Interviewer: Wow

Football: When you press flowers

Interviewer: Is that how she does it?

Orange O: No, she normally just takes the whole flower and then she cuts off some of the stalk, and some of the sap comes out and then she sticks it into this foam

Interviewer: Ah I see, so she makes a flower arrangement?

Orange O: Yeah

Interviewer: Lovely. So with our collages today

Football: What's a collage again, I've forgotten

Orange O: Already?

Interviewer: Do you guys know what a collage is, or shall I explain? So a collage –

Orange O: I know what a flower one is

Interviewer: - is when you take lots and lots of different things –

Football: Oh, pictures and then you put them together

Interviewer: Today, we're going to do pictures yeah

Football: So it's like your own made up newspaper?

Pizza: Yeah

Interviewer: Yeah! Kind of. I was wondering if you guys could make a collage that shows what STEM means to you? So what does STEM mean to you?

[pause]

Interviewer: Or you can decide as you go through. So I've got a couple of magazines, with some different pictures there

Football: I want to cut out this bit and stick it at the top

Interviewer: Yeah, definitely. So you can cut out whichever bits you want from all of these, and there are pens as well so if you can't find the word that you want, you can just write the word instead. And you can all share the different magazines, so if you're not happy with the one that you've got, you can look and use some of the other ones okay?

Mad M: Wait, so what kind of… [unclear speech]

Interviewer: It's what STEM means to you, so as you're flicking through there – do you see anything in those pictures –

Orange O: I'm just cutting out plants

Interviewer: Okay, so do you see anything that might mean something about science, technology, engineering or maths?

Orange O: Yes! Plant!

Interviewer: So do any of those pictures make you think of that?

Orange O: Yes, these!

Interviewer: Yeah, those. Brilliant

Football: Can we keep coming back to look at these?

Interviewer: Yeah of course you can

Football: We're missing French, I don't like French.

Orange O: I like doing the numbers

Football: We only like counting up and just have to write everything in French

Orange O: I like doing the number song

Interviewer: Ooh there's some glue as well, you can use to stick things down

Orange O: Do you like the number song?

Interviewer: What's the number song? I'm not sure I've heard of that

[pupils sing numbers in French]

Interviewer: Whoa you guys can go really high!

Football: We can do it up to 100 if we have it on the board

Orange O: Mini glues! [Friend's] got these at home

Football: They're mini!

Orange O: Are these new glues?

Interviewer: Yeah, they're brand new – I bought them yesterday for you guys

Orange O: Yay!

Football: I just like looking through [the magazines], they have interesting pictures

Interviewer: See what's in there? Yeah

Football: I think we could look through them first, then see if we see a picture, then we can use that picture

Orange O: This is going to be my title

Interviewer: That's a good title

Football: I've done a science title

Interviewer: What does yours say on there? 'Science, technology' it says on there already?

Football: I found science and technology, I found it on this [magazine]

Interviewer: Wow, that's handy

Football: Have you got some technology ones or is this the technology one?

Interviewer: There are lots of different ones, so this is just a mixture of different magazines

Football: Can I cut out this robot, because he's technology?

Interviewer: You can cut out whichever pictures you want

Football: And we can cut out the iPads, because they're technology

Orange O: What iPads?

Football: iPads in my newspaper

Interviewer: I've got these magazines here as well, oh you've got that one

Orange O: I've got plants!

Interviewer: Plants, very nice

Football: Are we going to be doing these in class?

Interviewer: No, this is just now

Football: No, when you come and teach us after lunch

Interviewer: No no, we're going to do something different after lunch

Football: Are we drawing after lunch?

Mad M: This is an engineer because you're designing clothes

Interviewer: Ahhh, very good.

Mad M: What does this mean?

Interviewer: 'Top of the Crops'? Have you heard of Top of the Pops?

Mad M: No

Interviewer: Top of the Pops is an old TV show, that all of the people that had made music that was popular that week, whoever's song was most popular in the charts, they would play it on that programme. So *that's* a joke, 'crops' is referring to the cropped trousers. So do you see how it's a play on words with Top of the Pops?

Mad M: Wait, so does it go on engineering?

Interviewer: That's not necessarily anything about engineering, that's just a joke that they've put in there

Orange O: I'm going to put this big bunch of flowers

Interviewer: That's a nice bunch of flowers

Football: We've done half an hour

Interviewer: We've done half an hour? Fab, thank you. Is there anything else in there that makes you think of technology?

Mad M: It's just 'summer'

Orange O: This has a big robot!

Football: Whoa! I've got a Samsung Galaxy S9 on the back

Interviewer: Do you want to have a look at a different one? I've got a couple of pages that I've pulled out there

Orange O: My mum's got that!

Mad M: I'll have a look at this

Orange O: My Mum's got a Samsung Galaxy

Football: My Mum's got an iPhone 8. I don't know, what should I cut out? Should I cut out this or should I cut out the robot?

Interviewer: Well you could do both couldn't you?

Football: Yeah

Interviewer: Do both if you want to

Football: Is that 'design'?

Pizza: That's design

Interviewer: Yeah, that's designing – really good

Orange O: There's a football goal! How amazing

Football: I'm not going to cut out him, he looks a bit…

Interviewer: Does he not look interesting enough?

Football: No

Interviewer: Okay

Football: Only the robot does

Interviewer: If that person is in the same picture as the robot, why aren't they related to technology but the robot is?

Football: Well he's controlling the robot I think, with the head thing

Interviewer: Yeah, do you reckon? So is he related to technology as well?

Football: Nah, he looks like a real person, not a robot man

Interviewer: But he might work with the robot? He might have designed it?

Football: I don't know, should I cut out or not?

Interviewer: Whatever you want

Orange O: I'm going to write about it as well

Football: I'm going to cut out the robot, and now I'm going to cut out the Samsung Galaxy as well

Mad M: Can you stick it down?

Interviewer: Yeah if you want to

Pizza: Ew!

Interviewer: Oh what are those?

Pizza: Spiders

Football: Is that my magazine?

Pizza: Yeah

Interviewer: All the magazines belong to everyone

Football: I need to cut out the Samsung Galaxy

Orange O: They belong to me!

Football: You can have one of the Samsung Galaxy S8s [Pizza]

Interviewer: You can look at the rest of the magazine

Football: You can have one of the Samsung Galaxy S8s and I want the other one

Interviewer: Yeah, there are three of them aren't there?

Football: I want the big one at the front

Interviewer: What do you say?

Football: I'd like the big one at the front

Pizza: I'll have that one

Interviewer: You guys have sorted it out? Fab

Football: You have the pink one, I'll have that one

Pizza: Okay

Football: You can have them two and I'll have that one

Pizza: No, I want this one

Orange O: I'll have the middle one then. If it's still there [laughs]

Interviewer: There'll be some other pictures of phones

Football: Yeah like this! [gesture to phone recording the session]

Interviewer: [laugh] well you can't stick that one on there

Football: You can have both, but you're not having that other one

Pizza: Okay

Interviewer: Do you want to look at some other magazines?

Orange O: No, I like the plants one

Interviewer: You like the plants one, okay

Football: I like the technology one, and all the robots and stuff. I'm going to overlap mine, and have them like that

Interviewer: Ah, so you've got more space? Nice!

Football: And I like putting them on an angle, so you get more [on]. I'm going to put small ones in the corner and then bigger ones here

Interviewer: Smart

Orange O: I'm going to be smart

Interviewer: You're going to be smart as well?

Football: I'm going for a border around the phone, so it's not just going to be the phone, I'm going to have a bit of white around it

Interviewer: Ah, I see very nice

Football: Like how [Pizza's] done it

[chat about glue sticks]

Orange O: I'm being clever, because look – there's one there and one there

Interviewer: Uh huh

Orange O: I'm just going to stick this part

Interviewer: So you can lift it up?

Orange O: Yeah

Interviewer: Very smart, I like that

Orange O: Yeah, you can lift

Interviewer: So you make a little fold?

Football: Yeah, you can have something underneath, like the latest technology – then you could have an old picture

Mad M: Are you allowed to cut that out?

Interviewer: You can cut whatever you want out. All of these magazines were collected by my mum, so that you guys could cut them all out

Football: This is better than French

Pizza: And they're also doing science

Orange O: Yes!

Interviewer: Oh, you're missing science?

Football: But we're doing better science

Interviewer: Well this is kind of science, well a *little* bit – we're talking about science. We're not learning any new science, but we are talking about it

Orange O: It's about archaeology

Interviewer: We'll be talking about archaeology this afternoon

Football: I can't wait to do archaeology

Orange O: We had an archaeologist come into [school]

Pupils: yeah!

Interviewer: Ahhh

[chat about magazines/ newspapers to choose from]

Football: [Pizza] can I have that front picture?

Pizza: Seriously?

Interviewer: Which picture is it that you want?

Football: The lamppost is technology

Interviewer: Is that alright [Pizza]?

Pizza: Yeah, I don't want it

Football: I'll wait till you've finished

Interviewer: You could have a look through some of the other ones if you wanted, while you're waiting?

Football: This one is boring

Interviewer: That one's a clothes magazine.

Football: Yeah that's a clothes one

Interviewer: But there are people in there, do people do science?

Mad M: Yeah

Orange O: No

Pizza: They could be models!

Football: I'm going to find one with that weird pattern

Mad M: It's engineering designing clothes

Football: I could cut out this picture!

Interviewer: Oh yeah, what's he doing in that picture?

Football: Talking

Interviewer: Who's he talking to?

Orange O: His parents

Football: I don't know. I'm going to have a hand in the middle

Interviewer: That's okay

Football: I'll just cut from here

Interviewer: Nice

Football: We have done 38 minutes

Interviewer: 38 minutes? Well you guys are going to need to go back to your lessons soon

Football: We go to play at 10:45

Interviewer: Oh okay, well you might go back to your lesson before then, because I'm not sure when Miss wants you to come back again

Football: We could stay here all the way till break!

Interviewer: We'll see how we go guys. Are you okay [Pizza]? Do you need anything else to look at?

Pizza: I'll look at this one

Interviewer: You're going to look at that one? Cool

Orange O: Oh yeah, that one's a really good magazine. I like that one

Football: [Orange O's] gone for really big pictures. He's got more bigger ones

Orange O: I'm only putting three pictures in

Interviewer: That's okay

Orange O: Actually no, I might actually put some smaller ones in now

Interviewer: You're going to put some small ones in as well?

Football: This one can go in small gaps, then I have all this big space!

[chat about school 'helping hand' scheme]

Orange O: What is that?

Football: It's a lamppost. I cut half of it off

Interviewer: You cut the hand off

Interviewer: [to Mad M] did you want to look at any other magazines, or are you enjoying that one? Are there lots of things that you like in there?

Mad M: I like baking

Football: Can you find me a maths one?

Interviewer: I'm not sure I have a specifically maths magazine, but what things might you find in all of these that are to do with maths?

Football: I'm going to have a look in this one

Interviewer: You might find something that's to do with maths

Pupils: Whoa!

Interviewer: What is it guys?

Football: I want to put that in mine!

Interviewer: What is it? [image of a large robot] Oh wow!

Pizza: How is that going to fit?

Football: I'm going to cut half of it off

Pizza: Don't do the legs

Football: I'm going to do that

Interviewer: Who do you think that is?

Football: A Japanese robot

Interviewer: Ah, does it have a description?

Football: [reading from magazine] "The child Japanese engineer"

Mad M: How do you know it's Japanese?

Football: It says Japanese on it

Interviewer: It's got some Japanese writing on it

Football: Whoa that is big!

Orange O: A child made that?

Interviewer: Did they? Wow

Orange O: It says

Interviewer: Let's have a look. So the engineer when he was a child he liked watching robots. That would be impressive though if a child made it

Football: I'm going to just cut half of his body off, because I don't think it will fit on mine

Interviewer: That's fine

Football: But then, I really want some more space but then I'm going to do this guy. I'm just going to use his head

Pizza: Only his head?

Interviewer: Poor robot, having his head chopped off

Orange O: His head's dead. And the machine gun

Football: Yeah and the machine gun

Mad M: Can science be doing with glasses? Because something with glasses has science to make people see

Orange O: [about the robot] He's dead!

Interviewer: Absolutely yeah, that's really good

Football: He's officially gone!

Orange O: [Football] you've lost the page!

Football: He's officially gone

Interviewer: Oh okay, you've just got his head now

Football: I'm going to do one of his arms as well, I want to show it's a proper robot

Orange O: A machine gun! It's because he has a machine gun

Interviewer: I don't think he has a machine gun

Football: No it doesn't

Orange O: Yes it does!

Interviewer: Surely he's a friendly robot?

Orange O: He's got a machine gun!

Football: O it's not a machine gun

Orange O: Well it looks like it!

Football: Oh I'm cutting out these laptops! E do you want a laptop?

Pizza: Yeah

Football: And I'm going to cut out a watch

Orange O: Oh come on! It's a machine gun!

Football: I'm going to cut out the laptop and watch

Orange O: Can I get another piece of paper?

Football: Mine's more technology

Pizza: O's is more science, mine's more…

Interviewer: At the end we're all going to get a chance to explain what we've done, to each other – we're all going to talk about it with each other

Football: We've done 43 minutes. He [robot] looks funny now without a body

Interviewer: He does! He looks silly doesn't he?

Interviewer: What are you doing [Pizza]? Oh, you're waiting for that?

Pizza: You can have that one

Orange O: How do you spell technology?

Interviewer: [spell out technology]

[chat about schools theatre production]

Interviewer: Do you need some more pictures for yours or are you still writing a title?

Orange O: Can I get a laptop to research stuff for this?

Interviewer: You'd like a picture of a laptop for yours as well?

Orange O: No, I'd like to research on a laptop

Interviewer: You just want to look on one? That's fine yeah

Football: Look how much money they are! They're £979!

Orange O: I've got one of them

Pizza: Almost £1000! Is the difference just because it's a rainbow keyboard?

Orange O: I've got one of them at home

Football: This is a rainbow keyboard, this ones the smallest and that one's £1269!

Pizza: That's basically £1270

Football: They do that because then you think it's a bit cheaper, but actually

[chat about who is getting which laptop image]

Football: And now it says E's is £1599! That's actually £1600!

Interviewer: So what have you guys just been talking about there?

Mad M: Money

Interviewer: And what's that related to?

Football: Maths!

Interviewer: You were looking for some maths weren't you?

Football: I'll cut out the money! I'll cut out one for you [to Pizza]

Pizza: Okay

Interviewer: [to Orange O] Is your computer turning on?

Orange O: Yeah

Pizza: That one's mine

Football: No, this is mine, that's yours.

[pause]

Football: Where's my watch? I'm going to stick it in, once I've got my laptop [word missing]

Interviewer: Oh look, I've just found a picture of a laptop

Football: Where?

Interviewer: Does someone want a picture of a laptop? I'll leave it there in case anyone wanted to use that one. What are you waiting for now [Pizza]?

[Pizza gestures to magazine being used. Indistinct chatter]

Interviewer: were you looking for any price or that particular price?

Pizza: I don't care what price

Interviewer: There's a price written on there

Football: I can cut you out this one?

Pizza: No, I'll just do this

Football: This is not how messy it's going to be cut out

Interviewer: You're just doing it quickly to get it out?

Football: So I can get it out, and then I'll…

[children decide they want another table, add one to the group and shift around accordingly]

Football: Where's your phone gone?

Interviewer: It's here don't worry – what are we on?

Football: 50 minutes. Well it's on 49, but it's closer

Interviewer: What have you done there to get it to 50?

Football: Rounded

Interviewer: Did someone need…?

Football: Oh that was part of mine, but [Orange O] can have that

[chatter]

Football: My laptop has been in the wars [it has a chunk missing where it has been cut out]

Interviewer: It's been in the wars? [laugh]

Football: I've got a really good idea

Pizza: That man's doing something

Interviewer: What do you think he's doing?

Pizza: He's…

Orange O: Look what I've found

Interviewer: Oh wow, what do you think that one is?

Football: A steam turbine

Interviewer: A steam turbine? What do you think a steam turbine is?

Pizza: O… O…

Football: [Orange O] you *need* that on yours

Orange O: Oh yes please

Interviewer: What makes a turbine go around normally?

Orange O: Wind

Interviewer: Yeah, so if this is a *steam* turbine, what do you think they use to make it go around?

Orange O: Steam!

Interviewer: Yeah!

Football: Open my laptop up! [Football has stuck half the laptop to the page, allowing you to 'open' the lid and see the price underneath]

Interviewer: [laugh] very good!

Football: There's the price on there – 1000… There's more space now because I…

Interviewer: Because you put that one underneath? Maybe you should do a little arrow, so you know to flip it?

Football: Yeah

Interviewer: [to Orange O] have you lost your orange pen? Which one are you looking for?

Orange O: I've lost my 'science' thing

[looking for 'science' label]

Football: [to Pizza] Oh you took the shoe! You've got the shoe. [Pizza] took the shoe

Interviewer: You've got the shoe? Nice

Football: [Orange O] and [Mad M] have gone for plants, me and [Pizza] have gone for technology

Mad M: I haven't just done plants. I've done glasses and I've done [indistinct]

Interviewer: Ah you've got loads of things on yours

Football: I've got loads, mine's just more bunched up.

Pizza: Are we allowed to do some on the back?

Interviewer: Of course you are!

Mad M: I'm just doing this one on the back

Interviewer: That's fine with me, do whatever you want guys, it's your picture. Make it however you want it to look

Football: I need to find my special magazine, where's my special magazine?

Pizza: This is my special magazine

Football: Where's my special magazine?

Interviewer: Which one is that? The technology one?

Football: Yeah

Mad M: I think I have it

Interviewer: Are you finished with it [Mad M]?

Mad M: I'm still looking

Interviewer: [Mad M's] just using it at the moment [Football], but you can have a look at some other ones while she's using it

[pause in chat while children are working]

Football: I might cut out that page once you're done

[children continue working without speaking]

Football: Whoa! No no no, I'm cutting out that robot here! Look at that

Interviewer: Did you want to use that robot [Mad M]?

[Mad M shakes head]

Interviewer: No? Okay, so you don't mind?

Mad M: You can use that as well

Pizza: [Orange O]? Are you using that magazine?

Orange O: Yes!

Football: [Pizza] you took the man's head off!

Pizza: No I didn't

Football: Yeah you did

Orange O: No, I did that

Football: Oh [Orange O] did that!

Interviewer: Are we done with this one?

Football: Yeah

Interviewer: What are you looking for [Pizza]?

Pizza: A big plant

Football: Whoa, look at all that rubbish on the [unclear, but referring to image in magazine]

Interviewer: A big plant? There were some plants in those ones

Orange O: Look at all the rubbish on that [indistinct]

Interviewer: Oh no, that's no good is it?

Orange O: Cut it out and stick it in [Football]

Football: No!

Orange O: Yeah! Then we can warn other people

Football: This is the scientists!

Interviewer: You've found some scientists?

Football: Brains!

Interviewer: Ooh very good

Orange O: Who needs a brain when you've got a muscle?

Mad M: I need a brain, I need a brain to think

Interviewer: Everyone needs a brain!

Football: We're on 54 minutes

Interviewer: 54 minutes?

Football: Remember when we said "oh six minutes isn't a long time"?

Interviewer: Yeah, right!

Pizza: Time's gone fast!

Orange O: It's a long time now!

Interviewer: It is

Mad M: Wait, is it still recording?

Football: Yeah! It's on 54 minutes

Interviewer: So I can remember everything that we talked about

Orange O: That's my sister! [pointing to image in magazine]

Football: No it isn't

Orange O: Yes it is!

Pizza: That's not [her]

Orange O: That *is* [her]

Interviewer: Why's she in that magazine?

Orange O: It looks like her

Football: It looks like her, it's not actually

Mad M: That's definitely not [her]

Orange O: It might be

Mad M: If it was, you would have been there

Orange O: No, I might have been at a party

[children laugh]

Football: Random thing. [To interviewer] I think *you* should make one

Interviewer: You think I should make one? Oh if I make one then there'll be no pictures left over for you guys

Football: Yeah there will

Mad M: I only need one more picture

Football: We don't mind! You make one! Use that extra paper Yes!

Interviewer: I'll use the extra bits?

Football: Use a yellow thing

Interviewer: No one wants the yellow paper do they?

Football: You can use it. And then we can all show each other each other's [work]

Interviewer: Okay I'll have a go then

Orange O: Where is the scissors?

Football: I think you should start with this book first, the fashion one. And you can also borrow this page if you want some brains

Interviewer: Yeah I like those brains

[children working without speaking]

Football: There you go, if you want to cut some out

Interviewer: Ah thank you

Mad M: I can hear [Class Teacher]

Interviewer: Does that mean it's time for you guys to go back to lesson?

Football: No, she's not teaching us

Mad M: What are we on?

Pizza: 57 minutes

Interviewer: So I think now, because [Pizza] and [Mad M] are finished we're going to talk about what's on our pictures

Orange O: Can I go videos and watch something? About technology and science?

Interviewer: Is your collage finished?

Orange O: Not yet

Interviewer: What video did you want to watch about technology and science?

Orange O: Erm, so this. One of these. So technology since the 1970s

Interviewer: Oh that sounds interesting, it's quite long though – do you mind if you maybe save that one for later? See how long it is? We're going to talk about what we've what we've done now

Orange O: This one is seven minutes

Interviewer: It's still quite long, that's not quite the task that we're doing at the moment. You can watch it later maybe?

Orange O: Okay

Interviewer: Is that all right?

[Children suggest Class Teacher comes in to look at pupil's work]

Interviewer: Are you all finished?

Football: I've just got two or three or four more pictures to do

Interviewer: Okay, you can carry on doing yours quietly while we all talk about ours?

Orange O: And mine

Interviewer: Okay!

Mad M: Shall we tidy up first?

Football: What's this? [image in magazine]

Interviewer: Oh I don't know, what does it say it is? What does the advert say?

Pizza: Electrotonic

Football: Oh I know what it is!

Orange O: Imagine if it hadn't been recording the whole time!

Interviewer: That would be silly wouldn't it?

Orange O: I'm going to wait till it turns an hour.

Football: [about image in magazine] It's like a mini magnifying glass, but you stick onto the…

Orange O: Can we pause it when it's an hour?

Interviewer: Yeah, course you can

Football: Why do we need to pause it?

Interviewer: So you can see it saying an hour

Football: Oh. And then can we un-press pause and it will carry on?

Interviewer: Yeah! Are you ready?

Pupils: 3, 2, 1 go!

[recording is paused and un-paused]

Football: We need to go and get [Class Teacher]

Orange O: Shall I go and get [Class Teacher]?

Football: Yeah go on [Orange O]

Interviewer: If you're still going, you don't need to go and get her

[chat about getting Class Teacher and tidying up]

Football: I cut out the mini…

Class Teacher: Hello!

Football: We've been recording for an hour!

Interviewer: They've been really good Miss, they've had some really great ideas. Can we tell Mrs A what we've been doing? What was the first thing that we did?

Football: We done a map

Interviewer: What was that for?

Football: STEM! It stands for Science, Technology, Engineering and Maths

Interviewer: And what are all the words around it?

Pizza: These are things that you could be, so 'learn about plants' for science

Football: And you could be a youtuber

Pizza: A museum

Class Teacher: All the different jobs you could do?

Pizza: Yeah. And then for technology, you could be a youtuber. And for engineering, if you break down on the motorway, maths: police, teacher, shop keeper and pizza dough

Interviewer: What are we doing with the pizza dough?

Mad M: Weighing it

Football: And we also made a – what're they called again?

Interviewer: Collage

Football: We also made collages, well we haven't finished them yet

[children all speak over each other to tell Class Teacher what is on their collage. Class Teacher agrees that pupils may come back to the session after break]

Orange O: Can I tell you [what he's researched]

Interviewer: Yeah of course

Orange O: Google's been around since 1998, Wikipedia's been around since 2001, Facebook's been around since 2004, YouTube's been around since 2005, Twitter since 2006, iPhone since 2007, Kindle since 2007

Interviewer: Really? So that shows how technology has changed then?

[Children go for break time]

Interviewer: Okay, so [Football], you want to tell us about your picture first?

Football: Mine's –

Interviewer: Can you talk us through it please?

Football: Well, mine's more technology and maths more than science and engineering. Yeah, just science

Interviewer: Yeah? How come?

Football: Cause I have all pictures of – I have robots, I have computers, I have phones, telescopes, TVs, iPads.

Interviewer: Yeah?

Football: And then on my picture, I mean paper

Interviewer: Yeah?

Football: I've got a picture of a computer, then I thought money goes with maths, so I made a flappy bit on the computer, so it lifts up. And underneath the price

Interviewer: Ah brilliant, okay

Football: It's a lot of money

Interviewer: It *is* a lot of money isn't it? Okay, and what made you choose technology things?

Football: I just like – I like games, video games and stuff. I like playing and I just like technology

Interviewer: Okay

Football: And maths

Interviewer: And maths? So you like technology and maths – and that's what made you choose those pictures?

Football: Yes

Interviewer: And [what are the] pictures you've got here?

Football: So [those] two are – one's a robot that's controlled by a man, and I just haven't done the man because it was too big. And then I found a two page size robot, and I've only got his head

Interviewer: You only put his head on? Why did you only put his head on?

Football: Because the paper was two times the size of this [gesture to collage]

Interviewer: Oh fair enough, so you just put his head on so it would fit?

Football: Yeah

Interviewer: Okay, is there anything else you want to tell us about?

Football: Yeah, I got two health things

Interviewer: Yeah

Football: To go with my title. My title is 'science, technology and health'

Interviewer: Okay

Football: That's what I found

Interviewer: Yep, why did you choose this title?

Football: Because I just found it on a magazine and I thought it would be interesting to do 'science, technology and health'

Interviewer: Yep?

Football: And then with three of my pictures, they relate to health

Interviewer: Which three are those?

Football: That one, that one, that one [brains, heart rate monitoring watch, and iPad with image on it]

Interviewer: How does this one relate to healthcare?

Football: That's a watch, underneath it has a heart count thing

Interviewer: Oh so this watch, what does it do sorry?

Football: It counts the beats of your heart – to make sure you're healthy

Orange O: Heartrate

Football: Yeah, heartrate and how well you do. And a brain. There's more pictures on [of brains]

Interviewer: Why did you choose the brains?

Football: They've found interesting parts on it [the brain has sections highlighted] and so where bits of the brain are important. So the back of your brain will go to the side, like here. That bit's important, and there's a ridge going over your head, that will connect these blobs here

Interviewer: Okay, and which bits here do you think are important?

Football: The back bits

Interviewer: Which bits sorry?

Football: The back brain

Interviewer: Ah right okay, do you think that these coloured bits mean anything?

Football: Yeah, that's the most important part of the pictures

Interviewer: Ah so you think they've 'lit up' the important parts

Football: Yeah, and then this one's a – that's an x-ray

Interviewer: An x-ray? [the image is an iPad showing a close up of a beetle]

Football: That's what I found on the magazine, it said an x-ray

Interviewer: An x-ray, okay. And what made you choose 'health' as part of science and technology?

Football: Well, I just found this [title of magazine, which he has cut out and stuck on the collage] title and I just thought I'd just do health if it was on the title

Interviewer: Ah okay, so you chose to talk about health because it was on there as well?

Football: And I've got a mini microscope, so it attaches to the actual thing and you put your eye through it and it will make you see clearly

Interviewer: Ahh

Football: A telescope. I thought about a bit of engineering as well, for the phone, the laptop and iPad and TV

Interviewer: Okay, and what makes them 'engineering'?

Football: The light, lamppost has a lightbulb in it, so that will make it brighten up. The phone has technology to make it work. So say you want to look up the World Cup scores or something, you'll look it up on google and that will link the engineering. Because the engineers that made it are like scientist engineers. Because they found out how to do it. And the tv is the same as the phone

Interviewer: Okay

Football: But you can't really – you watch stuff more instead of

Interviewer: Yeah, you do

Football: An iPad, basically same as phone as well

Interviewer: Okay, is that everything you wanted to tell us about your pictures?

Football: Yeah

Interviewer: Who would like to go next?

Football: [Pizza]

Pizza: Okay. Well I did more technology as well. And I put on some phones, a robot

Interviewer: Yeah?

Pizza: And on the back, I did all flowers

Interviewer: Okay

Pizza: And then I picked the shoe out from – engineering?

Interviewer: Okay, and what was the shoe – how did that relate to engineering?

Pizza: Because it's like designing

Interviewer: Okay yeah

Pizza: And also I did money for maths

Interviewer: Very good

Pizza: And my title was education, and also I put this price tag for maths

Interviewer: Ah okay. So you've got a little stack of coins at the bottom. And why did you choose this picture?

Pizza: Because it was just in the magazine and looked science-y

Interviewer: What looks 'science-y' about it?

Pizza: Because she's playing with sparks and she's wearing goggles. Because you normally wear those goggles in science

Interviewer: Ah so you've used the clues in the picture to [think about] science. Okay, fab. And why did you choose the plants?

Pizza: For science, for gardening and stuff

Interviewer: Okay, so you chose the plants because they reminded you of –

Pizza: Yeah

Interviewer: What was it that we were talking about before, you could learn about plants in a science job

Pizza: Yeah

Interviewer: Is that what made you think of it? Is there anything else you want to tell us about your picture?

Pizza: No

Interviewer: What about this person here – and everyone can chat a little bit about this one – so this person's doing some

Football: Isn't she a scientist?

Interviewer: Do you think she's a scientist?

Pizza: I do

Football: Or she could be a child from secondary school.

[all children speak at once, Interviewer asks them to take turns]

Football: You know at secondary school they have laboratories, she could be – they've made it all dark, so they could see the sparks they've been making?

Interviewer: So do you think she's in a laboratory

Football: At a secondary school

Interviewer: Okay and [Mad M], what were you saying as well?

Mad M: I was going to say that the newspaper – or something like that – they normally have real people, because they tell you about stuff. So that might be a real person, carrying out an experiment

Interviewer: So you think that she's a 'real' scientist, rather than someone just pretending to be a scientist? Okay. [To Pizza] what did you want to say about her as well?

Pizza: I think she's just advertising, in the newspaper

Interviewer: Oh okay, so [Mad M] thinks she's a real scientist – do you think she's a real scientist?

Football: I think she's in a secondary school

Interviewer: You think a secondary school? You're right the picture is quite dark, so you can't tell what's in the background

Football: There's a big screen behind her

Mad M: And there's a person there

Pizza: A teacher

Football: Yeah, there's a teacher

Interviewer: Oh maybe – what's she wearing?

Pizza: A blue shirt

Football: It doesn't really look like school uniform. Or it could be a school where you don't wear school uniform

Mad M: Or she could be a doctor?

Interviewer: She could be, why do you think she might be a doctor?

Mad M: Because – not just scientists wear those goggles, sometimes doctors can – just in case when they're doing something to [patients]

Orange O: But why would she be wearing goggles?

Interviewer: [Mad M] was just telling us – why do you think she might be wearing goggles if she's a doctor?

Orange O: Why would she be using the sparks?

Interviewer: If you cut someone open, you need to sew them back up again don't you?

Football: Stitch

Mad M: And the needles might fall onto something and bounce and it might go into your eyes?

Interviewer: Yeah, you wouldn't want that. But we can also use a really hot iron to fuse skin back together again, so it sounds a little bit mean

Orange O: Would it burn you?

Football: Does it hurt?

Interviewer: Well it wouldn't hurt because

Mad M: You'll be sleeping

Interviewer: Yeah, they would have put you to sleep for an operation. But that's called cauterisation

Football: Do they wake them up once…?

Interviewer: I think they wake them up later, after the operation – I'm not sure if that would make sparks – but that could be one way? [to Pizza] did you have anything else you wanted to say about this?

Pizza: No

Interviewer: What about the pictures on the other side, was there anything you wanted to tell us about them?

Pizza: I just picked random flowers

Interviewer: Okay – and what was the reason for picking the flowers?

Pizza: Because I didn't have enough space here

Interviewer: Okay, fair enough. Can you tell us about yours [Mad M]?

Mad M: I did a little bit of everything, because I like baking and making stuff, and plants and planting

Interviewer: Okay

Mad M: And maths

Interviewer: And maths? What have you got on there that relates to maths for you?

Mad M: On the back, so the coins [image of three people stood on stacks of money]

Football: [laughs] that's cool

Interviewer: Oh yeah, I see. And the coins – how do they relate to maths for you?

Mad M: Because I don't really know what they're for, but you could count up how many coins

Interviewer: Yeah that would be maths

Mad M: You could do anything with that picture. Or you can see how much more [money] does that man have to that lady?

Interviewer: mm okay

Mad M: Or you could create a bar chart

Interviewer: Ohh you could, couldn't you? It almost looks a little bit like a bar chart at the moment doesn't it?

Mad M: mmhmm

Interviewer: What do you think that picture's showing?

Mad M: That he has more money?

Interviewer: Yeah, that's what it looks like

Football: Oh could be it be like [they're] showing how much money they have – but not like they only have a few pennies – like a lot of money. That would be an average person, that would be a rich person, that would be a celebrity or..?

Mad M: Well he looks rich

Interviewer: Why does he look rich?

Pupils: Because he's wearing a tie

Interviewer: Oh okay, because he's wearing a tie? And a suit

Mad M: But then she looks like she works in an office

Pupils: yeah

Interviewer: So he's wearing a suit, what's she wearing?

Pizza: She's wearing a skirt

Mad M: And a suit

Football: She looks a bit grumpy

Interviewer: She looks grumpy does she?

Football: She wants to be up there

Mad M: She looks like she works in an office

Football: M what's the glasses to do with?

Interviewer: Of course, good question

Mad M: So I did that as science because you know people with bad eyesight, somehow glasses make people see

Football: That's science. Scientists made that so you can see

Interviewer: Yeah

Football: My dad has glasses

Interviewer: Does he?

Mad M: Yeah, my dad has glasses

[chat about parents with glasses]

Interviewer: What about these people here, why have you chosen these people?

Mad M: Because in our garden, we usually do gardening because we grow strawberries and gooseberries and raspberries and potatoes

Interviewer: Is that what that [picture] reminded you of?

Mad M: Yeah

Interviewer: What about this picture here, why did you choose this one?

Mad M: Because I like flowers

Interviewer: Okay, it was because of the flowers rather than..

Mad M: And the dog!

Interviewer: Yeah the dog's nice as well

Football: We're 13 minutes in

Interviewer: 13 minutes? Thank you very much. Is that everything you wanted to say about it? Was there anything else you wanted to tell us? In fact what's this one down here?

Mad M: It's an electronic, like a engineering

Interviewer: Okay, what do we think it is? What does it say on it?

Mad M: It's like an Alexa

[chat with someone putting out tables in room]

Interviewer: Go on [Pizza], what do you think it is?

Pizza: You know you get those 'Alexa's'?

Interviewer: Ahh

Football: So you say "Alexa play some music"

Pizza: It could be one of them

Mad M: No, because 'Alexa's are black

Orange O: No they're not, you can get white ones, silver ones

Interviewer: It could be a different *brand* of 'Alexa' couldn't it?

Mad M: Yeah

Pizza: Yeah

Mad M: It does say 'vax'

Interviewer: Vax? I'm not sure what that is, but it could be like [Alexa] couldn't it? So what did that relate to for you? Why did you include that picture?

Mad M: Because it kind of looks like the Alexa that we have at home

Interviewer: Okay and which one did you think that relates to?

Mad M: Engineering and technology

Interviewer: Yeah? Okay, cool.

Football: [Orange O's] turn

Interviewer: Is that everything you wanted to say?

Mad M: Then I also like baking stuff

Interviewer: Yeah? Is that what these guys are doing?

Mad M: uh huh

Interviewer: Okay, and what is about baking that makes you think of STEM?

Mad M: The weight, because sometimes you have to measure stuff. So if you want to make a cake, you have to measure out how much flour and eggs

Interviewer: Brilliant, is there any other maths skills that you use while you're baking?

Football: Weighing grams of sugar

Interviewer: Yeah? How do you know how long to leave your cake in the oven?

Mad M: You'll have a timer, you'll have to set a timer

Pizza: Or you can just [guess]

Football: You have to use maths to set the timer

Mad M: Yeah. I know how to set a timer, I've done it often

Interviewer: What kind of cakes do you bake?

Mad M: I normally bake cakes when it's my dad's birthday and [brother's] birthday, and then when it's [my dog's] birthday in August, you can make dog cakes. And that's what I'm doing

Interviewer: Really? What's different about a dog cake and a people cake?

Mad M: So a people's cake you have to have stuff, you normally have stuff that dogs aren't allowed, like eggs

Football: Chocolate

Mad M: Chocolate yeah, and then in dog cakes sometimes you only need to use four ingredients

Interviewer: What do you put in a dog cake?

Mad M: You put an apple in there, but not the seeds

Interviewer: Okay

Mad M: And that's the only one ingredient I remember

Interviewer: Oh okay

Football: How do you take the seeds out?

Mad M: You just slice it up

Football: I made chocolate brownie

Pizza: I made just cakes

Mad M: Also I made cup of teas –

Football: I made coffee with the coffee machine

Mad M: - and cheesy pasta

Interviewer: Ohh cheesy pasta? You guys are all so good at cooking? Brilliant. [to Orange O] shall we talk a little bit about your picture now?

Orange O: I've done plants, and I've done a bunch of flowers here. Different varieties. A mixed bunch

Interviewer: Okay. And what made you choose to put the plants on there?

Orange O: Because my mum likes gardening and so do I

Interviewer: Which bit of STEM does that relate to?

[pause]

Interviewer: You're not sure? That's okay

Pupils [whisper]: Science

Orange O: Science

Interviewer: Yeah?

Football: Because plants can be [part of] science

Interviewer: And what other things have you got?

Orange O: And then I've got

Interviewer: Go on, what other things have you got?

Orange O: This maze

Interviewer: That's a lovely one isn't it?

Football: It's the other half of [Pizza's] picture

Pizza: Yeah

Interviewer: So, a maze. What *is* a maze?

Orange O: A maze is this hedge with cut bits in and then there's just an entrance to go in. And then there's the other entrance to come out

Interviewer: Okay, so do the hedges just grow like that?

Orange O: No

Interviewer: How does it [happen]?

Orange O: You have to cut them in a shape

Interviewer: Who cuts them?

Orange O: The gardener

Interviewer: Ah okay, and how do they know what shape to cut them in?

Orange O: Um, they can do it any shape they like really

Interviewer: Ah okay

Orange O: And I've also got a technology and science one, so I've got computers

Interviewer: Yeah?

Orange O: And then I've got "Technology since 1998"

Interviewer: Yeah?

Orange O: And there's Google: 1998, Wikipedia: 2001, Facebook: 2004, YouTube: 2005, Twitter: 2006, iPhone: 2007, Kindle: 2007

Interviewer: Okay and why did you choose to write that list?

Orange O: Because mostly everybody else did one [laugh]

Interviewer: [laugh] so you chose to put technology on there? And where did you find these dates?

Orange O: I found them… where was it?

Interviewer: What are you using to find it right now?

Orange O: Google

Football: That's the thing that they made

Interviewer: Yeah! And [Mad M], what was it you wanted to tell us – because you put your hand up there – what did you want to talk about?

Mad M: I'm not quite sure, but I think how they make the maze's is that they have lots of bushes everywhere and then they just cut out lots of areas where you can walk

Interviewer: Okay, and so how do maze's happen? Is it because the hedges are just growing there in the first place?

Mad M: Yeah, what I think is that say this whole school was bushes?

Interviewer: Yeah?

Mad M: Yeah, even the inside. I think they would cut down lots of paths

Pizza: Yeah

Interviewer: Oh okay

Mad M: And then they create a maze like that. So way back ages ago, it would just be lots of bushes

Interviewer: Yeah? And what were you going to say [Football]?

Football: Could you not just do a big block of a hedge and go through, cutting your way through?

Mad M: Yeah

Interviewer: Is that what you guys thought? Do you agree as well?

Pizza: Yeah

Orange O: Can we watch something on YouTube about technology?

Interviewer: Yeah, we can do. Do you guys want to watch something about technology? How long is the video?

Orange O: I haven't got it yet

Interviewer: You haven't found it yet? Choose a video that's not too long okay? And we won't record it while we're watching the video.

[recording is paused for a moment]

Interviewer: So guys, there aren't many pictures of people on your collages?

Mad M: I kind of do

Interviewer: Yeah, you've got a couple of people on yours

Football: I've got none

Interviewer: How come you choose not to include people – or not many people?

Pizza: Because they don't, well they're not really –

Mad M: They don't fit in

Pizza: - yeah, they're don't really fit in because –

Mad M: It's not the objects

Pizza: Yeah, well sometimes it is – if it's a mathematician or a scientist

Interviewer: Okay

Orange O: Is ten minutes okay?

Interviewer: 10 minutes? Is there a slightly shorter one?

Mad M: I think that you sometimes need people because – say on [Pizza's] – it's showing that people set it [scientific process] off, not that it just magically sets off – they did it. So say, like that – they didn't [have] any people, but they just took a picture of glue and then they did a picture, if they didn't do a person in it how it would it magically type?

Interviewer: Yeah, that's true . What were you going to say [Football]?

Football: Because mine's all about technology, mine's not really – except for one picture, but I didn't put the man in

Interviewer: Yeah?

Football: There's not really any people with mine

Interviewer: Okay

Football: Really, except for that robot

Interviewer: So – yeah that one had a man next to it, what was that man doing?

Football: I think he was controlling the robot

Interviewer: Okay

Football: He had a black head – like a big bowl – but upside down on his head

Interviewer: He did, didn't he?

Football: But it had all cables controlled to that [the robot] and that [the man] picked up a connection to go with that

Interviewer: Okay, and why did you think the man wasn't important in the picture – why did you decide to cut him off?

Football: Because I thought I wouldn't really need it, because I could just describe it instead of actually showing [him in] the pictures

Interviewer: Okay. Go on [Mad M], what were you going to say?

Mad M: We just realised that you haven't shown yours yet

Interviewer: Shall I tell you about mine guys? I was a little bit interested in the fact that you said, that you didn't include people because you wanted to put more objects? Why do you think the objects are more important than the people?

Football: ummmm

Interviewer: Or *did* you think that? You might not have thought that

Football: No, I didn't think that

Mad M: Because the thing is about Science, Technology, Maths and Engineering – so you don't really need people. So you can just say – you're describing it, and you take a picture

Interviewer: Ah okay, so did you want to include the objects that related to those things, rather than the people doing them? So, this phone – like you said before [Mad M], that didn't just appear on its own did it?

Mad M: No

Interviewer: So who was responsible for making that?

Football: There was nobody with the [picture of the] phone

Interviewer: Yeah, it was just

Mad M: But that phone was advertising

Football: Yeah, because it was next to these two phones

Interviewer: [to Pizza] what were you going to say?

Pizza: I was going to say it's probably made by Samsung, and then they just took a picture of it, and stuck it in the paper

Interviewer: Okay, and who are Samsung?

Football: They're a phone company, no not phone – they do phones, TVs, all of them

Interviewer: Yeah? So which bit of STEM do they all relate to?

Pizza: Technology

Interviewer: Yeah

Mad M: And engineering

Interviewer: Well, a *little* bit of engineering do you think?

Orange O: Because they had to design it and make it

Pizza: Yeah because it's their company

Interviewer: Okay, so would you say Samsung are a technology company?

Pizza: Yeah, and engineering

[Recording is paused for a moment]

Interviewer: Okay, so you guys wanted to talk about my one. So what do you think I've got on here

Football: What's that?

Pizza: That's the maths

Interviewer: Yep, 15%

Football: Oh percent!

Interviewer: Yeah, 15% - that's for maths

Mad M: It could be coldness or hotness

Interviewer: Is that percent? What do we use for temperature?

Mad M: Oh! Degrees

Football: What's that one?

Interviewer: What does that say?

Mad M: Rocket

Interviewer: That one does, what does this one say?

Pizza: Aerosols or fluorocarbons

Interviewer: So I chose this because they sound like very science-y words don't they?

[recording paused]

Interviewer: So what is this picture?

Football: People having fun

Interviewer: Yeah, it is! But what is it [on]

Mad M: It's a TV

Pizza: Oh yeah

Interviewer: Yeah, it's a TV.

Football: Oh, it's a TV!

Pizza: I thought it was just a picture

Interviewer: Yeah, and I chose the word 'rocket' because I think that rockets are related to science

Football: Oh yeah, because the scientists make rockets go [rocket sounds]

Interviewer: Yeah, who else is in charge of making rockets? Who designs rockets?

Football: Rocket makers!

[laugh]

Interviewer: So out of these jobs, if you're a scientist, you work in technology, if you're an engineer –

Pupils: Engineer!

Interviewer: Yeah, I reckon they make rockets. And what about – so this is something where everything gets linked together. So if you're an engineer – does that mean that you never use science, and you never use maths and you never use technology?

Pupils: No

Interviewer: So if you're a rocket engineer, what kind of [skills] do you use?

Pizza: You use science

Interviewer: Absolutely

Pizza: And also technology

Interviewer: Yeah, because you need the technology in your rocket don't you?

Pizza: So if there's an engine

Interviewer: Yeah?

Pizza: You'd have to do technology stuff – like making electronics

Interviewer: Yeah, and what about maths? Would you use maths? How do people know where to go in space?

Football: Sometimes, no – you can use compass – because that will go funny

Interviewer: So compasses work because of the magnetic poles of the earth – so if you're in space?

Football: Yeah, they won't work! [laugh] What will it do?

Interviewer: If you took a compass into space what would happen? I don't know – what do you think would happen if you took a compass into space?

Football: It wouldn't explode

Interviewer: [laugh] it wouldn't explode, no

Pizza: It would just

Football: It would just float around

Interviewer: So how to compasses work on earth?

Pizza: There's an arrow that tells you

Orange O: It detects north

Interviewer: Yeah, and how does the little arrow know how to point north?

Football: The metal on the floor?

Mad M: Wait, what are we talking about?

Interviewer: We're talking about compasses

Mad M: It's a kind of magnet

Interviewer: Perfect, and is that little arrow a magnet?

Football: No, doesn't the magnet attract?

Interviewer: So what is magnetic that the arrow is attracted to?

Football: In space it would repel?

Interviewer: Do you reckon? So the way compasses work, is because our planet is so massive that that little arrow is attracted to the magnetic pull of the north pole – does that make sense?

Pupils: yeah

Interviewer: So if that little arrow is being pulled towards the north pole, and then we take it out of the earth, and now it's nowhere near the north pole

Football: It wouldn't do anything

Interviewer: Would it still work?

Mad M: No because it's not magnetic

Football: Good point [Mad M]

Interviewer: So a compass wouldn't do anything in space would it?

Mad M: No

Interviewer: Interesting chat guys. And then I chose this one [picture] here. So what's this one?

Pizza: Computer

Interviewer: Yeah, I chose that one because that's technology

Football: You've got some bits of my brain

Interviewer: [laugh] I've got some bits of your brain, yeah

Football: Not *my* brain – that brain

Pizza: That's a picture!

Mad M: You could have surgery and cut it open!

Interviewer: [laugh] and I've got the flower because that relates to biology – remember earlier we said biology is plants and animals? And for this last one, I've got some people doing some science here – so I thought that was nice to have a picture of people actually doing science. Because a lot of the time, all the pictures we have here, are the *end* products. So these are when someone has already done some technology and done some science – so I thought it might be nice to show a picture of some people *actually* doing it. What do you guys think of science, do you think you would do a science job?

Pupils: Yeah

Interviewer: Yeah? What kind of science job?

Football: Archaeology!

Mad M: I would like to find out stuff from ages ago

Orange O: Are we going to do *actual* archaeology later?

Football: We're done 90 minutes

Interviewer: Okay, you can stop the recording now, and save it

Football: Byyyee!

19 Appendix 7: Rationale for Question 2 statements on pupil questionnaire

The following explains the rationale behind each of the statements for Question 2 on the questionnaires given to pupils before and after each intervention (see Chapter 3 for method and Chapter 6 for results).

The first statement ‘I want to be a scientist when I grow up’, was chosen to identify whether participants differentiate ‘being a scientist’ from working more generally in an area of STEM. Findings from the ASPIRES project indicate that even children who find science lessons interesting did not wish to pursue a career as a scientist (Archer *et al.* 2013, 12). It is also possible that children’s understanding of the ways in which science might be used in a career is limited. The same ASPIRES report suggests that more children wished to work in ‘medicine’ or ‘sport’, than ‘science’ (Archer *et al.* 2013, 10), despite that fact that scientific knowledge might be useful in all three areas. While this may reflect the restrictive nature of questionnaire responses, it might also indicate that ‘science’ was viewed as separate from other career pathways. It is hoped that over the course of this project, children will become more aware of the range of ways to engage with STEM and its associated careers. The statements ‘I enjoy science lessons’ and ‘I enjoy maths lessons’ provide insight into the level of enthusiasm pupils currently feel for the subjects, and were influenced by questions used by Murphy and Beggs (2003, 112) in their analysis of pupils’ perceptions of science in Northern Irish primary schools. Similar statements, and use of attitudinal scales have been used by a range of other researchers to determine enjoyment of school-based maths and science (Pell and Jarvis 2001, 855; Osborne *et al.* 2003, 1057; Sturman *et al.* 2008, 98). At primary school, maths and science lessons are two of the most frequent ways in which pupils engage with STEM, therefore insight into enjoyment of them are valuable in assessing current attitudes towards STEM.

The statement ‘STEM is an important part of my life’ assessed how relevant children felt that STEM was to their personal experience. This statement may have captured responses from children who understand the influence that STEM has had on many parts of modern life, such as entertainment technology (i.e. smartphones, tablets, the internet), medicine and healthcare, transport etc. It may also have captured the opinions of children who have an interest in STEM and its associated subjects, and may feel a personal connection to some aspect of it. The final two statements: ‘I would like to learn more about STEM in the future’ and ‘I would like to use STEM in my job when I am older’ were designed to ascertain whether children seek to pursue their interest in STEM into secondary and higher education, and then into a career in STEM. A great deal of time will pass between lower KS2 and these children making choices about GCSEs, A Levels, and Higher Education or careers, and many people who express an interest in STEM at the age of 7-9 may not continue with it into later life (AT Kearney 2016, 7). However, these questions can provide insight into pupils' current perceptions and aspirations.

Appendix 7 references

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20 Appendix 8: Teacher interview transcript, YPT1 and YPT2

Title: STEM Teaching Experiences

Date: 13th March 2018

Speakers: Poppy Hodkinson (interviewer), YPT1 and YPT2

File Duration: 25 Minutes

Interview location: YP

Interviewer: As I mentioned before I'm interested in the reasons why the UK has low levels of participation in STEM careers. For this interview, I'm using the word 'STEM' to refer to Science, Technology, Engineering and Mathematics. To help me understand some of the reasons, I'd like to ask you guys some questions about your experiences as a primary school teacher delivering STEM content. How many years have you been teaching?

YPT1: 26 years on and off

YPT2: And I've been teaching five years

Interviewer: Fab, okay. And what are your positions in this school?

YPT1: I'm the Science Coordinator and I teach science across the school, except in Reception and Year 1

YPT2: And I'm a Year 3 teacher and I'm in charge of literacy across the school

Interviewer: Okay, cheers. In your opinions, what is the level of pupil enthusiasm for STEM in your class, or classes?

YPT1: I think they're quite enthusiastic about science - that's what we call it I suppose in Primary school. Because there's lots of hand on activities, and engineering and designing and creating stuff involved. So it's not the same as writing a story in their posh purple books

YPT2: Yeah, they get excited don't they?

YPT1: Yes

YPT2: And it's something different for them to do. It really engages them, I think, all the different things that we do, in this school anyway

Interviewer: Okay, marvellous. So, do you think that your pupils ever engage with STEM at home?

YPT1: They are doing this week, because there's actually British Science Week, and they're all having homework, and scientific projects to do. The theme is explorers, there's lots of engineering to do. Year threes are all excited going home today with a challenge to try and beat a Guinness World Record of building a bridge out of Lego in three minutes, that has to be ten cm high. And so they were practising today and all the STEM skills that they had to do without realising, was very exciting

Interviewer: Do you think that they engage with STEM outside of special weeks like this?

YPT1: At home? We try and encourage the parents to take them to the museum, and to look at -

YPT2: And [local Science] and to do different things. But if they actually go and do it, it's hard to tell really

Interviewer: Fair enough. I'm also interested in whether you guys interact with STEM at home? When I trialled this question before people were a little bit unsure, so I've got an example of STEM activities that you *might* do, if you see anything on there that you know that you do, just shout it out

YPT1: Is there cooking or baking involved there somewhere?

Interviewer: That is not on there, but I thought I'd put it on there, and then took it off in the end. Yeah, I definitely agree it could be on there

YPT1: [to YPT2] That's over to you then!

YPT2: [to YPT1] Oh and you! Yeah, so we bake quite a bit, both of us do together. So that's one massive thing we do. TV documentaries, I watch quite a few: David Attenborough. Puzzles and games: I do Sudoku sometimes. [to YPT1] We do a bit of website design don't we? We have! Both of us have, together

YPT1: Yes, at home with the business

YPT2: And museum visits

YPT1: I'm a mum as well, so I tend to do something like a museum visit. I did just this Sunday that's just gone. As a Mothering Sunday treat for me, we had a picnic in [history museum], so that counts.

Interviewer: Nice!

YPT1: But we do run a [bakery] business together

Interviewer: So you've done bits and pieces for that?

YPT2: Yeah

Interviewer: That's the thing isn't it? There's so much STEM stuff that you do, that doesn't even seem like -

YPT1: There's designing, wedding cakes [to YPT2] you're doing that at the moment?

YPT2: Yeah

YPT1: There's a lot of engineering involved there

YPT2: Dowels, to make sure it stands up!

Interviewer: You know, I don't even need to ask about 'other', you guys have done loads of stuff! So, would you describe yourself as someone who's interested in STEM in your personal time?

YPT2: I think I am. Designing things and creating things. My project over the Easter holidays is I'm going to be renovating a horse box, into a trailer to sell some cakes and things. So that's a project I want to do, it's something I'll be designing and creating myself.

Interviewer: Awesome! That sounds cool!

YPT1: And you did art didn't you for A levels?

YPT2: I did yeah, and Design Technology. And I did ICT, website building and things when I was in A level

Interviewer: Awesome

YPT1: I think I come from a different background, I did more of the arts and languages at university. But I've always had a fascination for STEM because it's more of a hobby, and enjoyment for me. Baking is really the main aspect, and also things like finance. I help out with chapel, I'm a payment secretary there. So accounts and stuff

Interviewer: Yeah, that definitely counts. What do you think pupils enjoy most about STEM learning?

YPT2: The not knowing what's going to happen, with language it's always 'skill skill skill' based, and then you build up to be able to write whatever on this end product. So it's not as structured, I suppose. Well, it is structured, but in a different way. The lessons that we do: sometimes there's a problem that we have to solve, or it could be a challenge that we have to do. Or there might be a letter that's arrived in the classroom and then they have to design whatever or react to whatever the letter is asking of them. So it's a different approach to teaching and learning, I suppose to your maths and language lessons

YPT1: There is more of the pupils' voice, they have more of a say. When we're designing something -

YPT2: Yes!

YPT1: - Like a stall for Children In Need, there's more of a "let's vote on all the ideas that we've got" -

YPT2: There's a lot more team work as well. So working in different groups and they all have to collaborate together, and work hard as a team to get things done

Interviewer: Okay, that's nice. What do *you* enjoy most about teaching STEM?

YPT2: I like seeing the other children, the children that wouldn't normally interact with other children. Seeing them succeed, well contributing. And actually enjoying some lessons

YPT1: And that it's not about recording, on paper. It's more about ideas, sharing orally. And it's more practical, so there are children who are usually quiet in another lesson, they might be leading a situation

YPT2: Yeah, they're shining

YPT1: Because it happened today in your [to YPT2] class, we had a little girl who's usually very very quiet, she was the first one to build a Lego bridge today in the challenge. And we were all astounded, and you could just see the confidence in her building, and it was lovely. So that kind of thing

Interviewer: So it's a way to express themselves in a way that isn't in traditional lessons?

YPT2: Yes

Interviewer: When you're preparing for your STEM lessons, where do you look for ideas and resources?

YPT1: I tend to use a lot of the STEM challenges, you know the 'See Science' and STEM Ambassador's website?

Interviewer: Yep

YPT1: And this week, we're using the pack from British Science Week

YPT2: Most things, I just create myself really

Interviewer: Oh really?

YPT2: Yeah, so I'm doing the Celts at the moment, so I'm thinking "What can I do around the Celts?". So we've built our own roundhouses, finding materials and that sort of thing. So they [pupils] have to do their own research. It didn't just come from nowhere, we decided it as a class that was what we were going to be doing. So they did their own research and they had to [speaks in Welsh] –

YPT1: Weave

YPT2: Weave, we had to weave to begin with, to get the structure. And then we added clay and added different things as they [the Celts] would have done, and straw for the roof. And then they had to make sure that it could stand

Interviewer: That sounds so cool! So you use the internet and then your own ideas?

YPT1: And we use a lot of parent's involvement as well. So if we know that there's a father in one year that's a geologist. What do you call a scientist who finds out things about volcanoes?

Interviewer: I'd say that could be a geologist?

YPT1: There's another name I'm thinking of…

Interviewer: A volcanologist?

YPT1: Yes, I think you're right. So he'll come in while we're learning about rocks and things and then he'll do a little presentation about volcanoes and his explorations around the world. And then he'll set an experiment up with cola bottles and Mentos and things. So, we like to look at parents as a way of showing them [pupils] different careers and options within STEM

Interviewer: That's a really nice idea, I'll probably be asking more about that later. Do you find that the physical resources, so your cola bottles and your bits to make the roundhouses, do you find they're easy to come by?

YPT1: We don't have any money [to YPT2] do we? To buy anything, so we tend to rely a lot on parental support and to recycle stuff

YPT2: The things for the roundhouses, I personally bought everything to make them. I try to use as many things as we have in school, but the clay and things I just went to buy myself

YPT1: And I'll do things like, if I'm having a coffee in town I'll keep the cups and I'll consciously recycle them and use them then in school. So we've got lots of everyday items, kitchen stuff that we just constantly collect all the time

Interviewer: So, my mum's a teacher and for pretty much all of my childhood, there was a stack of egg boxes that would grow

YPT2: Yeah, you're just finding *anything* you can use!

Interviewer: Absolutely! Would you say you're satisfied or dissatisfied with the amount of STEM content you're able to cover in your lessons?

YPT2: Finding Welsh resources is quite difficult

Interviewer: Sorry, do you mean in Welsh language?

YPT2: Welsh language, yeah. We personally have to [speaks in Welsh]

YPT1: Translate

YPT2: Translate them ourselves. So that's just a pain really!

YPT1: Yeah

YPT2: But finding things? No. I personally just make my own

YPT1: I think there's loads of money being invested into STEM projects in primary and secondary school, so we tend to find a lot on the internet. And we get that newsletter from 'See Science' on a monthly basis, that's got a lot of information on what's 'in fashion' with STEM activities at the moment. And there's lots of funding to get shows into schools for free. We have found in the last couple of years, that people are advertising lots of opportunities for us

Interviewer: So there are loads of chances for you?

YPT1: Yes, I think there's been an overload recently in our school!

Interviewer: Well I apologise for bringing this here as well!

YPT1 & **YPT2:** [laugh]

Interviewer: So, the next question is in three parts, and I'm going to ask you each part separately. But I'd like to know when it comes to STEM engagement, which barriers, if any, you feel are in place for your pupils, teachers as a group and yourselves personally. So for the first part, what do you feel is the biggest influence on a pupil's long term engagement with STEM subjects and careers?

YPT1: Do you mean something like real scenarios and to give them hands on experiences? That tends to stay with them more. I don't know whether I understood the question…

Interviewer: Sorry! I always feel with this one, that I talk for so long that it gets a bit lost. So, basically, what's the biggest influence on their [pupils] long term engagement. So like you said if they see someone in real life do it [STEM] that might stick with them a lot longer

YPT2: Yeah, if you give them a real life situation or a problem –

YPT1: Not just something old fashioned from an old textbook, that's outside of their interest

YPT2: Yeah, give them something that they will engage with and understand and see a meaning to what they're doing

YPT1: And what we can do a lot with STEM as well, is we can ask them at the beginning of a topic, say we're looking at bridges or something, "What do you know already?" and ask them to fill a grid in –

YPT2: Yes, it's 'what they know', 'what they want to know' and then at the end they do 'what they've learnt'

YPT1: So we alter our planning then to actually start with what they want to know, and that enthuses them more

Interviewer: Knowing that they've got the input?

YPT1: Yeah. Because there's no point planning six hours of work if they already know the answers. So there's a lot of starting from the pupils ideas in STEM

YPT2: And what we're doing at the moment with pupil voice is they're writing their ideas on post-it notes and we've got six different sub-headings that they've got to distribute their ideas onto. So the six headings are from the curriculum really, and then we might see this area has less ideas, and as a class we all try to think of ideas to go there. We try and get [speaks in Welsh]

YPT1: Cross-curriculum

YPT2: Yeah, we make sure they're [sub-headings] balanced. So we might think of lots of ideas for maths, and we'd try to make sure that they balance across the curriculum

YPT1: Because the curriculum's changing, you know?

Interviewer: Yes

YPT1: And it's going to change from topics or subjects to –

YPT2: So there is a 'Science and Technology' area, and if that's empty we all as a class have to think of ideas so it's balanced…? It make sense in my head!

Interviewer: I think I know what you mean. Do you think there are any external factors on whether your pupils go on to be interested in STEM later on?

YPT2: I think, because as a Primary school teacher, you're there with them every day throughout the day. So *you* get to plan everything, with our theme you plan everything throughout that theme. So your maths lesson, language lessons and then the afternoon lesson, they all [speaks in Welsh] link together. I suppose in Secondary they're much more subject based, and [speaks Welsh]

YPT1: Isolated

YPT2: Yeah so in Welsh, you just do Welsh and then you've got your English lessons, and there's no cross-curricular –

YPT1: My own children in secondary school, they tend to say things like "I don't like geography because I don't like the teacher". But here if you were to ask a child "Do you like geography?" I don't think they could pinpoint what geography was –

YPT2: Because everything fits together

YPT1: Yes, it's more to do with themes, like 'Victorians' –

YPT2: We've done 'The Romans' today, so we've been looking at the Roman Empire, so that's all your geography then, looking at different places –

YPT1: But they don't know that it's 'Geography'

Interviewer: Well that is the beauty of Primary school isn't it? You can be so much more creative with it all. What do you feel is the key challenge faced by teachers, groups of teachers, when they're teaching STEM content?

YPT2: The fear of the unknown, I suppose. Because you can give them [pupils] a problem, but you don't know where that problem is going to take them. Or where their imagination, or where their ideas are going to go. So it's putting [speaks in Welsh]

YPT1: Responsibility

YPT2: Responsibilities on them. So you have to stand back and let it happen, and then you stand in when you feel like "Okay, they've not quite understood that part", and move them back onto the right path. But some teachers might be scared of letting go fully, because you just don't know where they're going to go

YPT1: And then at the end of that afternoon, there's nothing actually down in their workbooks. And then you get nervous about somebody coming in to look at your books and there's nothing there, and you're being questioned "Well what actually did they do on that day?". So it's all based then on evidence, pictures that you've taken on the iPad. And that bit is scary

Interviewer: By 'someone coming in' do you mean from within the school or…?

YPT1: It could be from the parents evening or the governors –

YPT2: We've got lots of people looking at our books at the moment! People come from different schools as well, to have a look –

YPT1: We could have an inspection, or Ofsted in. And it's very book-based, the way we monitor things

YPT2: So yeah, that could be a massive challenge. And some of the projects do take a long time. So that's another issue that they [teachers] could have. Because there's so many other things that you need to be doing in a week, it's hard sometimes to fit everything in?

Interviewer: mmm

YPT2: So when you think about a project, what else has to move to make sure that you finish that project? So that's a bit of a worry sometimes, yeah

YPT1: I think what you said about stepping back and letting them be independent learners, that is the emphasis with the new curriculum. That's the way it's heading, which is exciting

Interviewer: That's nice, you'll be able to be more creative without worrying you're going to get told off! So this one is a little bit more personal, what do you feel is the key challenge faced by yourself when you're teaching STEM content? The answer, might have been mentioned before. It might be the same sorts of things you've said already

YPT2: Grouping the children, I find a challenge. Because you don't know where their strengths are, especially with some subjects. Like you [YPT1] saw this morning, with that child who created that bridge. You might not have thought that she would be… so if you pair them, how do you pair them? If you group them, who do you put in a group together? You have to make sure that you have that balanced correctly. So that's quite a challenge that I face

YPT1: And the lack of room. We don't have things like laboratories and especially in this old Victorian building, we're always squashed into one classroom trying to do big things. But then we could be outside... Maybe adult support as well, we're very short of

Interviewer: Is that like TAs [teaching assistants]?

YPT1: Yes

YPT2: We've got 30 children in a class, and you've just got yourself trying to do a science experiment. It's quite hard

Interviewer: I can imagine

YPT1: Yeah, we're very conscious of that. If there's an experiment on insulators, thermal and [to YPT2] oh what do you call it in English? Anyway, using things like kettles and boiling water and thermometers, and there's only one adult in the class, you tend to decide as a class "There's lots of risks involved here, let the teacher do the experiment and then we can all observe". Then in other situations, you try and avoid that and you make sure that there's enough little stations for them to work in little groups. So that they get more involved, and they practice and develop their skills better

Interviewer: Okay, which of these three do you think's the most important? So, the influences on pupils themselves, the challenges that all teachers face, or the ones that you personally face? So which of those is the most important in pupil's going on to be involved in STEM in higher education and careers?

YPT2: Their involvement I think

YPT1: Yeah, and the way that they learn from one another. Peer teaching and learning, that influences them. That helps them doesn't it?

YPT2: If they're engaged, that's obviously going to spark something inside of them to want to carry on. They might not know it at that time, but it's something that they will remember and take with them

Interviewer: Awesome. So a couple of issues that you mentioned before, about having the right amount space and resources, do you think there's anything that practitioners – so teachers – can actually do to address the issues? I know you can't make the school bigger! But are there any things you might do?

YPT2: We could I suppose ask the Secondary school if we could use their laboratory. Because I know that Year 6 go, [to YPT1] don't they? They have a bridging session with them, so they have science lessons there with the Bunsen burners and things, and using the resources that they [the secondary school] have. So I suppose, just using who you know.

Interviewer: Yep?

YPT2: We've got some parents who are lecturers in the university as well, in Design and Technology in UWIC [Cardiff Metropolitan University]. So they've been in to create a project with the class, which was quite nice

Interviewer: Oh cool, so you can ask favours?

YPT2: Yeah.

Interviewer: That is actually all of my questions, so thanks guys! It's been really helpful cheers!

21 Appendix 9: Teacher interview transcript, NBT1

Title: STEM Teaching Experiences

Date: 15th March 2018

Speakers: Poppy Hodkinson (interviewer) and NBT1

File Duration: 13 Minutes

Interview location: NB

Interviewer: I'm interested in some of the reasons why the UK has low levels of participation in STEM careers. For this interview, I'm going to be using the word 'STEM' to refer to Science, Technology, Engineering and Mathematics. I want to understand some of these reasons, so I'm going to ask you some questions about your experiences as a primary school teacher, delivering STEM content

NBT1: Okay

Interviewer: So first, may I ask how many years you've been a teacher?

NBT1: This is my third year

Interviewer: Cool, and what is your position in this school?

NBT1: Year 6 teacher and Science Coordinator

Interviewer: In your opinion, what's the level of pupil enthusiasm for STEM subjects in your class?

NBT1: Yeah, I'd say quite high. I think we can improve, but I think they seem generally enthusiastic about STEM

Interviewer: Fab. Do you think that the pupils engage with STEM at home at all?

NBT1: I wouldn't say that's the sort of conversation that I've often heard, [that] the children are participating in STEM outside of school. But there are a couple of children who have been to after school clubs at the Secondary school, which are STEM related. So I suppose that counts?

Interviewer: Absolutely yeah. Okay, so they are engaging with STEM outside? I'm also interested in whether *you* interact with STEM at home. I've got a list of examples of things you *might* do, obviously there are loads more, so if there's anything else, just shout it out

NBT1: Yep, no worries

Interviewer: So these are some possible STEM activities

NBT1: Yep. STEM in mainstream media: New Scientist, magazines such as that. I wouldn't say STEM hobbies necessarily. Yeah, museum visits: regularly. Puzzles or games: absolutely. I'm taking a maths A-Level this year

Interviewer: Really?

NBT1: Yeah. My husband's a doctor as well, so we talk about science a fair bit

Interviewer: Ah my boyfriend's a doctor, they don't shut up about it!

NBT1: [laughs] Yeah, there you go then! All the time, exactly! STEM on social media, yeah I follow. I wouldn't say necessarily 'social media', but I do get emails through different STEM networks, some that I've come across

Interviewer: Mhmm

NBT1: Oh yeah, any David Attenborough documentary is a winner! The news, yeah – I'd say on that scale, definitely

Interviewer: Okay. Would you describe yourself as someone who is interested in STEM in your personal time?

NBT1: Yes

Interviewer: Okay, I think that's probably fair! You seem to do plenty of things. Do you think that this is reflected in your teaching?

NBT1: I think so, I think if you're passionate about something outside of school, if you're passionate about something generally, then your teaching is more sparky, as a result

Interviewer: Absolutely, what do you think that your pupils enjoy most about STEM learning?

NBT1: I think it's being able to explain what they see. So, what I'm thinking of now, is 'Science'. So investigating why certain things happen, and being able to explain it. And I think in maths, it's actually that challenge of problem solving, going beyond your normal limits. I think they do enjoy that, when they go beyond that level of resilience. I think that's probably what they enjoy most about it

Interviewer: Okay, and what do *you* enjoy most about teaching STEM?

NBT1: I think almost the same thing: being able to deliver lessons that relate to things that we see in real life, that will have a direct impact on their [pupils] understanding of the world, as they grow up. The same with maths actually, it's a subject that you can link to everyday things they will need when they're older. And it can be great, it can be energetic, it can be interesting and you can challenge them in lots of different ways. So yeah, the same reason they like it probably

Interviewer: Yeah? When you're preparing for STEM lessons, where do you look for your ideas and resources?

NBT1: So I've just moved from [Place] to Hampshire. The way it works in Hampshire is: you have the Hampshire Key Ideas. These are a set of 'Key Ideas' based on the national curriculum, which have then – by me – been put into a progression grid from Year 3 to Year 6. So the idea is that the knowledge and scientific skills – so that's where I'd go first, to find out what I'm meant to be delivering

Interviewer: Okay

NBT1: And from there on, either just consider ways of experimenting. Because they have suggestions for what you could do. I did go on the STEM website and the British Science Association have some bits as well. But largely, I'd go from the Hampshire Key Ideas first

Interviewer: Okay, that's good that there's something formally in place for you guys to use

NBT1: Yeah, it's a very well structured county for that actually

Interviewer: That's quite sensible. A lot of the teachers that I've spoken to when I piloted this said that they use the internet, so they were relying on sites like the STEM learning, and that they weren't always appropriate. So it's really good that you have a formal –

NBT1: Yeah, I can show you it. It's got areas that you ought to be covering, and some suggestions for how you could do that.

Interviewer: so do you find that the physical resources for your lessons are easy to come by?

NBT1: So, in this schools we are fairly well stocked with resources in terms of primary resources. The Head here, is very good – he's said that I can spend some more on getting new resources

Interviewer: Oh okay?

NBT1: Which is great, I've put in a proposal for some resources to make it a little bit more scientific. So recording levels of light, rather than just going "It's shiny! It's not shiny!". That sort of thing

Interviewer: Yeah

NBT1: Then, at my previous school, we used to borrow our resources from Secondary schools, but we haven't done that here yet

Interviewer: Are you linked with a secondary school?

NBT1: We have a lot to do with [local secondary] school, but in terms of our science – at the moment we haven't got any links

Interviewer: But you're working on it?

NBT1: Exactly, yeah! I'm working on it, yeah

Interviewer: So you'd say they [resources] are relatively easy to come by?

NBT1: I think so, I think we're very lucky here, and previously I've been very lucky

Interviewer: So, you might have already answered this question a little bit, but are you satisfied or dissatisfied with the amount of STEM content you're able to cover in your lessons?

NBT1: Yeah, I think I'm satisfied. It is challenging to fit everything in, and the nature of the curriculum as it is – especially when you get to Year 6 – but I do feel we're very lucky that it's prioritised as well as maths and English. I know that's not always the case, and certain primary schools wouldn't get to the end of Key Stage 2, but yeah – satisfied, in conclusion!

Interviewer: Excellent. Do you ever try to make your STEM lessons cross-curricular?

NBT1: I'm trying to think if I have ever done that. Have I done it here? In terms of evolution, we are actually looking next year at linking it with our English

Interviewer: Okay?

NBT1: Because we're going to be doing Fantastic Beasts, so we've talked about that for next year. Previously, I used to link it in with Sports Day – so in terms of heartrate and stuff like that. This term we looked at Alaska, and for our Science Day a few months later we looked at 'what if you got stuck in the middle of nowhere'? And linked the science to that

Interviewer: Okay

NBT1: It's something we've talked about, making stronger links across the curriculum. So, in some ways, I think it can be made stronger

Interviewer: Okay, so it's something that you're working on?

NBT1: Yeah

Interviewer: And, presumably you think that is of benefit?

NBT1: Definitely

Interviewer: So the next question is quite lengthy, it's in three parts and we can chat about each bit separately. But I'm interested to know, when it comes to STEM engagement, which barriers – if any – you feel are in place for pupils, teachers as a group, and then yourself as a teacher. So firstly: What do you feel is the biggest influence on a pupil's long term engagement with STEM?

NBT1: That's an interesting one. I suppose it's being able to see the importance of the science you're doing and how it will be relevant to what you do later

Interviewer: Yeah?

NBT1: To some extent, if children think "This is what I want to do, why do I need to do science?", it's making it clear why you need to be doing [it]

Interviewer: Yeah

NBT1: And it depends on the social context I suppose: some children won't have access to resources at home, to trips, to visits. Perhaps knowledge of parents and family around them, to be able to explain why things are happening, so then you're perhaps a bit overwhelmed by science as you get older. But I think it's opportunities as well, that might be a barrier

Interviewer: Yeah?

NBT1: And then I suppose – not for our age group, these children don't seem to be overwhelmed by stereotypes of 'women in science' – I don't see that in this classroom – I haven't seen it in my Primary school classrooms, but I know it's something as they get older. We don't really see it here, I would say

Interviewer: That's really good. So what do you feel is the key challenge faced by teachers as a group?

NBT1: As a whole, I imagine it's elements such as resources, training. Making links with – there's so much out there – it's just linking it all together. So you've got your museums nearby, you've got your [local] Secondary schools, I think they'd be the main ones: resources, knowledge

Interviewer: Okay? Again, this might be something that you've already said, but what do you think is the biggest challenge faced by yourself when you're approaching STEM?

NBT1: I think it's just – I've just come to a new county – so it's getting to know the structures of how that works. It's just being up to date on the best ways of teaching science, and best ways of delivering these theories and materials. Yeah, I had something else in my head then – I might come back to that

Interviewer: Okay

NBT1: Yeah, I think it's just – for instance: with investigations, coming up with the most interesting, but also the best opportunity for children to learn about whatever we're covering, by developing their scientific skills

Interviewer: Okay, so which of these three factors do you think is the most important for actually getting people *into* STEM careers?

NBT1: Oh, which three of those?

Interviewer: Yeah, of the pupils, teachers as –

NBT1: Oh, yeah. I suppose if the teachers are enthusiastic and skilled and know their subject, then the pupils – it might be an opportunity, especially if it's not there at home, to be able to learn and to be able to access – here we make links with secondary schools and universities

Interviewer: Yeah?

NBT1: – a lot of STEM careers require that – and that's a barrier in itself isn't it? But then again, you could see if the pupils are enthused and they have access, and have overcome all their barriers then that could be a big drive for them getting into STEM. I suppose it's a bit cyclical in some ways isn't it?

Interviewer: Absolutely! I think it's probably fair to say that *all* the factors play in together

NBT1: Definitely!

Interviewer: Is there anything that you think, as a practitioner, you can do to try and address the issue?

NBT1: Yeah, I think we've got a big place to ensure that we've got the right resources, that we're providing opportunities for children to get out and see things and take visits and make suggestions for things they could read, places they can go

Interviewer: Yeah?

NBT1: And making sure that they have opportunities to overcome any barriers that might stop them from accessing STEM things. I think at this age, it's just giving them all those opportunities to experience things

Interviewer: Cool, so that's actually all of my questions, is there anything else that you wanted to add?

NBT1: No, I don't think so – if that's all right?

Interviewer: Yeah, awesome. Thank you very much

NBT1: Pleasure!

22 Appendix 10: Teacher interview transcript, BFT2

Title: STEM Teaching Experiences

Date: 16th March 2018

Speakers: Poppy Hodkinson (interviewer) and BFT2

File Duration: 22 Minutes

Interview location: BF

Interviewer: I'm interested in some of the reasons why the UK has low levels of participation in STEM careers. For this interview, I'm using the word 'STEM' to refer to Science, Technology, Engineering and Mathematics. To help me understand some of the reasons, I'd like to ask you some questions about your experiences as a primary teacher, delivering STEM content

BFT2: Okay

Interviewer: Cool! So first may I ask how many years have you been a teacher?

BFT2: I've been a teacher for 20 years

Interviewer: Okay, fab. And what is your position in your current school?

BFT2: I'm a Year 1/2 class teacher, and because we're a small school that means I'm the whole Key Stage. I'm also the English and Art leader

Interviewer: Okay. In your opinion, what's what level of pupil enthusiasm for STEM in your class?

BFT2: I think it's quite high. If I say to the children that we're going to do a science activity, there's definitely excitement and enthusiasm. There's not a "Awwwwh", there's more of a "Yeah!!". I think the word 'investigation' or 'experiment' gets them excited. Rather than just saying that it's going to be a science 'lesson'. So a 'science investigation' gets them quite buzzed. We've just actually been to the science centre in [City], and they really loved that. They were really engaged with it. I think in terms of maths, I think maths is one of those subjects that some children just find very – I don't know what the word is – I suppose difficult. I think for some children, they enjoy the challenge of trying to come to an answer. And I think other children, they find that a bit overwhelming

Interviewer: Sure

BFT2: So yeah, I think maths is a mixed bag

Interviewer: Yeah sometimes, just the word 'maths' can be a little bit intimidating can't it?

BFT2: Yes, and I think for some children – if they've got that 'number brain', or they've got that resilience for learning, then maths is something they really enjoy. For other children, who find it more of a challenge, I think it can be a scary thing

Interviewer: Yeah?

BFT2: Sometimes because it's more definitive: trying to find the 'right' answer is more scary than just experimenting

Interviewer: Okay, so do you think your pupils engage with STEM outside of school – at home – at all?

BFT2: I think some children do, interestingly there was an assembly this week about science week. And they were asked to go home and investigate, or find out something – very open ended – only one child has come back in and has actually done that. Out of 29. So I think that's an interesting thing

Interviewer: mmm

BFT2: Some of my children had been to the science centre before, but by no means all of them. Maybe a third of them had been there before? In terms of outside clubs, quite a low level would be doing science-y type clubs. Yeah, relatively low

Interviewer: What reasons do you think there might be for that?

BFT2: I think a lot of children – at the age I teach – if they're doing a club, it is a sports club or a music club. I'm generalising. I don't think there is a lot out there in terms of afterschool activities that are science-based for Key Stage 1. I think when they get to KS2, teachers sometimes run 'fun science' club and that kind of thing. Whereas, KS1 not so much. I think people are more scared of the mess and the hullabaloo and whatnot

Interviewer: [laughs] sure!

BFT2: I think it depends on whether a parent has got an interest in science, as to whether they explore that with their children

Interviewer: Yeah, of course

BFT2: One of the children in my class who's really engaged with science, his parents are very interested in that. So he will come in and they'll have been looking at the planets, or looking at constellations – that sort of thing. Because I know his parents are very interested in that. Whereas, with other children that is not always the case

Interviewer: Yeah, if there's no support there, they can't access it I suppose?

BFT2: Yeah

Interviewer: Do *you* ever engage with STEM at home? I've written a list of possible STEM related activities that you might do, I'll show you now. Obviously, there's loads more so if you do anything else, just shout out

BFT2: Okay, so I would watch a documentary or news items. I've got to say though, that probably wouldn't be the thing I most engage with on the news. But I do watch the news and documentaries. I wouldn't engage on social media with it, I don't do puzzles or Sudoku. I've got two teenage sons and they have science homework that I engage with – to the best of my ability! Which at the level they're at, is not awesome…

Interviewer & BFT2: [laugh]

BFT2: When my boys were small, we did loads of model building. They boys were really into Lego, so we did *so much* Lego. The museum visits, I've always done science museum visits, because my boys have always enjoyed quite hands on exhibits and figuring out how things work. I did that particularly when they were smaller, they're a bit too 'cool' for that now

Interviewer & BFT2: [laugh]

BFT2: And my own devices – that is something that I find really tricky, just because of my mind set. But I'm getting better

Interviewer: Cool, thank you. Quite a lot of stuff then. Within that, would you say that you're someone who's interested in STEM in your personal time?

BFT2: No, I think I would say that. A lot of the STEM activities that I've done are to do with my children and their interests. I wouldn't, in my own time, probably go to a science museum or engage with something specifically 'STEM'

Interviewer: Yeah?

BFT2: But because I've got two boys, and they've always enjoyed breaking things up and putting things together and figuring out how things work, and touching things – that has given me that…

Interviewer: That's why you've accessed it [STEM]?

BFT2: Yes

Interviewer: Okay, fine. What do you think your pupils enjoy most about STEM learning?

BFT2: It's the interactive nature of it, and I think it's the open ended – say when we do an investigation, maybe even I don't know what the answer's going to be. And I think they like that. It can't be wrong – it's up to them to find out about it. I think they really engage with that. They engage with them physically doing something and finding something out, that at the start of the lesson, none of us knew

Interviewer: Would you say that it's having that impetus themselves to come up with an idea, followed it through and found something out?

BFT2: Yes! Totally

Interviewer: Okay, fab. What do *you* enjoy most about teaching STEM?

BFT2: The same thing actually. I really like seeing them 'doing' something. So not the writing about it as much, but I really enjoy watching them investigating something. And I enjoy the conversations that they have. And being able to ask questions to take that on a bit. And I love that feeling where we've all found something out together, by creating something. So I like the creative aspect of it

Interviewer: Lovely. When you're preparing for your STEM lessons, where do you look for your ideas and resources?

BFT2: The previous Head [teacher] here loved science. And so she has planned all our science for us so generally speaking, that is what I would use. But I do sometimes 'Google' ideas of how best to present something. I might use the TES [Times Educational Supplement] has got resources on it, so I might use things like that

Interviewer: Do you think that the ideas that are put in the TES etc. as they are, are appropriate? Can you just take them and put them in your lessons?

BFT2: Sometimes. Not always. But that's the case with *any* educational resources, generally speaking: some of it you can use. You can literally print it off and you can use it. Then others might just give you the germ of an idea, you might not want to do it in that way. But I think that's the case with all of them [educational websites], sometimes you see something and you think "Yes! This is the exact thing", and other times you think "Mmm I like *that* bit of it, but I'm not going to use *this*"

Interviewer: Yeah?

BFT2: So no, I think as a good teacher, you should never just use anything wholesale. But that's just my opinion!

Interviewer & BFT2: [laugh]

Interviewer: So you find that the sites are pitched appropriately for your…?

BFT2: Yes, because you can be quite specific. For example: we've been doing 'Space' at the moment, I can put in [a search box] "I'm looking for KS1 space resources"

Interviewer: Oh really?

BFT2: And so what will come up – on that particular website – is teachers who've put in things they've used: "I used this and it was great". Some of it is great, some of it isn't. So you go through and some of it you'll think "This isn't what I'm looking for". But it is quite specific what you can find on there

Interviewer: Okay, that sounds really useful. Do you find that the physical resources that you use in STEM lessons are easy to come by?

BFT2: Yes, generally speaking I think that they are, yes. We can resource some things from local garden centres, if we're doing 'Habitats'. We've got quite good maths resources in school I think. But yeah, usually pretty easy

Interviewer: Okay, and are you satisfied or dissatisfied with the amount of STEM you're able to cover in your lessons?

BFT2: I'm satisfied with it, we do maths every day and we do science once a week. Like a full science lesson. So I think that's –

Interviewer: A good amount?

BFT2: Yes, I think so

Interviewer: Okay, fab! Do you every try to make your STEM lessons cross-curricular?

BFT2: Yes, we do. It's very dependent: so The 'Habitats' topic is one we're doing. Obviously we just went to the science centre and that's linked to our space topic. So yeah, we will try and link it, but some things don't link. Then we've just got to teach it

Interviewer: Yeah?

BFT2: Where we can, we do

Interviewer: And the next question is a long one, it's in three parts. So we'll touch on each bit separately. Overall I'm interested to know, when it comes to STEM engagement, which barriers you think there are - if any – in place for pupils, teachers as a group and then yourself personally

BFT2: Okay

Interviewer: So the first part would be: What do you think is the biggest influence on a pupil's long term engagement with STEM?

BFT2: Probably parental interest

Interviewer: Okay, and what do you feel is the key challenge faced by teachers, as a group?

BFT2: I think subject knowledge. I'm really comfortable teaching KS1 science, if you asked me to teach Year 6 science, I would have to read up and learn it myself - probably - before I taught it.

Which is fine, I can do that, but if you're not 'a scientist' yourself, I think your subject knowledge can be a bit of a barrier – even to your enjoyment of it

Interviewer: Yeah?

BFT2: If you said to me "Right, this afternoon you're going to Year 6" to do a science lesson on something that I don't understand, I would feel quite anxious before I started. Because I'd know that I'd need to read up and have that understanding. Whereas, if you're someone who's got a really good knowledge of science, that would be a "Yes!" rather than a "Oh no!". So I think it's about subject understanding

Interviewer: Okay, fair enough. And what do you feel is the key challenge faced by yourself? Which might be the same?

BFT2: For me personally, I've got quite a lot of maths and science baggage from when I was at school. Which I've worked really hard to overcome. So in terms of maths, I always felt as a primary student that I couldn't do maths. I can remember the feeling, really well, of sitting and crying because I didn't understand. And I can remember teachers shouting it louder at me, and just that feeling of it being a mystery to me. I think, in a way, that's a good thing for me as a teacher because I totally remember that feeling. And so I try really hard to think of lots of other ways of understanding things. So that when somebody says they don't understand, I don't just repeat the instruction

Interviewer: Yeah?

BFT2: I try to find other ways to access it. In a way, that's been good for me. And science as well – I would never say this to my children, because they quite like science – but my feeling at school was that I wasn't particularly good at science, that there were aspects of it that I didn't understand. And I don't know whether that's that they weren't explained very well or whether it's just that my brain doesn't work that way. I'm not sure. So I wouldn't have chosen science as an A-level because my general feeling was that it wasn't my strong [point]

Interviewer: It makes sense that people want to pursue things that they feel confident with

BFT2: Yes

Interviewer: It's really good that you've managed to turn a negative experience into a really good one!

BFT2: It's really important to try and put yourself sometimes, back in your five year old self and what that felt like. I can remember learning fractions and I just could *not* understand the tiny numbers. "Why are they small?". It just didn't make any sense to me. I didn't know why they were small, I didn't know what they meant – I had no proper concrete understanding. So then when someone's asking to you add fractions, if you don't already understand what a fraction is, you've got no hope

Interviewer: Absolutely

BFT2: So that has been really helpful for me. And it turned out I was good at maths! I got an A at GCSE for maths

Interviewer: Brilliant!

BFT2: So clearly, I wasn't bad at maths. But I had that negative feeling about it. Which is quite interesting

Interviewer: Yeah, that is interesting that you can feel a certain way about something, whether it's true or not

BFT2: Yes, and it is about the way that you're taught it. I remember my mum saying to me: "Don't worry, I was always bad at maths". And that gives you your get out clause doesn't it?

Interviewer: Yeah

BFT2: Which is why I'm careful not to say that to my children about science

Interviewer: That's something that I've come across before, when chatting to other teachers about it. One in particular said "No one ever comes to you and goes: I'm not very good at reading. But for some reason everyone says that about maths!"

BFT2: Yeah, and science

Interviewer: So which of the factors – the pupils' influences, the challenges for teachers and the challenges for yourself – which do you think is the most important when we're trying to create long term engagement [with STEM] in children?

BFT2: So hang on…

Interviewer: Sorry, of the three factors, which do you think would be the most important, and would influence a child's likelihood to study science at a later date?

BFT2: I'd have to speak from my own personal experience that it is about your home situation, and how your parents feel about science. And how much they encourage you to take science – and maths as well. And your own self-belief about those subjects. I'm thinking of one guy in my class, his parents are *so* interested in science, and I think they've given him that. Not only that interest, but also that "I can do science: because my parents understand science, I can understand science". And so already, I feel like he's going to fly away with it. Because he has that. Whereas if you're someone who has a parent who says "Oh well I was never very good at that", your voice in your head is "I might not be good at that either". And you're already losing then

Interviewer: Yeah?

BFT2: So, clearly it is about how you're taught it as well. But a lot of these beliefs that we have about our abilities start at home. In my opinion

Interviewer: Do you think there's anything that practitioners can do to address the issue?

BFT2: Yes, definitely. I think sometimes those subjects *used* to be taught in a very dry way. And I think that's improving. Maths particularly, I think there's a much greater understanding that children need to be able to draw it as a picture, they need to be able to get resources and show it. They don't just need to know that five times three is fifteen, they need to understand what that means, how they can juggle it, how they can relate it to division. So I think in terms of maths, I feel like what I'm teaching now is definitely not what I was taught

Interviewer: Yeah?

BFT2: And I think that's got to be good. And for science, I think Primary science – I think we deliver the curriculum. I think it's very teacher dependent how exciting that is. And how engaging that is

Interviewer: Okay

BFT2: We actually had a conversation a little while ago, the lady in the office's daughter and my son are the same age. And she said that when she'd [daughter] gone to secondary school, they were shocked how at how little science they felt she'd done

Interviewer: In Primary school?

BFT2: Yeah. I think it's very much about what your teacher is engaged with, and what their subject knowledge is, as to what [you think when] you leave Primary school. And that's the good thing about having a different teacher every year. But are you going to get seven teachers through Primary school who are really engaged with maths and science? Not necessarily

Interviewer: True

BFT2: So yes, you cover it – but you know and I know that the teacher does have a big influence, as well as your parents. One of my boys is 14 and it still matters to him whether he likes the teacher, as to whether he engages with that subject

Interviewer: I think it always matters doesn't it? Even at university, if there's a lecturer who's a bit dry, you'll miss one lecture here and there and then eventually you don't go

BFT2: Yeah, you switch off from what they're [talking] about. When I was at school and I did R.E. I had a brilliant teacher: she was really big and flamboyant, and it was so interesting to me. My son's got the opposite of that and he just doesn't see the point in the subject. So I think it does start at home, but it is also influenced by… I met a guy on a course who's a Year 6 teacher and he was really into design tech and engineering, and he had his class doing these amazing things. Things with electronics, and I was looking at it and I didn't understand how he'd got them all working. He had circuit boards and everything else, and so that class have spent the year doing these incredible things. If that was my class, they most certainly wouldn't have done that! Because I wouldn't have understood. And possibly my interest isn't there, in that area. So yeah, I think it's hit and miss

Interviewer & BFT2: [laugh]

Interviewer: So that's actually all my questions, thank you very much for answering them!

BFT2: No, thank you very much – I hope that's helpful

23 Appendix 11: Teacher interview transcript, BFT3

Title: STEM Teaching Experiences

Date: 16th March 2018

Speakers: Poppy Hodkinson (interviewer) and BFT3

File Duration: 17 Minutes

Interview location: BF

Interviewer: I'm interested in some of the reasons why the UK has low levels of participation in STEM careers. For the interview, I'm using the word 'STEM' to refer to Science, Technology, Engineering and Mathematics. To help me understand the reasons, I'd like to ask you some questions about your experiences as a primary teacher, delivering STEM content. So first, may I ask how long you've been a teacher?

BFT3: Nearly 15 years

Interviewer: Okay, and what's your position at your current school?

BFT3: I'm the Year 3/ 4 teacher

Interviewer: Okay, are you head of any subject areas?

BFT3: And English

Interviewer: English? Cool, okay. In your opinion, what's the level of pupil enthusiasm for STEM subjects in your class?

BFT3: Sorry, remind me. It's science…

Interviewer: Technology, engineering and maths

BFT3: They particularly like technology, and science. Yeah, I'd say they do like them. They enjoy them if they can get involved, if it's hands on

Interviewer: Okay. And do you think that they ever engage with STEM at home?

BFT3: Technology in particular, because I think that's the way the world is now. Certainly in the 15 years I have been a teacher, that's more apparent. How much they know now that perhaps even I don't know despite keeping up. The things that they can do: I've seen that shift, particularly technology. The science side of it? I don't think so. I did a Science Week in assembly the other day, and only one little girl from Year R came back, having done something at home. I said "If you want to do these experiments" – they were quite basic, simple ones. Yeah there's not many of them actually

Interviewer: What do you think might be the reason for that?

BFT3: I think some of it – with those sorts of things – it's family pressure, life. Parents are at work, it's having the time – barely even having the time to hear them read. So I think it's some of that. And it's easier, technology is just there. You've got iPads, computers at your fingertips, so I think there's less of the practical stuff, and more of that

Interviewer: More of the digital stuff?

BFT3: Yes

Interviewer: Okay, cool. So I'm also interested in whether *you* interact with STEM at home. So when I've asked this question before, people haven't been able to think of things that they might do. Because there's loads of things that you might do that doesn't seem like STEM at first. So I've got a list here, and if you've done any of those things in the past year…

BFT3: Yeah

Interviewer: Just shout out

BFT3: Oh yeah, I like Sudoku! I've been to a museum. And the other one, what I have done – when I started this job – I did go on the website [STEM Learning website]. Because our science topic last term was very much around the human body. So I went on there and found some resources and things to do with that. Because there's planning and things on the website, so I have accessed that as well

Interviewer: Okay, cool. Thank you! Would you describe yourself as someone who's interested in STEM in your personal time?

BFT3: No. [laughs]

Interviewer: Yeah? Fine. What do you think pupils enjoy most about STEM learning?

BFT3: I think it's when they can get involved. And the answer's not necessarily just there. The investigation side of it, and the problem solving. I think they like those things

Interviewer: Okay, and what do *you* enjoy most about teaching STEM?

BFT3: You know what, I'm not the biggest fan! Because, I've always *wrongly* said: I could take all the fun out of teaching science. I've developed myself in being more open ended, rather than the whole: "This is what we're going to do, this is the answer". So I have come from a point of view, where I've been quite closed about it [STEM teaching], and trying to [improve] based on what the children like. So I wouldn't say it's something I *enjoy* teaching, because it's not something that I – my husband is the technological one in our family. So I don't *need* – oh that's awful – what I need to know for my job I know, and that's kind of it really

Interviewer: Okay, fair enough. When you're preparing for STEM lessons, where do you look for your ideas and resources?

BFT3: Well I have looked at the actual STEM website, and previous planning, and video clips – quite often YouTube you can find things. And we also look to actual people as well: we had a doctor in last half term. So we actually had someone who knew the more technical things better than I did

Interviewer: Oh yeah?

BFT3: So actually, real life experience. A combination of those really

Interviewer: Okay, that's an interesting idea: getting – was it a parent?

BFT3: Yeah, he was a cardiologist and we were doing the circulatory system. So he came in and brought in a model heart. So they learnt about it from video clips, from looking in books and research on the internet and things – but for someone to come in and show them real life pictures

Interviewer: Yeah, and to say "I do this every day"

BFT3: Yes! And to answer the weird and wonderful questions they came up with. That I'd have been like "Oh, I don't know that bit"

Interviewer: Great, so you were learning too!

BFT3: Exactly!

Interviewer: Cool, so do you find that the physical resources for your STEM lessons are easy to come by?

BFT3: Not necessarily. I think some of the things we've got are useful, but these things can easily become outdated quite quickly. Science: actual apparatus? Maybe not so much. But the technological side of it, is changing all the time. And I think that's probably the frustrating one, that you haven't always got what you'd like

Interviewer: So has this ever affected how you plan and carry out lessons?

BFT3: Yes. On occasions when we've had to not do something that week, because it wouldn't quite work out. There's only so many laptops in school, if someone else is using them you can't then do whatever it is: debugging is what they've been doing more recently. So, yeah. It's the constraints of the technology that you have

Interviewer: Yeah, absolutely. It probably doesn't make sense to have a *thousand* laptops just in case?

BFT3: Exactly! Yep

Interviewer: So would you do anything differently if you had access to more resources?

BFT3: Yes, obviously like with the laptops. But also its knowing what you need, so I've only been in this school since January –

Interviewer: Oh really?

BFT3: - yeah – so it's knowing what I need. But yes I would [do things differently], because sometimes I think that there must be ways of making something more exciting. So with forces, it's always: cars down ramps. There must be something more exciting ways than 'cars and ramps'. But I don't know what that is! So I think yes, I'd like those sorts of things…

Interviewer: Okay, so to just be a bit more 'different'?

BFT3: Yes

Interviewer: Are you satisfied or dissatisfied with the amount of STEM you are able to cover in your lessons?

BFT3: With what we've got, I think yes – we do the best, they [pupils] cover everything they're meant to

Interviewer: Yep?

BFT3: Whether it's at a level where they're as excited as I'd like them to be is something else. But I'd say yeah, we get it done with what we've got

Interviewer: Okay, you just wish it was a bit more exciting?

BFT3: Yep

Interviewer: And have you ever tried to make your STEM lessons cross curricular?

BFT3: Yes, always. Or I try to make the most of my learning. So we have an over-arching topic, so at the moment [our topic] is geography based, but then in I.T. [Information Technology] with the debugging, we're learning about the journey of a little boy in a boat, so they're learning about debugging, and then creating their own instructional programs that they can copy: they're going to 'go on a journey' imagining it's a boat

Interviewer: Oh okay

BFT3: It's about trying to make them see the links. I don't like doing things standalone, if I can

Interviewer: Yeah, fair enough. So, the next question has three parts to it, and we'll touch on each bit separately. I'm interested to know: when it comes to STEM engagement, which barriers – if any – you think are in place for pupils, teachers as a group, and yourself personally. So the first part of the question would be: What do you feel is the biggest influence on a pupil's long term engagement with STEM?

BFT3: Probably us. Probably our engagement with it, which is why I'm very conscious of the fact that my area of comfort – no, comfort's the wrong word. It's not something I default to – my default would be English, a different kind of 'creative' subject. So I think probably us, I'm very conscious of the fact that [I need to] keep it engaging and fun, because otherwise they'll get turned off by whatever it is

Interviewer: Yeah?

BFT3: And we did do that with the science, and they *loved* it! They went away and found out so much more and came back with home learning, and things so, I can do it! Talking myself down aren't I?

Interviewer & BFT3: [laugh]

Interviewer: Not at all! If you know something about yourself and then you improve on it…

BFT3: Yeah, you try harder! Because I don't want to put that influence on them

Interviewer: Absolutely

BFT3: And, as I said, they really enjoyed it. They pretended to train to be Junior Doctors [and presented] at the end, based on the different things they'd learnt about

Interviewer: Oh really? Did you just keep them awake for like 20 hours straight?

Interviewer & BFT3: [laugh]

BFT3: That's true, that's the proper experience!

Interviewer: That's really interesting actually, quite a cute little project to do – I like that. What do you feel is the key challenge faced by teachers as a group, when teaching STEM content?

BFT3: I would say subject knowledge and resourcing. It's all very well that we've now got to teach '*this*' – like the debugging – that I talk about, but I'm not confident with it

Interviewer: When you say 'debugging' do you mean on -

BFT3: Yes, using a program on the laptops. So they've done it very much practically, giving instructions to each other and then applying it to a program. I think it's subject knowledge and resources

Interviewer: Okay?

BFT3: So, as the curriculum changes, you'll have your I.T. person in school that perhaps will know and therefore be able to apply it to their year group. But how does everybody else – it's not that person's fault – but the way it works is [you get told] "This is what happens and you have to teach it", but at no point since I've been a teacher, have I done *anything* I.T. training related.

Interviewer: Yeah?

BFT3: Other than being taught to use particular programs in school, or just having to 'have a go'. And like I said, I default to my husband and my daughter – who is in Year 5 – so she's taught me to use things that I think "Oh I've got to teach about that now!". So I think that's probably the problem, that actually if we [teachers] felt more confident, and inspired so you'd think "Yes! I know exactly what I can do with that", then you'd do a better job of instilling that "Yeah! We can try this…". Yeah, I think it's all about our confidence but then also having the resources and the equipment to actually do it

Interviewer: I suppose if you're going to be making large changes to curriculum, you need to be providing a bit more training and support for you guys to actually be able to do that. I think that's fair? So what do you feel is the key challenge faced by yourself personally, when you're teaching STEM. You've chatted a little bit about this already?

BFT3: Curriculum, subject knowledge. How I can do it with the resources that we *have* got, because you can work with what you've got if you're confident with what you're doing. So, I haven't had that training, in that particular area

Interviewer: Yeah?

BFT3: Which is daft when you think about it, considering how much it [technology] moves on, that you just have to learn from other people. And everybody's busy – sometimes you just have to have a go

Interviewer: And just see what happens?

BFT3: Yeah! [laughs]

Interviewer: So which of these three factors, do you think is the most important in getting pupils into STEM careers and higher education?

BFT3: I think our [teachers'] knowledge, our enthusiasm for it. Our confidence with it. Because then you're more inclined to not let it drop off of your week: "Oh we can't do that, snow days have happened, we're leaving I.T. now, we're leaving science". Here [current school], science is a core subject so that doesn't tend to happen, we just do it. But having been a teacher this long, science has been known to drop off the end.

Interviewer: Really? Okay

BFT3: So I would say it's all around that – the subject knowledge, the confidence of the teachers, with how things [technology/ curriuculum] have moved.

Interviewer: You mentioned the weather there, that's quite an interesting thing because you guys have so little time in school. You lost what – two, three days – to the snow?

BFT3: We lost two days

Interviewer: So you're almost depending on how much the weather changes – from year to year, would affect how much time the kids spend in school

BFT3: Yep

Interviewer: I'd not even thought about that! That can go down as well: The Snow, global warming!

Interviewer & BFT3: [laugh]

BFT3: Well yeah, and then this week it's meant to snow again?!

Interviewer: So is there anything you think practitioners can do to address the issue?

BFT3: At my level or higher up than me?

Interviewer: Both?

BFT3: At my level, making sure you are a bit independent with it: finding out what you need to be able to teach, rather than *not* teaching it! I think that higher up than me, in education: I think that offering those sessions – whether it's one person in the school who's trained and disseminates it to everybody else. I appreciate you can't send the whole lot of us on it

Interviewer: Of course, yeah

BFT3: But something at that level where actually you are confident and you know what you're doing. We use Barefoot Computing, and I *know* we use it, but as a new member to the school – it's not what we used at my old school – I know it's all there, but sometimes that doesn't make it easier. If it's all there, I've got no ownership over it

Interviewer: Yeah?

BFT3: I think at a higher level, there's more that can be done to skill us [teachers] up, to be able to teach it, and prepare children, and engage them – get them more excited about it

Interviewer: Okay [CPD training] – is that the kind of thing that you're after?

BFT3: Yeah, they're quite often courses. So we've got an I.T. coordinator, and then Holly's the Science [coordinator], so *they* would go on those sorts of things. But it's coming back with the information that's personal, so "That would suit Year 3/ 4"

Interviewer: Yeah?

BFT3: I also don't know if that training is out there, that's focused enough on what we need to know "We need to know, examples of how you do 'this'!". There has been more of that within science, we had examples last year – a huge pack that had come from teachers. "When I'm teaching about animals, these are the activities I did". So it's not so bad for science, I would say it's more the I.T. side of it

Interviewer: Okay?

BFT3: Definitely. There's not – you can't give people a bank of ideas – because they still don't know how to actually do *that* [specific I.T. skill]. So I'd say it's more skills. Science is better because it's more ideas of what you can do, but with the I.T. it's more the skills – we haven't all got them

Interviewer: Yeah, I think with science – you did it at school, you can probably remember it – but with brand new technology, you've got no prior experience

BFT3: Exactly! And we're always told "You're preparing them for a digital world, that doesn't exist yet, and jobs that don't exist yet!", well I am, but I'm not sure… [laughs]

Interviewer: [laughs] yeah! "How do I do that??"

BFT3: Exactly!

Interviewer: Well that's actually all of my questions, so thank you very much for answering them. Is there anything else you want to say?

BFT3: No no

24 Appendix 12: Teacher interview transcript, BFT1

Title: STEM Teaching Experiences

Date: 16th March 2018

Speakers: Poppy Hodkinson (interviewer) and BFT1

File Duration: 40 Minutes

Interview location: BF

Interviewer: So, I'm interested in some of the reasons why the UK has such low levels of participation in STEM careers and higher education. For this interview, I'm using the word 'STEM' to refer to Science, Technology, Engineering and Mathematics. To help me understand some of the reasons, I'd like to ask you some questions about your experiences as a primary school teacher, teaching STEM. So first, how many years have you been teaching?

BFT1: 9 years

Interviewer: And what's your position at this school?

BFT1: I am the Year 5/6 teacher and I lead assessment, P.E., outdoor… growth mind set. And next half term, just for the term, I'm going to be taking over maths. But I've had quite a lot of experience of leading maths in other schools I've been in

Interviewer: Okay, so you'll be sound?

BFT1: Well hopefully!

Interviewer: Ah you'll be great! So in your opinion, what is the level of enthusiasm shown by the pupils in your class for STEM?

BFT1: I think they really like it when we do science-y based things. They love the exploring part, they love the experimenting part. The theory can be a bit dry I think, with the Primary curriculum. And I think it's quite factual based, whereas there's been more of a shift recently to focus on the scientific skills rather than the knowledge

Interviewer: Yeah?

BFT1: Which they all quite like. In terms of maths, they do enjoy maths. I'd probably say the main difference between the boys and the girls is the boys will just give things a go, and don't mind as much if they're wrong. Whereas, the girls are more perfectionist, and like to get the right answer. So although they're quite capable in the subjects, they don't take as many risks. And I think particularly in the science, where if something goes wrong – it's good to go wrong, because then you can learn from it and you can retest it, that type of thing.

Interviewer: Yeah

BFT1: But I think with the girls, it's our job to a bit more work with them younger down to [make them] realise that's actually just part of learning. But I think they're like that in all the subjects really. They like to get it right, they like their work to look all neat and stuff.

Interviewer: Yeah!

BFT1: I would say, they definitely do enjoy… like technology, they love technology! We don't do as much as maybe we should in Primary schools. All of it is very maths and English heavy, especially up in Year 5/6 where they've got their end of Key Stage 2 tests

Interviewer: Yeah?

BFT1: So all morning is basically for that, and then you might have one hour a week for science, and technology might be in block, like a day in a half term or something like that. So I think they like it 1) because it's different from their routine, but also they like it because it's a bit more free? And it's a bit more ownership on them?

Interviewer: Yeah, there's kind of more scope for them to play with it?

BFT1: Yeah, I think so yeah

Interviewer: Okay, do you think that they ever engage with STEM at home?

BFT1: I know some of the children's parents have backgrounds in some of those subject areas. So I think those children do, but I don't think it's something that parents, apart from doing homework and stuff, a lot of parents maybe wouldn't know how to do activities. They're very outdoorsy, obviously the lovely environment that the school's in – so I know a lot of them are outdoorsy people. So I think they learn a lot from the outdoors. So that side of it, yes I think they are probably quite above maybe other children at their age range. But I don't think the technology side, the more detailed science-y side, I think it's probably limited opportunities

Interviewer: Yeah

BFT1: And maybe parents not knowing? And being honest, we probably don't promote things, or we could maybe give them more ideas of stuff they could do at home as well. Or bring them [parents] in and do days with us, for them to lead on at home. Which is something we don't really do a lot in Primaries at the moment

Interviewer: Okay, my next question was going to be why you think that might be, but you've answered that perfectly – cheers! So I'm also interested in whether *you* interact with STEM at home? So I've got a list of examples of ways you *might* interact with STEM, obviously there are loads more, so if there's any that you think aren't on the list, shout out

BFT1: Okay

Interviewer: So if I show you the list here, could you say anything that you've done in the last year or so?

BFT1: Oh I definitely like David Attenborough, and I watch a lot of those sort of news documentaries and nature stuff, so I'd say that. I do puzzles and games. I've got quite a logical mind, so I quite like that logical thinking side of it. I'd go to museums, especially with my partner, but it's more historical I would say

Interviewer: Rather than science?

BFT1: Yeah, rather than science. The only time I probably read about STEM is related to my job, if it's something in school. Probably outside of school, in my personal life I probably wouldn't come across a magazine or a paper with it in. But in schools we get sent things, so I know about it, but only really through the job I do, not through my life outside of school

Interviewer: Okay, so would you say that you had a personal interest in STEM, or..?

BFT1: I think [pause] I love maths, I'm a maths-y girl. So I love all the maths, I love logical thinking, trying to solve problems, all that type of thing. And I like making things, or working out things as well. I wouldn't say I'm particularly talented in any of those areas!

Interviewer: You don't have to be talented to enjoy it!

BFT1: Yeah, I do always like it when I teach maths to the kids. I like when we do D.T. [Design Technology] projects. I like doing science as well. Although I probably would say, if I was being honest, my science knowledge and probably my D.T. knowledge is limited. It's okay for their age, but if you've got some children who are particularly talented in that area and when they start to ask those questions, I don't always have all the answers

Interviewer: Fair enough, yeah

BFT1: We do try and research the answers, whereas with maths and English – the year groups that I teach are very heavily focused on that [maths and English], I do normally have the answers and the subject knowledge for that. So that's sometimes when I don't know if I'm doing the best job for the children, because I don't have all the knowledge myself. But I always make a point of "We'll try and research it" or explore it or we'll try and find it out together

Interviewer: Oh that's good. [chat unrelated to interview] So I think you've chatted about this a little bit already, but what do you think the pupils enjoy most about STEM learning?

BFT1: I think they enjoy the exploring side of it. And the freedom, because from my understanding of it, it's more child-led. And that is the way the curriculum is supposed to be going. And it's more them [pupils] asking investigations and leading, and they get a big buzz around that, whereas some lessons have just a bit too much teacher talk. They love practical things, they love hands on, they love to try and work things out. Most of them really like working together, to solve problems as well. And also, I think because it's [STEM] not a large percentage in our curriculum at the moment, because it's something different they really like it and it really interests them

Interviewer: So the chance to not only do something that they don't do every day, but the fact that they have a bit of ownership over it?

BFT1: Yeah, they definitely like that ownership. They like the independence and having the freedom to say "Oh what if this…". Sometimes you've got time restrictions, so you say "We've got to move on", so it's nice to have a little bit more manoeuvring in those subjects. If you're doing it over an afternoon or something, to explore slightly more

Interviewer: Oh okay? So what is it that *you* enjoy most about teaching STEM?

BFT1: I like that all the skills it develops are invaluable to *every* part of education, and transferable. So I like all the skills that it does, but I also like that it's child initiated and that it's setting up activities and then seeing where it goes. And I really like that idea, because the children are so capable and they do it when they're in Year R, where it's all child-led, and then as they come through the school, we seem to squeeze the creativity and the thinking out of them a little bit into structured formed lessons. I quite like that it's just "Right we're going to go with this and see where it goes". I think the skills it teaches them is so important for their future life. Obviously, the role I'm in, I have to start thinking about their next steps in Secondary school

Interviewer: Yeah

BFT1: and preparing them and what jobs they might go into. And start getting them some of the basic skills. And although, yes they've got the maths and literacy skills, there's so many other personal skills. I think if they can practice them more in a safe environment, and it's just part of their everyday learning, then I think it will make them more successful and more versatile in the future. I like the opportunity to do all of that. And also as a teacher, it's nice because sometimes you think you're working harder than the kids! Whereas [with STEM] it's actually like "Right, over to you guys, where are we going to go with this?" and you're more there as a facilitator rather than telling them what we're going to be doing all the time. So that's quite nice, because it's not as tiring!

Interviewer & BFT1: [Laugh]

Interviewer: So when you're preparing for your STEM lessons, where do you look for ideas and resources?

BFT1: I'd mainly look on the internet, at teacher sites – TES [Times Educational Supplement] is a good teacher site for us. Or I'll look at previous planning that I've used in other schools or this school. I think there is a website, but I haven't used that website

Interviewer: Is that just because you're satisfied with the other ones? Do you get enough from the things you use?

BFT1: To be honest, I'd probably say I honestly don't know how well I'm doing those subjects. Maths is a bit different because I know the curriculum, it's quite set out in stone. And I know the objectives in the curriculum and I'm covering it. But I think it can definitely be done in a more creative, open way. And I think because I don't have the knowledge, I'm almost too scared to go out without someone's guidance? I'd be scared - not to do the wrong thing, because I like trying new things – but I would think I really don't feel confident in myself about it, and the way to teach it. I think we all probably would honestly say that we then don't end up teaching it in the way that we know it should be taught. Because we're not sure how to make that step. We know how it should be taught, but we're not sure actually how to…

Interviewer: Get from where you are to –

BFT1: Yeah! How to do it yet? I want to teach that way, but then we end up just going back to what I've used before in schools, or tweaking it. Or talking to others, or thinking of ideas. I think I've taken elements of it, I'm trying to make it more child-led and trying to give them more freedom and working out – particularly in science – working out their own experiments and then doing follow up ones from their results. I definitely wouldn't say I'm confident to do it was well as it could all be done

Interviewer: And do you think that the sites that you use, are the things on them pitched correctly for your pupils?

BFT1: The sites I use is stuff [ideas] from other teachers, but not necessarily from STEM experts, so I think although it's good because teachers know how to package things together to teach it effectively. Unless you've got a teacher who's particularly talented in that area - which there will be, but the majority maybe not, I don't know. I think we're just stuck in our little circle of sharing things, which is great, but then sometimes you need a little bit of intervention to boost it up, and *then* have the 'teacher touch' on it

Interviewer: The STEM Learning website does have things – so I'm a STEM Ambassador and if I came up with a resource, I could put that on there for teachers to access.

BFT1: Oh okay, yeah

Interviewer: So if you were trying to teach something about astrophysics or whatever, an astrophysicist might have uploaded something onto there. Although, the only thing that I've found, there is so much on there, it's quite a lot to trawl through. I think there's quite a good search –

BFT1: Oh okay, yeah. Because until you came in, apart from having leaflets delivered to the school – and this is the fifth school I've been in – there's been no training or focus on it. So it's one of those things that you hear about, but you don't actually know the ins… so I knew there was a website, I could have gone on there and had a look, but we haven't been introduced to any of that. Apart from getting the odd flyer, or the odd email saying "Do you want to do this thing?"

Interviewer: It's easy just to skip past an email though isn't it? When you're dead busy

BFT1: Yeah, and you think "Oh yeah that looks interesting" and then you've forgotten about it in an hour's time

Interviewer: I can understand how that can happen! When you're planning your lessons, do you think that the physical resources are easy to come by, for STEM?

BFT1: I think it depends where you are, what school you are in. Some schools, yes I would say have quite a lot of resources. And then some schools not as much. What I tend to do is, if I know I'm going to be teaching something, then I'll go out and get the resources. Because some of them are things that you can't just store in a shed. Or they're more things that you need to buy to experiment with. So definitely in terms of science, that's what people tend to do. Before their unit, they'll check what we've got in school and then they'll go out and buy or order the things we need

Interviewer: What sort of things do you use? What would you go out and buy yourself?

BFT1: It depends what topic we're doing. Year 3 and 4 were investigating rocks and soils, so the teacher would go out and get the different types of soil

Interviewer: Oh, so just to the garden centre or something?

BFT1: Yeah, bits and bobs like that. Or if we're doing melting, or reversible changes or something like that, we'll go and get food products

Interviewer: Oh like melting chocolate bars?

BFT1: Yeah!

Interviewer: Does this ever affect how you plan and carry out your lessons?

BFT1: No, I always try to get the resources that I need. I'm a bit of a 'controlling' teacher, so I'm over-organised in some ways. I'll normally have what I need, but I can imagine some teachers – if it's a bit last minute – saying "Oh we don't have that, we can't do that!". I have probably done that a couple of times, but I do try to think "Right…". And I try to block it as well, if I'm doing science, we might do three days on that so we can just keep it going

Interviewer: Oh so you can just leave everything

BFT1: Yeah, so obviously I've got the learning objectives that I need to cover within it, but then it's nice because they're [pupils] in that zone, so they can just carry it on. Then in terms of a teacher as well, it's quite handy because the resources are out. So you can just leave them out, rather than having to put them away, get them out again

Interviewer: Yeah, that's true, it takes time to tidy up again doesn't it?

BFT1: Yeah, so I've found with D.T. we always tend to block that. I find that works quite well

Interviewer: That's a good approach! So are you satisfied or dissatisfied with the amount of STEM that you cover in school?

BFT1: I think dissatisfied. I think there's so much pressure on the results for maths and English. And they are important, I know they underpin a lot of things. But I would probably say – so my school days starts, the kids come in at 8:50 and until two o'clock, that is *all* maths and English.

Interviewer: Oh okay

BFT1: Whether it's maths, English, SPaG [spelling, punctuation and grammar], handwriting, guided reading, spelling would all be included in that. And then maybe mental maths. So actually, I get an hour a day of something else

Interviewer: Yeah?

BFT1: Whether that be P.E. or science or R.E. [religious education]…

Interviewer: There's so many other things as well as STEM isn't there?

BFT1: Yes! You've got so many other subjects. I think that's [pressure of math and English] more so up the top of the school, because like I said Key Stage 2 testing. But you think, that's five hours a week of all those other foundation subjects, I don't think does it justice. That's why I try to block it. I'll say "Right, this week: half we're block R.E. and half the week will be our science", just because I think it gives them a little bit more time

Interviewer: Yeah

BFT1: But I don't think I'm satisfied with the coverage of technology, and things like that. And it's what the kids love, and it's what they actually remember. If I think back to it, I can't remember a maths or English lesson, but I can remember what I made in D.T., or the tower challenge – things like that

Interviewer: That's so true!

BFT1: I find that hard, as a teacher, because you're torn from what you would like to do with the kids, to what you have to do from all the pressures that come from above

Interviewer: So that's things like Ofsted?

BFT1: Yeah, the government and then it goes down and filters through the food chain really

Interviewer: It is a shame, isn't it?

BFT1: Yeah, because at this age you've really got them [pupils] in the palm of your hand. And they're so flexible and they're so open to things, and creative and everything. And then I think, it's such a missed opportunity in primary school – because it's in such a safe, nurturing environment, that you can really empower some of these kids. But it just gets lost because it's "maths English, maths English" all the time

Interviewer: So I did a workshop on using isotopes in archaeology – I've done it twice this week, one for a primary school yesterday and the same workshop for a secondary school on Tuesday. And the *difference* in the reception of it: the primary schools kids were so keen, so curious. You're exactly right, as soon as you reach secondary school…

BFT1: You close the doors a bit?

Interviewer: Yeah! And it's not even because they're 'secondary school kids', it's just that they're not encouraged to be creative in the same way any more

BFT1: Yeah! And I think that even if you pop into our Year R here, you'd even see it within this school. Even though we try – we do outdoor learning with them a lot – we've tried to get out and about and do lots of creative things with them. But I think you'd see that even from Year R to Year 1, you'd see a difference

Interviewer: Yeah?

BFT1: And it's such a successful curriculum, the Year R curriculum, and the kids get so much from it, why can't it be like that throughout the school? Well, it can't be because of maths and English pressure. Which is a shame, because it squeezes a lot of the qualities out of the kids

Interviewer: Yeah you've spent so long building it up and…

BFT1: I think you get a lot of kids, by the time I see them towards the end of school: they're a bit unconfident. Year Rs are quite ballsy, they just run around trying everything, and then some of them [older pupils] can be more timid, less confident, doubt themselves a lot, scared of getting things wrong, take way less risks. You see that a lot, and that does affect their academic learning, as well as them as a person. Which I think is quite sad, because it's only what the system has done to them

Interviewer: Yeah

BFT1: I don't know what the magic answer is for that…

Interviewer & BFT1: [laugh]

Interviewer: So have you ever tried to make your STEM lessons cross-curricular?

BFT1: Yeah, I'll try and link it to a topic we're doing. So one of the topics we do is 'fun fairs', so we'd look at going to Paulton's Park [local theme park], and they'll do a workshop about going on the rides and feeling the forces, and then we'd make funfair rides in our technology lessons. Then we'd link our English to it, and do persuasive 'Dragon Den' style pitching. Once we actually took the ideas to Paulton's Park and pitched the ride to the park. Sometimes the topics don't link into what we're doing, which is why we might block it separately

Interviewer: Okay

BFT1: Next half term the project is 'Groundforce', so it's all out and about in our local environment, and plants. So we'll link that in a bit. The kids probably don't know what Groundforce is, which makes me feel so old! It works well when you can link it to the subject. But you've got set objectives of when you've got to cover them, so it doesn't always link. But as and when, I do try to – maybe 50% of the time they can be linked?

Interviewer: Okay, but where the links are, you make them?

BFT1: Yeah!

Interviewer: So the next question is in three parts, we'll touch on each one separately. But overall I'm interested in when it comes to STEM engagement, which barriers – if any – you think are in place for pupils, teachers as a group and then yourself personally. So, the first part of the question would be: What do you feel is the biggest influence on a pupil's long term engagement with STEM?

BFT1: I think long term, this is the time to do it now, when they're in primary. Like I said before, when they're mouldable, when they're open to things. When everything is sparking the interest and they're developing the basic skills. I think as soon as they hit those teenage years, they put up more barriers to things. They're a bit more unsure about things. So I think that could be one of the biggest influences, to them – actually starting young. I also think they really feed off staff and teachers as well. If you're really passionate about something and give them lots of opportunities to do that, then they're really passionate about it

Interviewer: Yeah?

BFT1: So I really like P.E. and they love P.E. Then I'll say "We're doing art" and because I really like art they'll say "Ah yes!". So it's a bit like the weather: if you come in like a rain cloud, then they're going to be little rainclouds. Whereas, if you come in like "Oh!" then they'll be like "Oh! Why's Mrs N excited? I'm excited too!". So I think it's teachers as well. And then I think it would also be helpful if there was more awareness and more knowledge about it [amongst parents and teachers] – the skills, and what we could do to develop them a little bit more. I think if they see things as part of their everyday life, then they're more open to it, they've got more opportunities to explore it. Whereas I don't feel that they – well some of the kids here do get this, because we're in quite a privileged area – but I've worked in inner city schools and [the pupils there] definitely wouldn't get any opportunities. And their parents wouldn't actually know anything about any of those skills either. So I think that start them young, and educate the people around them, would probably help with the long term influence

Interviewer: That makes sense, you can't aspire to be something that you can't see.

BFT1: Definitely!

Interviewer: Okay so, what do you feel is the key challenge faced by teachers when they're teaching STEM content?

BFT1: I think our knowledge: our subject knowledge, our confidence. The resources as well, we don't always have the right resources that we need. Because if we're not confident, and go into something half sure, then that will transfer to the children. But I think the biggest barrier will be the other demands from the other curriculum subjects. And the heavy maths and English curriculum that we're now presented with. Because honestly, if you asked all teachers nearly 100% of teachers would love to do more foundation subjects and would like to do less maths and English. But I just don't know how you can still hit those goals. And I think more teachers would want to be free and more creative and child-led and everything like that. I think that's why we went into it, to do what's best for the kids. I've got a lot of teacher friends and that's our frustration, right across the board – how it's quite focused just on some subjects. Particularly in primary, secondary they do give more [time] to the other subjects, because you only have five maths lessons in two weeks, whereas here you get five a day! Half an hour guided reading every day, 20 minutes spelling every day – an hour English every day

Interviewer: I suppose in secondary school, [by then] you guys have done all of the hard work – you've taught them [pupils] to read and add up – it's just the extra bits!

BFT1: Yeah! So they love going to secondary school, they love thinking about "Ah yes, in science you get the Bunsen burners! You get to mix chemicals". All of these things which we don't do with them, and don't give them the opportunity to do in primary school. So by the time they get to that point, they've outgrown primary school and what primary school can offer them. And they are ready, because they've got an idea at that point of what subjects they like and what ones they don't. And so they're looking forward to certain ones. But I think the subjects they like and the subjects they don't like is 1) personal interest and sometimes the way your brain works and 2) their journey through school; what opportunities they've had – what's their teacher been interested in? Which teachers have they liked and been influenced by? And what's been their [teacher] passion? Because they're [pupils] like little sponges, especially the little ones. They think you're some type of goddess who lives under her desk and they just want to be like you : "Oh if she likes that, I'm going to like that too!". Yeah, they are cute

Interviewer & BFT1: [chat about H's choice to pursue primary rather than secondary teaching]

BFT1: I do talk to some of my friends who are secondary school teachers, and their timetables are a lot less packed. They have free periods and they don't teach all day – they're home by half 4 and they'll rock up to school at half 8. And I'll think that we [primary] do *way* more hours, but then I know they've got all course work and things like that, so it probably balances

Interviewer: True. So what do you feel is a key challenge faced by yourself personally when teaching STEM? You've kind of touched on this a little bit

BFT1: Yeah, I think it would be my subject knowledge, my confidence and knowing what best practice looks like. I like to try new things and I'm quite open to new things and new initiatives. And there's *lots* of initiatives that get brought in weekly, monthly by the teaching community. So you're always thrown something "have a go at this!" and sometimes you need to filter through – "Let's look at our school at the moment and what's our main focus?". So I wouldn't feel confident just to look something up on the computer and try it, I like to see things – so "This is what a good STEM lesson would look like" or "These are the things you're aiming to achieve". Teachers are quite used to that – getting new training – but we're quite visual learners. It's easy for people to say "This is how you do it", but then how does that transfer to when you've got 30 kids in front of you? As teachers, we really like it when we're shown something [and we can say] "Yeah that *will* work". Because sometimes you get people come in and say "This is how you do it", and you think "Do you know *anything* about children?? Because that's not going work with the kids!"

Interviewer: Yeah?

BFT1: Whereas someone who's worked with kids, can come and show you with your kids – it's even more powerful. Then that gives you a lot of confidence

Interviewer: Okay

BFT1: So yeah, guidance – how do we create the best STEM opportunities. And like you said, where can we go for resources? And just to filter it down, because at the moment it's just this big Thing

Interviewer: Yeah, STEM is blowing up at the moment and there's almost *too much* information out there now isn't there?

BFT1: Yeah [you think] "I don't know where to start!". So that's why we've got you!

Interviewer: I'll try! Which of the three factors: the pupils, teachers, and yourself – which do you think is the most influential on pupils' long term engagement? So what is preventing or helping people get into higher education and STEM careers?

BFT1: I think teachers could have the biggest influence. Because we see the children more than a lot of their parents do in a week. And we've got very tight relationships with them, they trust us, we know them inside out. And if we can inspire them and provide them with opportunities now, I think they will then hold onto that when they move on. If you talk to my Year 6s, they already know what subjects they like and which ones they hate. But then if you unpick why that was, it might be down to "I'm not very good at it" or confidence or "I don't do it that much" or "So and so doesn't like it, so I don't like it either!". So they've already got these preconceived ideas. They're quite strong mini-adults by the time they get to Year 6, and you've got all this nurturing, safe environment. The more it becomes part of our daily practice, the children will become more confident to take risks and will try things and will have a go. And they are getting there. As for the teachers, we want pupils to do it [STEM] long term, but if we're not providing those opportunities for them, parents might not provide them – well where do they then get those opportunities to even know about it [STEM]?? So they can't develop themselves without someone developing them first

Interviewer: That's fair, yeah

BFT1: Then you have a knock on effect, so someone needs to develop the teachers to develop their pupils. Teachers are in a very fortunate position – we can really shape some of these kids and we can really make a difference to them – particularly in primary, because they trust us. If I think about this school, there's so many opportunities here, and it's so flexible because we've only got four classes, so we could really make a big difference to a lot of these kids. And in our community, in our parents we've probably got a lot of experts that we could call upon. My class are all going to go to [Local] university to do a criminology day, a careers day

Interviewer: Oh?

BFT1: one of the girls in the class, her dad is a professor… he just offered it to us. And in the summer term I want to focus a bit on aspirations and careers and exposing the children to jobs that they might not have thought of. Getting people in to talk about their jobs, and what they do and what skills they need. That type of thing to inspire them a little bit more

Interviewer: That sounds great!

Interviewer & BFT1: [chat about jobs they considered when younger]

BFT1: I always knew I wanted to work with children, and help children. And teacher was the obvious job, so I just went along that little cycle. But next year will be my tenth year [of teaching], and I think there's so many jobs with children, but I'm stuck in the teacher role now – which is an *amazing* job at times – but I think I don't even know how to transfer . Some of my friends do jobs that I never even knew existed, and I think "Oh that's a really cool job!" – it wouldn't even occur to me! And these kids that we're teaching now, there'll be jobs [for them] that don't even exist now. So I think it's important to prepare them for what the world might be like

Interviewer: So that's actually all of my questions, thank you very much!

25 Appendix 13: Teacher interview transcript, SPT1, SPT2, SPT3 and SPT4

Title: STEM Teaching Experiences

Date: 8th May 2018

Speakers: Poppy Hodkinson (interviewer), SPT1, SPT2, SPT3 and SPT4

File Duration: 45 Minutes

Interview location: SP

SPT1: Like I said, I'm interested in looking at some of the reasons why the UK has low levels of participation in STEM careers. To help me understand these reasons, I'm going to ask you guys some questions about your experiences as primary school teachers delivering STEM content. For this interview, I'm using the word 'STEM' to refer to Science, Technology, Engineering and Mathematics. So, can I ask how long have each of you been a teacher?

SPT2: One year

SPT3: This is my 14th year

SPT4: First year

SPT1: About 33? [Laughs]

Interviewer: Wow, cheers guys. And what are your positions within the school?

SPT2: Year 6 teacher

SPT3: Year 6 teacher and TLR [Teaching and Learning Responsibility] with a responsibility for maths and a member of the leadership team.

SPT4: Year 4 class teacher

SPT1: And I'm a year 4 class teacher as well. I haven't got an official responsibility…

Interviewer: What's your 'unofficial' responsibility?

SPT1: Well, science sort of and I suppose looking after Year 4 whilst the teacher who usually [does it] is away

Interviewer: Okay

SPT1: Other than that, nothing that I'm paid for

[All laugh]

Interviewer: So, in your opinions what is the level pupil enthusiasm for STEM subjects in your class?

SPT2: They enjoy maths

SPT3: Yeah they enjoy maths, if they're good at it

Interviewer: Okay?

SPT2: They do maths every day as well don't they?

SPT3: Science, I think the curriculum is changed so the focus now is too much on investigations

Interviewer: Yeah?

SPT3: As opposed to curriculum content and knowledge. We used to do loads of knowledge and very few investigations, but now we lots of investigations and very few knowledge based lessons

SPT1: Okay, do you find that's changed how the pupils engage with it?

SPT3: Yes. I think it's been diluted down. When I started here, I thought science was very strong – did you [SPT1]?

SPT1: Yeah, one thing that I've always thought about science is: the kids love doing science if it's a practical hands on activities and done in the right sort of way. D's right, the balance between knowledge and skills used to be 50/50 really at one time. But then it changed because the focus of the curriculum became very driven on skills

Interviewer: Okay?

SPT1: The children enjoy it, they enjoy the practical side of it. The problem with primary level is being able to cater for it and deliver it: equipment, man power, resources – that sort of thing

Interviewer: Yeah?

SPT1: So I tend to find they [enjoy science] on a practical level, but a lot of it now is – as [SPT3] said – is investigation, but done in a more formal sort of way. [To SPT3] Isn't it?

SPT3: That's all they're assessed on now, is just investigations

Interviewer: Just investigations? That's interesting

SPT3: It used to be: ‘physical processes’, something to do with ‘human’ science, ‘plant science’ and investigation skills. And there was equal weight given to those four

Interviewer: Yeah?

SPT3: Now it’s just investigations. You tend not to cover certain things, so they might leave Year 6 and might not have done photosynthesis. Which is shocking to be honest.

SPT1: I think you’ll find that it will change. Once the new curriculum comes in. I hope it will change, because it’s so glaringly obvious. They’ve moved so far from one way to the other

Interviewer: Is it almost an over-correction do you think?

SPT1: Yeah. You do find that in education a lot. Because I remember when the national curriculum first came in, science had about 14 targets and then they went to 3 and they never seem to get it right. And you tend to find that what goes round comes round

Interviewer: Oh really?

SPT3: There used to be SATs as well, so they [maths, English, science] were given equal weight

SPT4: I used to do science SATs when I was at school

SPT3: So there were standardised tests up until – 10? – years ago. So Year 6 children would do English, maths and science. Science was taken away and they don’t do it at all now. And that’s the government saying ‘It’s not that important”

Interviewer: Yeah?

SPT1: It’s affected the profile of [science] a lot

Interviewer: Do you think it changes your focus as well, as teachers?

SPT3: Yeah, I like science. I have a scientific background – [SPT1] does as well – and I enjoy teaching it. But being honest, I wouldn’t say – as enthusiastic as I am about teaching it – I wouldn’t say the children’s enthusiasm is the same

Interviewer: Really? That’s really interesting. [To SPT2] Would you say the same in your lessons as well?

SPT2: Well, in the year I’ve been here? [SPT2 and interviewer laugh]

Interviewer: I mean have you noticed that they're more or less enthusiastic or anything like that, maybe from when you were training?

SPT2: Yeah, I would. I agree with [SPT1], they do engage when it's practical – with the resources. But when it's just the investigation and write up, it's just formal writing – they're not as engaged and enthusiastic

SPT4: Compared to maths though? With maths, the ones who are good at it, love it and the ones who are not good at it, hate it

SPT1: It's the conceptual side of it. With maths the kids' famous expression is "I don't get it". And if they don't 'get it', it's very difficult to help them 'get it'. Whereas with other more language based activities, they can access it at their level

Interviewer: mm?

SPT1: So with writing a story – maybe they wouldn't write quite so much, or it won't be quite so detailed. Whereas with a piece of maths, they can either do it or they going to have to do something that is more geared towards them

Interviewer: Okay?

SPT1: And science straddles those, but it does tend to lean towards the concept and the understanding side of things

Interviewer: Okay, so related to the STEM enthusiasm, do you think that your pupils ever engage with STEM at home?

SPT2: Only if their parents are interested. A couple of mine will have – their mother has a background [in STEM] – they talk about it and they engage with it at home. But otherwise… they're not having it at home, they're not having it at school

Interviewer: You don't really hear about it?

SPT3: I only like science because my father was a biology teacher, it's passed on isn't it?

SPT4: Yeah, if they've got a background at home they can engage with it, if they haven't… well, you have the odd few who will

SPT3: It depends on your teachers at school as well I think. My favourite teacher of all time taught me biology and chemistry – he used to spit, he'd get so excited by it. We all used to laugh, but when he'd spit, you'd think "Oh what's he going to talk about now?"

[laugh]

SPT3: Human biology is fascinating isn't it? The human body is unbelievable –

SPT4: Yeah, it depends on the teacher doesn't it? It's got to be engaging

SPT3: Exactly yeah. You teach it like that: "Come on! Human body!"

SPT2: And activities

SPT1: Yeah it is the activities. If you're going to make it practical, make it 'resource heavy'. And I think that's where we've always got the short straw in primary compared to secondary in that we haven't got the equipment, or the man power – like lab assistants – to get it out. If you could just walk into a room and say "We're going to do this experiment" that someone's got ready for you, but it involves an awful lot of extra time getting it all together. I think that has an impact certainly

Interviewer: Yeah, I can appreciate that. I'm also interested in whether you guys engage with STEM at home, so I've got a little list here of activities that you *might* do in your own time that are STEM related. Obviously there are lots, so if there's anything that's not on here just say. If you guys want to shout out anything you've done in the last year or so

SPT4: I reckon documentaries like David Attenborough is becoming more and more popular, like the one he did about the ocean – they're becoming more and more common

SPT1: I've got them on DVD

SPT4: Because they are quite interesting

SPT1: So going to zoos, looking at museums, that sort of thing I've done that. "Mending or trouble-shooting your own devices? I don't know about that!

All: [laugh]

SPT1: So I've got a 'menagerie' at home, because my background is zoology. And I think my children have got that, my wife's also – so now we've got five rabbits, five guinea pigs a hamster. And then I've got a tortoise and I've also got two musk turtles as well

Interviewer: Really? That's cool!

SPT1: Yeah, in a tank at home – so I love those

SPT4: I can do a game of sudoku every now and then, if I was in a car. Not now so much, because I'm normally driving

SPT3: STEM on social media?

Interviewer: Yeah, so do you follow any astronauts on Instagram?

SPT4: Have you got an Instagram account [SPT3]?

All: [laugh]

SPT4: What's the guy who went to space? That welsh guy?

SPT3: Yeah, we watched him

SPT4: Yeah, he was televised more

Interviewer: So that was more the mainstream media?

SPT4: Yeah

Interviewer: Do you guys do anything with your kids – any STEM related activities?

SPT3: My two aren't old enough. But I'd buy them a science kit – a chemistry set – for Christmas

SPT1: My daughter is nuts on science, she's got the Carol Vorderman book. She's 14 and she's been on trips with school, and she always wants help with her homework.

SPT2: Museums? Sudoku, other than that, no. My niece – do you remember when [kids] were making slime?

SPT1: Yeah!

SPT2: Some science programs they watch, she had a science set where she was making 'potions'

Interviewer: Nice!

SPT2: It's what they see as well, that can interest them

Interviewer: Yeah definitely. So, is that everything? Are you guys happy that you've said the things that you do?

[agreement from group]

Interviewer: Okay, so would you describe yourselves individually as someone who is interested in STEM in your personal time?

SPT1: I'm interested in it yeah, I wanted to be a vet so I studied zoology. So that's my little area

SPT4: I'd veer towards maths, although I wouldn't pursue maths –

SPT1: It's not something you do of an evening time?

SPT4: No! But enjoy maths, I did A level maths – I wouldn't necessarily do it in my free time

Interviewer: Fair enough, but in your academic choices you'd choose it?

SPT4: Yeah! I'd always go for maths

Interviewer: Okay

SPT3: I did biology, chemistry A level and an environmental science degree. I wanted to be a physio, but I did work experience and the blood made me squeamish

Interviewer: [laugh] fair enough!

SPT3: Biology A level was the most interesting thing I've ever done. *Ever*. Without a doubt. The human body is unbelievable. Chemistry was the hardest subject I've ever done

Interviewer: It's tricky isn't it?

SPT3: Chemistry A level, I thought "There's no way I'm carrying on at degree level if it's going to get harder than this". I wouldn't say I spend much of my spare time doing it though

SPT4: Yeah, that's the thing I agree with that

Interviewer: Okay, so if someone said "Are you interested in STEM?" would you say yes or are you more interested in –

SPT3: Yes, I like science. I do like science, I watch documentaries – Brian Cox I like

Interviewer: Neil Degrasse Tyson? He's quite good! He's like an American Brian Cox?

SPT3: Charles Darwin? [all laugh]

SPT2: Not really. I like Horrible Histories, things like that – otherwise…

Interviewer: You're more of a humanities person?

SPT1: The hardest thing I think I did, when I was at [University], in my first year I did biochemistry as a module – oh!

SPT3: Well that's off-putting in itself isn't it? You've got to be highly intelligent to do chemistry

SPT1: Yeah, biochemistry was just… ridiculous

Interviewer: It's just next level??

SPT3: We haven't talked about technology yet have we? We don't really have much

SPT1: Again, it's the resources

SPT4: We've got a few iPads?

Interviewer: Okay. Do you think that your interests in science are reflected in your teaching at all? Sorry, your interest in STEM

SPT4: Your enthusiasm affects you doesn't it?

SPT1: If you've got a natural background knowledge – [to group] this has come up in our pedagogy and Inset hasn't it? It's about tapping into people's interests and their expertise

SPT4: If you've got a flair for the subject, and you enjoy it, and you've got a good knowledge – it's going to come out automatically in teaching

Interviewer: Do you find that when you're teaching maths?

SPT4: Yeah, whereas English…

Interviewer: So what do you think – you've touched on this a little bit already – your pupils enjoy most about STEM learning?

SPT1, SPT4 & SPT2: Practical!

SPT1: Things that get them away from writing in books and are hands on – that's why places like [Science Museum] are so popular, it gives them that chance to fidget about and investigate. That's definitely the key thing

Interviewer: mm?

SPT1: If you do a practical lesson, that easily gains their interest – far more than if you just sit and write about it

SPT2: Especially the ones that struggle with language, because when it's practical they're not thinking about what they need to say, how they need to say it. They just talk naturally in practical work

Interviewer: What do *you* guys enjoy most about teaching STEM?

[pause]

Interviewer: You're also allowed to say you *don't* enjoy teaching it!

SPT1: It's nice to be able to do these things, it keeps coming back to time and resources though. If you've got the time and the resources and you see them actually *doing* the activity and getting out of it what you hoped they would – that's quite rewarding

Interviewer: Yeah?

SPT1: I mean that's *teaching*, it's why most people go into it in the first place. You like to see –

SPT4: That you're doing something for [the pupils]. It's the same with technology as well – if we had all the resources, we'd be flying

SPT3: Personally, I think we used to teach it better when it was more knowledge based, with *some* investigation. Because they have to [be able to] write a scientific prediction, but they haven't got the knowledge to back it up

Interviewer: Yeah, you need the vocabulary

SPT1: It has to a certain degree knocked some of the fun out of it. Because it's quite prescriptive in the way they've got to organise their thoughts and findings. Rather than just messing about and getting on with it.

Interviewer: Do you think that's the difference between 'investigation' and 'experimentation'? It sounds like the investigations [were introduced] to make it more fun and make it more exciting, but it's not quite there?

SPT1: Maybe that's just us!

SPT3: [In the old curriculum] it would tell you "You have to cover 'this'". It was human biology and plants, and you *had* to cover all these things for the SATs. As a teacher, I know they'd leave here with far more scientific knowledge than they do know

SPT1: Yeah

SPT3: We'd cover a whole lot more. If I asked my class what photosynthesis is now, about four of them would know!

SPT1: It's definitely diluted. And the philosophy was that the knowledge is out there, [pupils] just need to know how to get it and use it. But then you're presupposing that this knowledge is going to arrive somehow, without it being taught to them!

SPT3: A good analogy is: if you're teaching somebody the skills to drive a car – so that's the investigation work – they need to have the knowledge of road safety, of the highway code to have a clue what they're doing on the roads

Interviewer: So you can change gear, but you need to know what the speed limit is?

SPT3: If you can drive a car, but you haven't got a clue what to do, or what a traffic light means or –

SPT1: If you're talking about animals – say a 'bird – you'd get some of them saying "A bird's not an animal, it's a bird". You're presupposing that [pupils] will know these differences

Interviewer: Of taxonomy?

SPT1: You'd be surprised, of what you as a scientist think is an absolute given, is not! One of the things I've noticed with – not so much science, but geography – both my daughters are absolutely appalling

SPT4: In terms of locations?

SPT1: Yeah, you'll say to my elder daughter, who's 17 "Where's Paris" and she might [tell you] it's in China somewhere – or something like that.

SPT4: They just don't have a concept of it – it's like my sisters. It's different now, they don't teach locations

SPT3: I just think the changes in the curriculum are massive. Especially science

SPT1: It was a similar thing as with the geography, they erred towards 'site' studying – it's all a bit woolly really. Ask them where London is relative to Bristol and

Interviewer: They're not sure? Okay, so when you guys are preparing for your STEM lessons – we talked about this a little bit already – where do you look for your ideas and your resources?

SPT1: Well we've got our schemes of work initially, they set out what we should be teaching and they will have suggestions as to the sort of activities you could be doing in them. And it's up to you then to deliver that in an interesting way. That you juggle with all the other curriculum demands as well

SPT4: We have to see if we can *find* the resources for it

SPT3: I just… google it

Interviewer: Yeah, I've heard quite a lot of people say that they look on the internet

SPT4: There's loads online

SPT3: Plenty on there: 'Primary Resources' is always a good one

Interviewer: Oh is that [the name of] an actual website?

SPT3: Primaryresources.co.uk – there's plenty on there

SPT4: There's loads similar to that as well

SPT3: Teaching Ideas, Woodlands. We very rarely come up with our own thing – its [already] there isn't it?

SPT4: You don't need to half the time

Interviewer: [To SPT2] would you say the same?

SPT2: Yeah

Interviewer: So you guys all use the internet basically? Do you find that those sites are pitched appropriately for your class? So you find stuff that's useful, but do you ever have to tinker with it?

SPT2: You do have to adapt sometimes

SPT1: Primary Resources, are resources made by primary school teachers and then put on the website

SPT2: You have different levels, different abilities – higher or lower ability. Depends what you're doing

Interviewer: Fair enough. Again do you guys find that the actual physical resources for your lessons are easy to come by?

All: No

Interviewer: So that's a *hard* 'no' from everyone is it?

SPT2: If you're able to print it off, then you can print it off and laminate it. But anything you'd have to buy, that would take a little bit longer – there's funding [to consider]

SPT1: It's getting everything together

SPT4: One thing's over here, other stuff's over there. Someone's taken it but they haven't put it back

SPT1: I always think primary school teaching, particularly at junior level, is a bit like [a circus trick] where you'd have plates on the end of sticks and they all start falling, but you've got to keep them going. That's the problem with primary school teaching. Because any one thing on its own, is not *that* difficult – and if that's all you had to do, then you could manage it

Interviewer: Yeah?

SPT1: But the trouble is, you go straight from a maths lesson to an English lesson to what have you. And you've got to have all the resources ready at hand to do it and there aren't that many hours free in the day to get things together. You do have PPA time [Planning, Preparation & Assessment] which has improved it a little bit. But the biggest constraint I would say is time and getting the right resources

Interviewer: Would you say that a lot of the things you might want to use, you'd have to order in – so they wouldn't necessarily be in the school already?

SPT4: Depends what the topic is, I suppose

SPT2: Yeah, some things you might be able to buy

SPT3: We've got a lot, but they don't work. Like torches – we've got a box of torches, but none of the batteries work

SPT1: Again, *someone* has got to maintain [it] – we haven't got a lab technician – by the time you've got all your meetings to go to, after school club or marking, checking all that over is probably the last thing that's on your mind

Interviewer: Fair enough. So does this affect how you plan and carry out your lessons?

All: Yes!

Interviewer: Okay, so are you satisfied or dissatisfied with the amount of STEM content you're able to cover in your lessons?

SPT4: Well maths is every single day isn't it?

SPT3: I think science needs a higher profile, personally. It has two hours a week [designated as a science lesson], maths is five hours, English is five hours

SPT1: We need to be careful we don't just think 'science' – they do maths every day. And again it comes back to what D mentioned about SATs and assessments. Science used to be an equal partner it's now the poor relative really isn't it? [pause] It's not ideal, certainly

Interviewer: Okay

SPT3: We don't cover enough anymore – nowhere near as much as we used to. I've got a science book from a child from about 8 or 9 years ago and it was that thick [indicates a few inches] – full of science! If you were to look at our science books now, there's about 10 pieces in there

SPT1: Well we haven't got a science book!

SPT3: Well it's not 'science', it's just investigations

SPT4: It's the same style investigation every time

SPT3: Predictions, methods, conclusion, equipment lists, evaluations and stuff

Interviewer: So it's not quite the same? Do you guys ever try to make your STEM lessons cross curricular?

SPT3: They're supposed to be!

SPT4: Maths is difficult to do cross-curricular really. Well it comes into others, but it doesn't link to most topics. But then it does come into science easily – with charts, bar graphs, that kind of thing

Interviewer: Do you every try and experiment with other things? Like colour wheels, so drawing it across into the arts or humanities at all?

SPT3: The Infants do that more than we do

Interviewer: Okay, fair enough

SPT3: Juniors I'd say is more discreet

SPT1: Their teaching is different – the way foundation phase operates. It might be interesting for you to talk to them, just to get a picture. Because we're all Key Stage 2

Interviewer: Okay, so the next question is in three parts, and we can talk about each bit separately. I'd like to know, when it comes to STEM engagement, which barriers – if any – you feel are in place for pupils, teachers as a group, and then yourselves personally. So first, what do you feel is the biggest influence on a pupil's long term engagement with STEM subjects and careers?

SPT2: Like lessons they remember, is that what you mean?

Interviewer: Yep, yeah

SPT4: Enthusiasm by the teacher plays a bit part I think

SPT2: Yeah

SPT1: Like you said, if they enjoy doing the subject at school – this stage is a formative stage isn't it? It's something they can carry on

SPT4: Engaging activities. If their learning is fun, then they're going to remember it, I think.

SPT1: They tend to enjoy things they do well at, they succeed at

SPT4: Yep

SPT1: Children love to be told they've done something well. They're not so good when it doesn't go so well. That's why maths can tend to be a bogey subject

Interviewer: Mhmm?

SPT1: Because it's sometimes difficult. Obviously you want to push them

Interviewer: Do you think there are maybe any *external* influences on pupils STEM engagement? [To SPT2] you mentioned a bit about if their parents work in science?

SPT2: Yeah, it's if they're doing it outside of school as well. A couple of mine have mentioned in school what they've done on the weekend, or the week off. But that's only if their parents are driving them to do it as well

Interviewer: Yeah?

SPT2: Not always their parents – they still need to have a bit of interest in it. Otherwise they won't be bothered?

SPT1: Obviously their I.T. skills, because of having iPads –

SPT4: Better than yours aren't they [SPT1]?

SPT1: Oh, way better than mine!

SPT4: They can fly through an iPad

Interviewer: Yeah?

SPT4: Because it's part of their everyday life at home

Interviewer: That normalisation of technology?

SPT2: Yeah, that's where technology comes into play I guess

SPT4: But a computer, like that [gestures to desktop PC] they wouldn't. Because often they've never seen a computer like that

Interviewer: Oh really? To be fair, I don't have a desktop at my house, you don't really have them any more do you?

SPT4: No, but an iPad – it's like second nature to them

Interviewer: Okay

SPT3: I think they're difficult as well. Sciences are a difficult subject to understand, GCSE especially. So I would say not many people carry on with science at A level because they've found it too difficult. And that's doubled at A level, because chemistry – phew!

SPT4: Well it's a massive step up from GCSE to A level isn't it?

SPT3: Well see, that's part of the reason why people don't do it!

SPT1: Well back in the 'Dark Ages', when I did A levels you had to be Oxford/ Cambridge level to get 'A's in subjects. 'A*'s didn't exist and very few people got 'A's

Interviewer: Yeah?

SPT1: Whereas now, the anti's been upped. My daughter was quite put out that she couldn't get into [University] unless she got 'A's and 'B's

SPT4: The level to get into a university now is… high!

SPT3: Talking about filling the jobs – what grades do you need to do medicine? 4 'A's?

SPT4: You'll need 'A*'s

SPT3: Physiotherapy? I imagine that's…?

SPT4: 'A's yeah. Anything like that – veterinary – that's high

SPT3: Whereas teaching, it's just any Tom, Dick or Harry isn't it? 'C's and 'D's – well that's changed now. Nursing even – that's gone up hasn't it?

SPT4: To get onto the teaching course I did – four, five years ago I started – [it was] 'B's I think you needed. Now you must have a 'C' as well in GCSE English and maths

SPT3: Mmm

SPT4: And they won't take you on without that, but that's only come in the last two years. That's how it was when I applied. Now – talking about science – they're thinking of bringing in a 'C' at science GCSE as well

SPT3: To teach?

SPT4: Not at the moment, but that's the next thing to come in

Interviewer: Okay. So what do you guys think is the key challenge faced by teachers as a group, when they're teaching STEM content?

SPT4 & SPT3: Resources!

SPT1: Resources, definitely. And man power as well

SPT4: Time to set it up, time to get ready

SPT3: If you spoke to most teachers, I don't think they'd say that science is a strength of theirs

Interviewer: Oh really?

SPT4: Yeah. Teacher subject knowledge

SPT2: I think the knowledge – like if you have maths, there's rules in maths that you can easily remember, but science is such a widespread subject

Interviewer: Okay?

SPT4: Yeah, teacher's personal knowledge with that as well

SPT1: Well it is a difficult subject

SPT4: Oh it is, yeah!

SPT1: Yeah, they're not easy subjects and I think it's no coincidence – is it? – that secondary schools struggle for maths teachers and sciences teachers. Because: a) there aren't that many people doing those subjects, and b) the ones who can do them can get better jobs elsewhere

SPT4: Better jobs than teaching, yeah

Interviewer: Do you think that relates to it a little bit – the fact that a lot of the people who are interested in physics, don't bring that enthusiasm back in the form of a teacher to the next generation?

All: Yeah

SPT4: Yeah, they go into their field then don't they? They're going to go into the field of physics if they're that good at it

SPT1: It's not always the 'cleverest' people who make the best teachers

SPT4: That's true! They've got to be able to teach it

SPT1: That's right – because I had a physics teacher – the reason why I didn't do physics A level – he used to strike the fear of god into you. He knew it inside out, but if you asked a question his response to that would be "It's in your notes, look in your notes". He wouldn't attempt to explain it to you

[SPT3 has to leave]

SPT3: We've made some interesting points here haven't we? It's made me think about things

Interviewer: Thank you for joining in! So, what do you feel is the key challenge faced by yourselves, personally, when teaching STEM? This answer can be the same as what you've said before

SPT4: Resources

SPT2: Knowledge, resources

SPT1: Time! Getting the time to get it

SPT4: I think those three are the key

SPT1: Almost everything with teaching is time

SPT4: You don't have time for anything! Your lunch break is taken up with marking, and whatever else you've got to do, and by the time you've had your lunch you start again

Interviewer: Yeah?

SPT1: We do duties twice a week, so we don't get breaks

SPT4: Morning meetings, afternoon meetings

SPT1: Yep. So say you want to set up something – I did something with blowing bubbles – I spent ages getting the stuff together for it, setting it up. And that's because it was an observation lesson. But that was it, once that lesson was done I was done for the day!

All: [laugh]

SPT1: I was shattered! But that was the [kind of] lesson [I'd always want to teach], it went really well. I know not every lesson can be an all singing and all dancing lesson. But at least you felt there wasn't anything holding back

SPT4: Perhaps that's why it went so well – because you put all that time and effort into it

SPT1: But because your time is dragged in so many directions. Getting resources together. A large part of the reason [they're] not there is because you've not had the time to get them!

SPT4: Yep! They're dotted around the school. It's usually the case that you'll go to get something and it's not anywhere it's meant to be. Someone hasn't put it back!

Interviewer: Do you guys – this might be more of the infants – do you ever get the kids to bring in the resources? So everyone brings a cereal box from home or something like that?

SPT2: Yeah

SPT4: It depends what you're doing doesn't it?

SPT1: That's more for art, that sort of thing

SPT4: Say we're doing something to do with absorption. We were using measuring jugs [to P] how long did it take for us to find the measuring jug we needed? About an hour?

SPT1: I know, yeah

SPT4: Before we managed to find *one* in the back of a cupboard somewhere

SPT1: It was one that was small enough to record what the children needed

Interviewer: Oh, the measurements?

SPT4: We had loads of big ones!

SPT1: Then we had a TA spend half an hour cutting up bits of paper. Because we set them an investigation: "What paper [is] the best for absorbing water?"

Interviewer: Oh yeah?

SPT1: So they came up with ideas, talked about what a 'fair test' was and then we got about five or six different sorts of paper. But of course they had to be the same size! And someone had to cut all that up

SPT4: [laughs] yeah cutting up kitchen roll. It went really well

SPT2: Yeah, when the children enjoy it

SPT1: They enjoyed that you see

SPT4: Yeah, and it went really well because we did put a lot of effort into planning it and finding all the stuff

SPT2: But with schools, you know you need to get English done, you know you need to get maths done – so you know you need that specific time for those lessons

SPT4: And it [STEM] doesn't take priority

SPT2: No [in agreement]. So if science and technology had a bigger priority, where you could spend more time focusing on activities – maybe that would make a difference?

SPT4: You can't throw out maths for the day, maths has got to be done

SPT2: I know you can link it – that's why they're trying to do more 'topic-based' now

SPT4: Especially maths and science

SPT2: So you're still doing the maths, covering the history

SPT1: But we've just finished doing tests haven't we? And you can see [gesture around room] a big pile of practice papers. We've been spending all afternoon marking

SPT4: About five hours marking just today, English and maths. As D was saying though, when I was in school, you had a science one as well

Interviewer: So which do you think of these factors is the most important in relation to getting kids into university doing a science subject, doing a STEM job?

SPT1: Which…?

Interviewer: What is the most important to *them*, what is going to have the biggest influence on whether a pupil continues in a STEM career or not?

SPT1: That they can succeed at and that they can enjoy succeeding at it

SPT4: Enjoyment. I think it depends a lot on what the teacher is doing with them. If they've got a good enough knowledge and can provide exciting activities and engage and [be enthusiastic] – then it's going to rub off, and they'll want to continue with it

SPT2: They need to know as well – there's so many jobs out there – what they can apply for [with their skills]. Because you don't really hear about it [SPT4 agrees]. You don't really hear about those certain jobs and how to get those jobs

SPT4: They don't know – they're doing a specific skill in maths – how that's going to help them in later life

Interviewer: So just because you've got your maths A level – what job can you do with that?

SPT1 & SPT2: yeah

SPT4: We do try, because we had one of the parents in – she's a surgeon, and we had someone in making rockets. So it does link, we do try. Because she was explaining how she uses maths for her job and he was explaining how science comes into his job. But then still, only the odd few activities might link to that

SPT1: Although they're very complex beings – children – they also can sometimes operate in very simple ways. You give one ten sums to do and he gets them right and suddenly he likes maths! Because he's succeeded at it. " Oh I like doing division, can I have some more, so I can get ten more right?

Interviewer: Yeah?

SPT1: And they need success, and as we said earlier – with something like science, which can be intrinsically difficult – it's so conceptual isn't it? And understanding it – we've got to give them a way into it and to enjoy it. And children don't tend to enjoy things that they don't do well at or they don't understand

SPT4: Yeah

SPT1: They don't say "Maths is brilliant, but I got all those sums wrong". They like it because they got things right. And I think that's our job to motivate them and give them a way into that

Interviewer: Yeah, so even if they're getting it wrong, they're given the opportunity to come back around and have another go?

SPT1: Yeah

Interviewer: So that is actually all of my questions, so thank you very much guys! Is there anything else anyone wants to add at the end? [pause] No…? Cool!

26 Appendix 14: Teacher interview transcript, NBT2

Title: STEM Teaching Experiences

Date: 21st May 2018

Speakers: Poppy Hodkinson (interviewer), NBT2

File Duration: 13 Minutes

Interview location: NB

Interviewer: Okay, so I'm interested in the reasons why the UK has such low levels of participation in STEM careers. For this interview, I'm using the word 'STEM' to refer to Science, Technology, Engineering and Mathematics. To help me understand some of the reasons, I'd like to ask you some questions about your experiences as a primary school teacher delivering STEM content. So, first may I ask how long you have been a teacher?

NBT2: Five years, this is my fifth year

Interviewer: Fifth year? And what's your position in your current school?

NBT2: So, I'm leader of English and then Year 6 teacher

Interviewer: Fab, and in your opinion what is the level of pupil enthusiasm for STEM subjects in your class?

NBT2: I think it's quite variable. You've got children that are really interested in it, and I think that comes from their parents. So quite a lot of them have got parents in that field who are really interested. And then you've got the children who don't really see the point of it. Because it doesn't really fit into their lifestyle. I think – it's not necessarily true – but they don't really see its relevance

Interviewer: Okay? And I was going to ask you: do you think your pupils engage with STEM at home?

NBT2: Some of them definitely. And I do think that definitely comes from the parents. Whereas those parents who share that view: they don't really see the point of it. Quite a lot of children will say "I'm not very good at this, because I know that my parents can't do it" – I think that does come a lot from home

Interviewer: Yeah? Okay. So I'm also interested in whether *you* ever interact with STEM at home? So I've got a little list here of *some* of the different ways you might interact with STEM. Obviously, there are loads so if there's not something on here, you can just shout it out. If you've done any of these things in the past year, just call out

NBT2: Yes to the first one

Interviewer: Yep?

NBT2: Yes the middle I've actually just bought his [David Attenborough] book.

Interviewer: Oh really?

NBT2: Yeah, I've bought David Attenborough's new one and Stephen Hawking's as well?

Interviewer: Oh yeah!

NBT2: So, those two, that one [indicates 'puzzles'], and this one [indicates 'museum visits']. I went to the Natural History Museum

Interviewer: Ah lush! So is that everything?

NBT2: Mhmm

Interviewer: Fab! So would you describe yourself as someone who's interested in STEM in your personal time?

NBT2: Yes

Interviewer: I think that comes across from your other answer. What do you think pupils enjoy most about STEM learning?

NBT2: I think when it's practical, they get quite excited by it? But I think in schools it can be quite writing focused, and that can lose quite a lot of their interest. So when it is really practical, they *love* it, and are really enthused by it

Interviewer: Yeah? And what do *you* enjoy most about teaching STEM?

NBT2: I think it's getting the children to realise that it *is* relevant to their everyday life. And that science is all around them, mathematical things are all around them – even down to things like patterns of natural things. And trying to get them to realise that it *is* all around, and it *is* relevant – to get them interested in it

Interviewer: Awesome! So when you're preparing for STEM lessons, where do you look for your ideas and resources?

NBT2: I try to look outdoors as much as possible – to try and use the natural environment. So it's not all class based

Interviewer: Awesome!

NBT2: Also trying to get things that are personal experience – so what I've seen in everyday life, and get that into the classroom. I do lots of reading, just trying to get information from different sources, so it's more of a broad approach to teaching

Interviewer: What kind of sources do you [use in your] reading?

NBT2: Normally just recommended books, so at college I did environmental science, and they would give us a long list of books to read. I bought them all, [NBT1] and I are quite –

Interviewer: Oh do you share them?

NBT2: Yes! And then also documentaries, and then using websites or watching things on the internet

Interviewer: Do you use any particular websites at all?

NBT2: Really it's just whatever pops up – I don't really delve deeply into it, but whatever is at the top of Google

Interviewer: Fair enough, and that comes up with interesting ideas?

NBT2: Yeah

Interviewer: Okay, do you find that the actual physical resources for your STEM lessons are easy to come by?

NBT2: It can be quite difficult, and in my last school we updated the whole science cupboard – so it was all ready to go. But I think they can become quite outdated quite quickly. So it's trying to keep [that] updated and current

Interviewer: Okay

NBT2: Also, just looking after it – in schools I think they have that tendency to not last as long as what they could do because different people are using them. Trying to really keep that focus on looking after it, so that everyone can appreciate the resources

Interviewer: Okay, is that because so many of the kids are using them or just because they're going all over the place?

NBT2: I think it's more just getting the children to respect it, and know that we're all sharing and using it – I think that's helpful

Interviewer: Okay

NBT2: Because they get carried away I think

Interviewer: Because they're so excited?

NBT2: Yeah, they get really carried away [so] it's just looking after it

Interviewer: So, does that ever affect your lessons at all?

NBT2: Sometimes. We're [herself and NBT1] new in September so we both started at the same time

Interviewer: Oh really

NBT2: So we're working on trying to just replenish resources

Interviewer: Oh yeah, [NBT1] mentioned before that you guys have been given the go ahead to get some new stuff?

NBT2: Yes, we have. So I've tried to bring in things from my last school. Like the new electronic circuits, and things related to different areas of science. So we can then bring it forward. I think it's making it appropriate for the technological age that they [pupils] live in

Interviewer: Yeah

NBT2: Because sometimes it's quite outdated, or not really current. So [we're] just trying to keep it following along with technology, as well as everything that they experience at home

Interviewer: Keeping it relevant?

NBT2: Yeah

Interviewer: Are you satisfied or dissatisfied with the amount of STEM that you're able to cover in your lessons?

NBT2: I think there could be more – particularly science – I think mathematically we cover a broad range. So that's always really well covered, but I think sometimes science *can,* not be as explored as the other sides of STEM

Interviewer: Okay, what about things like technology as well?

NBT2: We have I.C.T. time that is always scheduled in. So weekly, we're going into the I.C.T. suite and trying to use lots of different ways of exploring it. So that's *well* covered. I just think it's when science isn't so structured. We don't have: "This is when we're doing science", so it's trying to get it in more regularly

Interviewer: Okay

NBT2: And I think we've been lucky. When you talk in cluster meetings with other schools, I think science is an area that *does* get dropped off. Whereas, we've been really good trying to keep it in there, so they're [pupils] experiencing it regularly

Interviewer: Okay, so there's no 'Science Hour', it's down to you guys to decide?

NBT2: We decide, and I think that across the school, Science is something that you decide when you want to do it. That's why sometimes, in certain schools, you don't see it as much

Interviewer: mm?

NBT2: That's why we try and keep the coverage all the way through the year

Interviewer: Yeah okay. That's really interesting, because obviously you guys [NBT2 and NBT1] are dead interested in science, but I can imagine that if someone was less confident with it…

NBT2: Even being Science Coordinator at my last school, we'd go to meetings and there'd be quite a lot – particularly Year 6 – where science hadn't been taught in a long time. Which is such a shame because it is so important

Interviewer: Yeah

NBT2: But I think when English and Maths is the focus from the government. Science *is* core, but it's not assessed in the test framework

Interviewer: So it has less of a position?

NBT2: And like you said, it can depend on the enthusiasm – if you've got teachers that are really enthusiastic about it then it will have a higher priority. But if they're not, it can tend to slip away

Interviewer: It's understandable isn't it? People tend to play to their own strengths don't they? Do you ever try to make your STEM lessons cross-curricular?

NBT2: So we're currently in the process of bringing English into it. So next year we've got a whole unit where we're looking at evolution, and we've blocked it out so we've got a whole half term where we're looking at evolution in science and English to cross it over together. Which will really help them to see the purpose of it all, all across the subjects

Interviewer: Yeah

NBT2: And then in maths, in the autumn term we do D.T. – so they'll make bridges "across a river in Alaska"

Interviewer: Oh okay

NBT2: So that's linking it in as well

Interviewer: Okay, that's awesome. With your evolution and English, what form is that going to take? What's that going to look like?

NBT2: So, a lot of the English is really writing focused and we want it to be that they can access different reading sources too. So we've got lots of different books that they're going to look at, we've got documentaries that we want them to watch. In English they'll be writing things like biographies of Charles Darwin, and Mary Anning

Interviewer: Oh okay

NBT2: And also this year we had a science day. So they created their own fossils and then had to tell everyone about how the fossils are made and make a little storyboard

Interviewer: Ah, cool. That sounds so interesting

NBT2: We've got futuristic writing as well, so how the world might change in the future. Making predictions based on what we can see from evolution so far

Interviewer: Oh okay. That's *so* good!

NBT2: What we've found so far – being new – is that history was quite prioritised with the English, so we've just done the Victorians alongside the English, but we felt that science doesn't ever really get that priority. So we thought it would be really lovely to bring it all in and do it all together

Interviewer: Yeah – evolution, Charles Darwin and all of that is also quite historical as well so you're really mixing it all together!

NBT2: Yeah

Interviewer: So the next question is in three parts, and we're going to talk about each bit separately. Overall I'm interested in: when it comes to STEM engagement, which barriers – if any – you think are in place for pupils, teachers as a group and then yourself personally. So, the first part of the question is: what do you feel is the biggest influence on a pupil's long term engagement with STEM subjects and careers?

NBT2: I think it's having those memorable experiences. I think if they've got an experience they can really remember, then they're likely to keep going in the future. Whereas if they have this lack of self-esteem: "Oh, I'm not very good at this", then long term that can really affect them

Interviewer: Yeah?

NBT2: So I think we're [teachers] really key, because we obviously have them when they're quite impressionable at junior schools and primary schools. I think it's just about giving them those stand out experiences that they can associated with STEM. Because I think they don't necessarily associated it *with* something.

Interviewer: Yeah?

NBT2: It's just: science standalone, maths standalone, and bringing it all together and identifying – to them – that "This is what I'm learning about" and how it all will feed into their future life.

Interviewer: Yeah? What do you feel is the key challenge faced by teachers as a group, when they're teaching STEM content?

NBT2: I think sometimes subject knowledge. It's either something that you're strong at or something that you worry about. I think it all stems down to their own school experiences, I think quite a lot of people [don't want] to get something wrong, and also [don't want] to come across to the children that they *don't* know about [something]. I always encourage that actually it's okay – it's okay to learn *with* them. Even though you're teaching the mother elements – just share that understanding and that learning together

Interviewer: Absolutely. If you get asked a question that you're not sure of the answer to, saying "I'm not sure, but let's go and research it"

NBT2: Yes or "Hold onto that question" – I always get them to come up with questions at the beginning and then add to them, and when we've answered it we can swap them over and just keep going with that learning process

Interviewer: That's nice – teaching them that it's okay to not know an answer as well. So, what do you feel is a key challenge faced by yourself personally, when you're teaching STEM content?

NBT2: I would say the biggest thing is time

Interviewer: Yep

NBT2: Finding the time to cover everything you want to, in a short space of time. And making sure that you're giving it enough time, so that you can do it *well*. I think that's always a worry – you don't want to just skirt over the top, you want to really embed that understanding, and love for it, rather than just a quick fleeting visit, then you've got to move on

Interviewer: Yeah

NBT2: I think that's the biggest struggle, to try and cover it all. And give the full benefit

Interviewer: Okay. So which of these three factors – so the pupil influences, the teachers, yourself – do you think it the most important in increasing engagement with STEM?

NBT2: I'm torn between the time, and the subject knowledge. Because actually if you don't feel confident enough, you won't make the time? So they're a little bit linked together. Like I said: being in charge of when you teach science, if you're anxious about it, or worried about it then [you might think] "I'll do this instead"

Interviewer: Yeah

NBT2: And put it off. So I think those two link together

Interviewer: Yeah fair enough. Do you think there's anything that practitioners and teachers can do to address any of the issues we've talked about?

NBT2: I think it's really important to talk to other people. Because I know last year when I was in the science cluster group, just talking to people about barriers was really helpful. Because then you can see how other people have overcome those barriers, and share things

Interviewer: Yeah?

NBT2: And it was lovely having that communication, where you can say: "I've used this resource, it really worked" or "I used this video and it really captured their imagination or their interest in it". So I think that's really important to just communicate any fears that you might have, or anything that you're worried about

Interviewer: Yeah yeah, so you're sharing ideas amongst yourselves then

NBT2: Yeah

Interviewer: Okay, fab. That's all of my questions, is there anything else you want to add at all?

NBT2: I don't think so

Interviewer: No more science you want to talk about? Alright – thank you!

The interviewer continued chatting with NBT2 for a short while after the interview is ended and she describes an experience with her grandfather, who taught her astronomy: they would go on walks and read astronomy books together.

27 Appendix 15: Teacher interview transcript, BGT1 and BGT2

Title: STEM Teaching Experiences

Date: 3rd December 2018

Speakers: Poppy Hodkinson (interviewer), BGT1 and BGT2

File Duration: 27 Minutes

Interview location: BG

Interviewer: Okay, so I'm interested in the reasons why the UK has such low levels of participation in STEM careers. So, for this interview, I'm using the word 'STEM' to refer to Science, Technology, Engineering and Maths – as your classes know!

[all laugh]

Interviewer: To help me understand these reasons, I'd like to ask you some questions about your experiences as a primary school teacher delivering STEM content. So, nice easy questions to start off with, how many years have you been teachers?

BGT2: this is my 20th

BGT1: and this is my… 21st

Interviewer: okay

BGT1: yeah, 21st

Interviewer: okay, thank and what are your positions in your current school?

BGT1: classroom teacher, year 4

BGT2: yeah, same for me – part time class room teacher

Interviewer: okay, and in your opinion, what is the level of pupil enthusiasm for STEM subjects in your class?

BGT2: it's quite high

BGT1: yeah, I'd agree the same

Interviewer: do you think that your pupils engage with STEM at home at all?

BGT2: some, some do but not all of them

BGT1: I think they engage without realising it, so they might use a lot of technology

Interviewer: yeah?

BGT1: they might not realise that's STEM, maybe not so much the science

BGT2: but the maths

BGT1: if they like maths anyway, they play online games I think

Interviewer: oh okay

BGT1: and the engineering would be Lego and stuff wouldn't it?

BGT2: yeah

BGT1: and building – tend to be the building games and apps that they can have. Even something like – what's that one? Minecraft type of thing

Interviewer: yeah

BGT1: type of engineering really isn't it?

Interviewer: yeah, I suppose

BGT2: yeah I would say the school helps with the maths, with the homework. So we've got the maths homework online, so they do that don't they?

Interviewer: okay

BGT1: yeah, they do maths online

BGT2: but engaging at home, I think it is – there are the odd parents who are really interested, maybe it's their own career and they might talk to their children about it. But I think it's whatever their parents interests are. A lot of them have got iPads and things at home, so they can access the technology a bit better

Interviewer: okay and would you say a lot of the websites and things that they might use are ones followed on from school?

BGT1: not really, websites – no, because we tend to use a lot of apps. We wouldn't necessarily be working off a website

Interviewer: okay

BGT1: be more app based resources we would use, yeah.

Interviewer: okay, what kind of apps do you guys use?

BGT1: we use well, just like the data one I showed you – the numbers

Interviewer: oh yeah, that was good

BGT1: using that – we've got different apps on the iPad. I can't name them all, to do with maths especially

Interviewer: oh okay yeah

BGT2: there's one called 'tip top for time', and the 'mathletics' we do which actually has got a website as well, most of them do it at home on their iPads, and that's an app so we've got both versions. They're more maths related aren't they? Than science related?

BGT1: yeah, but they do things like coding as well

Interviewer: oh really?

BGT1: they do a lot of technology

BGT2: that's in school

BGT1: yeah that's all in school, they wouldn't necessarily use those apps – unless they're using the Lego

BGT2: yeah

BGT1: we've got where you can build it and then film it using the Lego creator

Interviewer: oh right okay

BGT1: they might do that at home, but… yeah, I wouldn't know because we don't really promote certain things at home

Interviewer: fair enough

BGT1: just the maths

Interviewer: it's the maths homework that they do?

BGT1: mm

Interviewer: I'm also interested in whether *you guys* ever engage with STEM at home? So I've got a list of examples, that you might do – but obviously there's loads and loads of ways you might engage with STEM, this is just a couple, so if you think there's anything else, do say. [If you've done any of these activities] in the last year – if you've engaged with any of those things?

BGT1: reading

BGT2: reading about STEM

BGT1: yeah and TV

BGT2: I like listening to – on Radio 4 there's a program called 'The Curious Cases of Rutherford and Fry' – Hannah Fry and, I've forgotten his name – ah what's his name? Anyway she's a mathematician and he's a biologist

Interviewer: ah cool

BGT2: and they do a 10-12 minute program, and they just answer questions about all different things and I find that really interesting. And I watch quite a few science programs on BBC Four, I can't remember what channel it is – well anyway my husband has them on so I end up watching them

Interviewer: [laugh] okay

BGT2: yeah, I watched the David Attenborough last night

Interviewer: oh it was good last night wasn't it?

BGT2: the painted dogs. Social media – well I follow Hannah Fry and Dr Rutherford and various other ones on Twitter

Interviewer: okay

BGT2: and then with my son, he's got like a hotwires, electric circuit kit, you can do all different things: you can make a radio

Interviewer: oh cool

BGT2: you can make…stuff like that, he's getting a chemistry set for Christmas

Interviewer: ah nice, lucky!

BGT2: puzzles and games, yeah we do those with the family. And we try to take them to places – yeah museums and things that are interesting

Interviewer: cool

BGT2: I'm not so good at troubleshooting my own devices, I often get Dan to do that

BGT1: I have to do all – I have to do it, I've not got any choice, because my husband's not interested in it. As far as for me – with the Apple family sharing, I control all of that and I've had to learn as I go along – it doesn't come naturally!

Interviewer: [laugh] yeah

BGT1: but I've had to. Yeah I follow – I'm really interested in things in newspapers, magazines like a range of things really. And watch the programs on TV – I quite like architecture

Interviewer: oh really?

BGT1: so I like how things are designed and made – that sort of aspect. I wouldn't necessarily build models myself, but my kids would

Interviewer: yeah okay

BGT1: they made a huge – we had a huge massive box that the Christmas tree came in, it was probably about four foot

Interviewer: yeah?

BGT1: two of my kids and went off and made something this weekend with it, and they were climbing into it. And they're actually quite old – so they're like 11, and he's still doing that which we thought was nice

Interviewer: yeah?

BGT1: and we do puzzles and games, and yeah take them out on trips, just as often as – it's just when you can fit it in isn't it?

Interviewer: yeah

BGT2: when you we're saying that – hobbies like model building and coding, and web design – I don't really. When we do anything to do with IT, because I've got my husband who does it, you say you do your IT

BGT1: I only do a little bit

BGT2: if there's anything else I do, it's usually to do with school because we're constantly having INSET and training – then you have to go home

BGT1: just use IT in that way

BGT2: and practice it and use it yourself before you teach it so you know what you're doing! [laugh]

Interviewer: [laugh] yeah! Yeah, fair enough – was there anything else on there that you wanted to talk about?

BGT1: my two boys absolutely just love maths

Interviewer: yeah?

BGT1: they want – and my daughter actually – they do a lot of, they want to find that maths activities and puzzles themselves, that's what they enjoy doing

Interviewer: yeah

BGT1: so they like things like that

Interviewer: okay

BGT2: yeah I'd say the same, there's one – we used to have them in school as well with cars and you've got to move them to get the cars out

Interviewer: oh yeah, to get it out the traffic jam?

BGT2: yeah

Interviewer: oh that's a good one, that

BGT2: so I think just having that in school you think "oh that's good" and vice versa, the other way round

Interviewer: cool – is that all good?

BGT1 & BGT2: yeah

Interviewer: awesome, thank you. So next question would be: would you describe yourself as someone who's interested in STEM in your personal time? So when you're not…

BGT2: I would, I would a bit because like I said: I listen to those programs

Interviewer: yeah

BGT2: but I don't probably do it as much as I'd like to – that's something I do if I can

Interviewer: yeah okay

BGT1: for me, because I do quite a lot of sport, I like the sort of biology side of things so I follow a lot of things to do with that part of science. So I'm very interested in how nutrition affects performance and my performance when I train

Interviewer: yeah

BGT1: that's what I would do *a lot* of in my personal time, followed threads and things on Instagram, Twitter about athletes – I watch them, if that's linked at all? I don't know. But that really would be my, and then architectural stuff

Interviewer: yeah

BGT1: but it's more like looking at galleries and you know designs rather than - I wouldn't go off drawing anything [laugh]

Interviewer: [laugh] you don't go designing buildings in you spare time??

BGT1: no!

[all laugh]

Interviewer: okay, so what do you think pupils enjoy most about STEM learning?

BGT2: I think hands on

BGT1: mmm

BGT2: hands on, first-hand experience – like you had today with the bones. Or then we're also doing science with the electricity and the wires

Interviewer: yeah

BGT2: and they absolutely loved it, and they're just really engaged. And they're all talking to each other – so if you came in, you might think "oh this is a bit noisy" but they're *all* engaged, they're all talking about what they're doing

BGT1: mmm

BGT2: and how they're going to get the light to light, or what the bones are and "where does this go?" and "what bone is it from?"

BGT1: yeah, I agree

Interviewer: cool! What do you enjoy most about teaching STEM?

BGT1: that aspect I think

BGT2: yeah, that aspect

BGT1: that it is really hands on

Interviewer: yeah?

BGT1: you can do a variety of approaches and methods like you did today – the children, you let them find out for themselves – so when we're doing the electricity they'll say "oh it's not lighting up" and it's nice to stand back and wait for them to find out why

BGT2: yeah

BGT1: trying to work out how to fix it

Interviewer: yeah? So when you're preparing for your STEM lessons, where do you look for your ideas and resources?

BGT1: the internet for me

BGT2: yeah, definitely the internet

Interviewer: yeah? Could you give an example of the kind of sites that you use?

BGT1: BBC do a lot of Bitesize

BGT2: yeah, there's a lot of educational websites that you can go to

BGT1: Primary Resources is a good one for teachers

BGT2: Primary Resources, Twinkle

BGT1: TES

BGT2: teachers put the items, you share and then also you can go to some of the science museum, well just sort of science websites as well, you know

Interviewer: yeah

BGT2: they can have something, but it depends what comes up on your search

BGT1: mm

BGT2: but we also have to follow a certain – we've got our national curriculum and our context, and we have to think to a certain line of what we're doing. But it's just finding the best things. We used to use a lot of books in the past didn't we?

BGT1: mmm

BGT2: but it's changed now because of the internet

Interviewer: yeah okay. And do you think those sites are pitched appropriately for your classes?

BGT1: sometimes, it's very Americanised

Interviewer: oh really?

BGT1: there can be some fantastic little film clips, like on YouTube, to introduce – because they just expect everything to be so interactive now, the children

Interviewer: yeah

BGT1: but the voices are often American, and it's not the way they're used to hearing things presented

Interviewer: yeah?

BGT1: so there needs to be I think a bit of a British market for that

BGT2: we've got the Hwb – in Wales there's a Hwb isn't there?

Interviewer: oh okay

BGT2: Where there's resources that teachers do, but there's not always what you need. You have to search, sometimes you can spend half an hour searching for a really good clip, and it would have been easier just to make it in PowerPoint sometimes

BGT1: [laugh] yeah!

Interviewer: okay, so do you find that the physical resources for your STEM lessons are easy to come by?

BGT1: no

BGT2: not anymore

BGT1: we'll have to trawl the internet or make them ourselves

BGT2: yeah

BGT1: combine what we find to make appropriate resources

BGT2: yeah

Interviewer: so does that affect how you plan and carry out your lessons?

BGT2: sometimes I think, sometimes you know you want to get something really good and you think "oh we just can't afford to get it" and you try to get hold of it, but it's not available. If you know someone who might have it

Interviewer: yeah

BGT2: well sometimes – I don't know if they still do it, but you used to able to borrow things off the museum

Interviewer: yeah?

BGT2: you have to do it so far in advance, it's just things like that really

BGT1: mmm

BGT2: and the money – finances

BGT1: it's the financial side I think

Interviewer: yeah?

BGT2: and the way we teach is quite different, because in the past, there was a science person who was in charge and they had a scheme of work, and each year group had this, that and the other to use. But the way you teach is so different now isn't it?

Interviewer: okay – and how has it changed?

BGT1: instead of Year 2 doing – say sources of light, and then the science coordinator in charge would know in Year 2 this term, they're doing light. So they would have all those resources ready

Interviewer: ah okay

BGT1: and just check the stock – people can dip into those resources, as and when so reception might use sources of light when they do "When I went to sleep" or whatever because they talk about nocturnal animals

Interviewer: oh yeah

BGT1: so they'll dip into those resources, then because we're doing electricity, we might say "oh we want to grab some torches and have a look at how they're working" and it ends up, that it's so mixed, and now the responsibility isn't just of one coordinator – it's everybody's responsibility

Interviewer: yeah

BGT1: but then the budget is really harsh, so we can't just buy in masses of resources any more. We've just got to really mind the ones we have

Interviewer: yeah? Do you find maybe that when things become everyone's responsibility, somehow they suddenly stop being – if there's not that one person taking care of them especially?

BGT1: it can just be that you don't think that you need it until the last minute

Interviewer: ah okay

BGT1: I think that's it really

BGT2: yeah

BGT1: and the focus is very much on IT I think in this day and age – that aspect, so there's lots of iPads and great resources, but then more practical science, we might not have as many resources as we may have in the past

Interviewer: okay

BGT2: I agree yeah

Interviewer: okay, and are you satisfied or dissatisfied with the amount of STEM content you're able to cover in your lessons?

BGT1: satisfied I would say

BGT2: I feel, because it's maths as well – we do loads of maths

Interviewer: yeah

BGT2: I'd like to do a bit more of the physics, that bit I sometimes feel is a bit lacking. But I don't know if we look throughout the whole school, you'll probably see it there

Interviewer: yeah

BGT2: because of the way we teach now in context, so we've got sort of a topic, and we'll have a science one won't we?

BGT1: mmm

BGT2: where we'll do *a lot*

Interviewer: yeah

BGT2: but I think we're okay really aren't we? We cover everything we've got to cover. But sometimes I feel like it would be nice to have a little bit more, because – like you were saying, people aren't engaging in it when they get older. But whether that's something about when they get to high school or something I don't know. Because the way we teach is so different, in primary school to high school. They're so engaged at this age

Interviewer: yeah

BGT2: something seems to happen I think maybe as they get older… possibly

Interviewer: yeah, I think a lot of people would tend to agree with that. Have you ever tried to make your STEM lessons cross curricular?

BGT1: yeah, we do don't we?

BGT2: that's the *main* thing we do

BGT1: we teach cross curricular, it's all linked

Interviewer: yeah, I noticed with your Harry Potter – you've got geography, and the maths and reading, everything on there

BGT1: yes. We've got quite a few really good science-y contexts coming up, so we do robot rampage – which is fantastic. That's robot design, engineering

Interviewer: oh that's cool

BGT1: and we also do Blue Planet, which is the environment

Interviewer: yeah

BGT1: and then we also do Burps, Bottoms and Bile, which is popular

Interviewer: yeah

BGT1: so they're coming up next year, so the last two contexts have been – well this one's Victorians, which is obviously very historically based

Interviewer: yeah

BGT1: so there's some good ones coming up

BGT2: can I just put in: I came to Year 4 this year, so for me it's all new – so I didn't know how much science we've got coming up. I knew we did have quite a bit

Interviewer: yeah?

BGT1: yeah, it's very science-y after Christmas

BGT2: yeah, and we also have science weeks or days don't we?

BGT1: yes. We have a STEM week

BGT2: STEM week

Interviewer: oh yeah?

BGT1: across the school, we have a focus and we just try and do science all week, and then present to the school in assembly on the Friday

Interviewer: ah

BGT1: It's just a little extra focus

BGT2: mmm

Interviewer: how do you find those weeks?

BGT1: they're lovely

BGT2: yeah, they're lovely yeah

BGT1: because we usually get people to come in as well, you know – even if we have parents that work in that field, or any of those fields – just come and talk to the children

Interviewer: yeah

BGT1: about what they do

Interviewer: ah brilliant. So the next question is in three parts, we can just talk about each part separately – but I'll summarise it now: I'd like to know when it comes to STEM engagement, which barriers – if any – you feel are in place for the pupils, teachers as a group, and yourselves personally? So the first thing that we would talk about now is: what do you feel is the biggest influence on a pupil's long term engagement with STEM subjects, and careers?

[pause]

Interviewer: I just talked for ages… do you want me to say it again? [laugh]

BGT2: so say that question again, the last one you said

Interviewer: what do you feel is the biggest influence on a pupil's long term engagement with STEM subjects and careers?

BGT1: It's got to be enjoyment

BGT2: enjoyment yeah

BGT1: and how it's taught to them I think

BGT2: maybe also, having that at home? Because you can enjoy it in school, but if you're not following or doing things at home, to do with it, you may not fully embrace it

Interviewer: okay

BGT2: I'm pretty sure – I think that's quite – particularly with more the science rather than the maths, because I think most parents will try and engage with the maths

BGT1: mmm

BGT2: and then technology

BGT1: yeah yeah

Interviewer: and what do you feel is the key challenge faced by teachers as a group, when teaching STEM content?

BGT2: we always have a difficulty with time, because there's so many things that we have to try and fit into the curriculum

BGT1: mm

BGT2: Generally, It all gets fitted in – maths definitely, and science is all fitted in, but we always have restrictions with time because there's so many other things that are being piled onto us

BGT1: we just seem to be asked to do extra things – a lot to do with health and wellbeing, which takes a *long* time to sort out

BGT2: it was in the news as well, wasn't it? About children coming into school – I don't know if you saw

BGT1: yeah, I heard it

BGT2: one of the inspectors in England, was saying

BGT1: too much pressure on teachers

BGT2: to sort problems out - wellbeing issues

Interviewer: yeah

BGT1: it does take up a lot of time, but we are supposed to give that time – but you can't make time for other things then! [laugh]

Interviewer: yeah

BGT1: so something's got to give, it is very pressured. Probably the science wouldn't be as open ended as I'd like it to be, because of that

BGT2: yeah

BGT1: because you want them to get to an end result?

Interviewer: yeah?

BGT1: so you're kind of guiding them the whole time, whereas if you had a little bit less time constraint, *they* could find out for themselves

Interviewer: yeah?

BGT1: even if they didn't come to the 'right' conclusion, it doesn't matter but you feel like you've got to tie everything up don't you?

BGT2: mmm

BGT1: because we are literally – if you don't tie that up and end that there, we can't get onto the next thing. So probably time pressures

BGT2: mmm definitely

Interviewer: you're not the first teachers to have said that

[all laugh]

Interviewer: so what do you feel is the key challenge faced by yourself personally? That might just be the same as what you've already discussed

BGT2: yeah time

BGT1: and finding the resources – which comes down to time

Interviewer: yeah

BGT1: so when we're faced with whatever we've got to plan, sometimes you have an amazing idea and you think "oh we could do this", but then we've got to spend x amount of hours preparing it and planning it – sometimes it's easier to go with what you've done before

Interviewer: yeah

BGT1: and that comes purely down to the pressure we're under

BGT2: you've got so much –

BGT1: other stuff to do!

BGT2: - and marking and it's just time really

Interviewer: yeah, you've got your own lives as well

BGT1: that's it! [laugh] time and resources I would say

BGT2: yep!

BGT1: because resources have an impact on what you can do

BGT2: I agree

Interviewer: okay, so which of those things that we discussed do you think is maybe the most important factor in STEM engagement for the pupils?

BGT2: I do think – this is personal to me – I do wonder if it's not followed up at home then that doesn't help them. I think the children who go off the museum, they come in and they know things already, and they're already talking about something. So when they start the lesson, they've already got a bit of an idea of what's going on

Interviewer: yeah

BGT2: it's not brand new – do you know what I…?

BGT1 & Interviewer: yeah

BGT2: so some of the things we were talking about today – with the electricity – some of them already could tell me some things, and really they were already there: engaged, ready

Interviewer: yeah

BGT2: yeah… personally. [to BGT1] can you think of any?

BGT1: I still think there's a massive gender issue there

Interviewer: yeah?

BGT1: huge. I think because they get older, they suddenly perceive that it's not a 'girly' thing to do

Interviewer: yeah

BGT1: or girls feel the pressure – I don't know what it is. Not primary level, they're not aware of it at all

BGT2: mmm

BGT1: but definitely in secondary

Interviewer: yeah?

BGT1: I hope it's changing

Interviewer: well, hopefully

BGT1: I hope it is

Interviewer: so the girl guides do a 'girls outlook' thing every year – they did one in 2009 and the most recent one, they've compared it a decade apart and girls are now less worried about what they look like, and more concerned that they might not get a career

BGT1: yeah

Interviewer: obviously it's focussed on negative things – what they're worried about – but it shows a shift that people are thinking more about it,

BGT2: ah that's good

Interviewer: so it's quite nice

BGT1: yeah, that's really good

Interviewer: so my last question is: is there anything that you think that practitioners can do to address the issues?

BGT2: if we had more money and more time –

BGT1: get a Dr Who TARDIS please!

BGT1 &BGT2: [laugh]

BGT2: it would be nice – sometimes it's good to have someone in to do an INSET,

BGT1: mm

BGT2: because if you're like us, you've been teaching for quite a long time, but in that time you've seen so many different things, sometimes you forget them and then someone comes in – or they have something brand new that you've never seen before and that is really exciting then, because if it sparks your imagination, then you want to go back and do it

BGT1: mmm

BGT2: so that's quite nice, having INSETs and just having the resources at hand is nice – that's my personal feeling

BGT1: but also, having somebody like yourself – you're working in that field, you're so enthusiastic, you know what you're talking about – and the children – it's great because that's your job, they can hopefully aspire to be like that

BGT2: mmm

BGT1: and you're coming first hand with that experience, and bringing fantastic resources that we don't have. And if we had more things like that

BGT2: yeah

BGT1: kind of just speckled throughout the year, it just keeps that little boost of interest – it really does

BGT2: and we do have things like that

BGT1: yeah we do

BGT2: we do but I think – we have the STEM week when it happens – and we do have it generally, but it's just to actually get someone in again is time, and to find someone

Interviewer: yeah

BGT2: although we do send out letters asking parents – like today one of the girls was saying, her dad designed a water turbine in America and I said "oh you should ask him to put it on a memory stick and we'll see photos of it". She told me she had a video and

Interviewer: oh that's cool! Do you find that there are a lot of parents that you can tap into?

BGT2: yeah

BGT1: yeah, especially because we're by the hospital as well a lot of them do come, and they work for [Universities] and they have in the past definitely come in

BGT2: yeah I've had in Year three – we were doing things about bones – about three or four years ago. We had a couple of the dads in, and one of them his wife is a teacher, so she did a PowerPoint for him. He brought in a skeleton, and he's a nurse and he fixes the breaks

Interviewer: oh cool

BGT2: he told them what food they should eat and things like that. So that's really good when the parents come in

Interviewer: ah awesome. Well that's all my questions – is there anything else you guys wanted to say at all?

[teachers decline and say thank you]

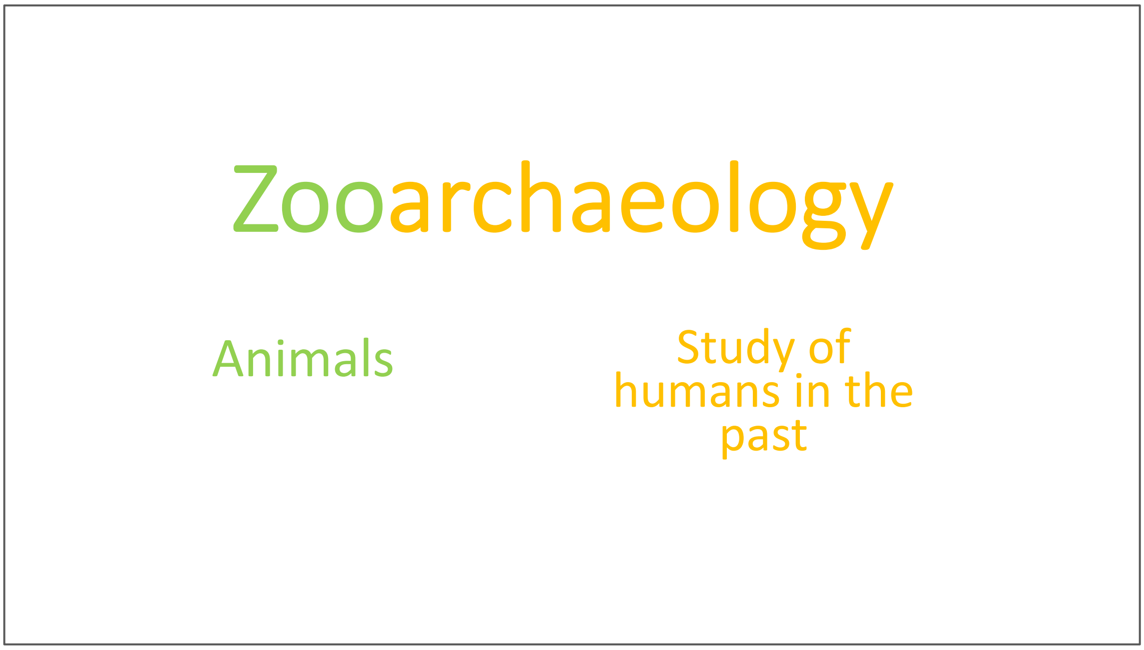


Figure 28.1: Slide 1 from faunal analysis PowerPoint.

Figure 28.2: Slide 2 from faunal analysis PowerPoint.

Figure 28.3: Slide 3 from faunal analysis PowerPoint.

Figure 28.4: Slide 4 from faunal analysis PowerPoint.

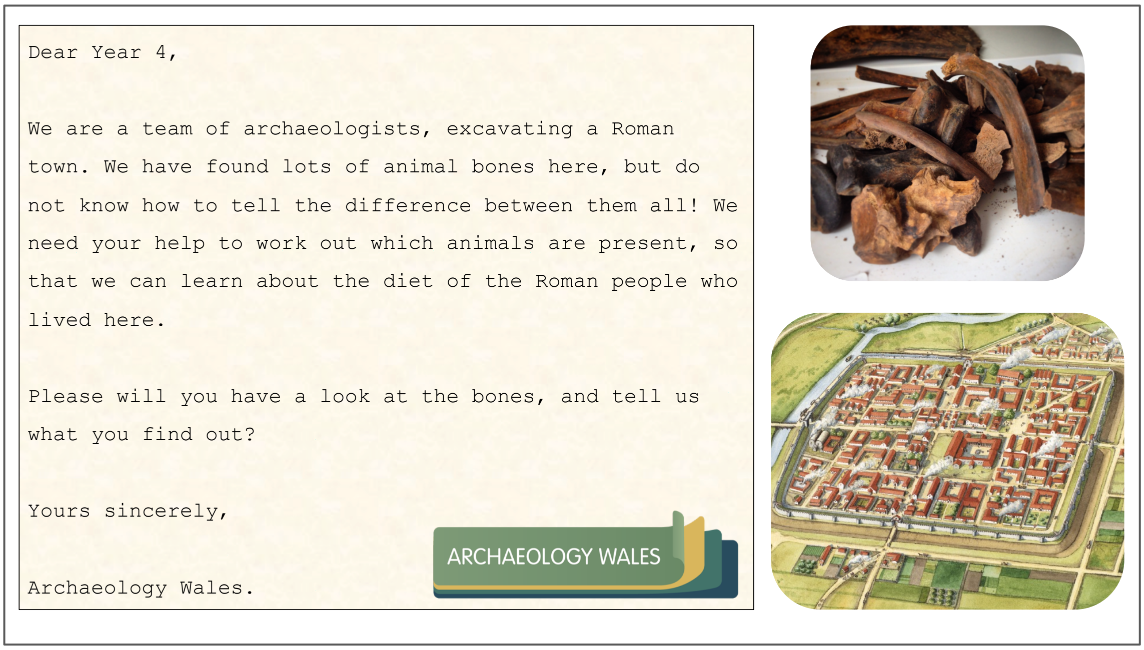


Figure 28.5: Slide 5 from faunal analysis PowerPoint, including reconstruction of Caistor Roman Town, Norfolk. Illustration by Sue White.

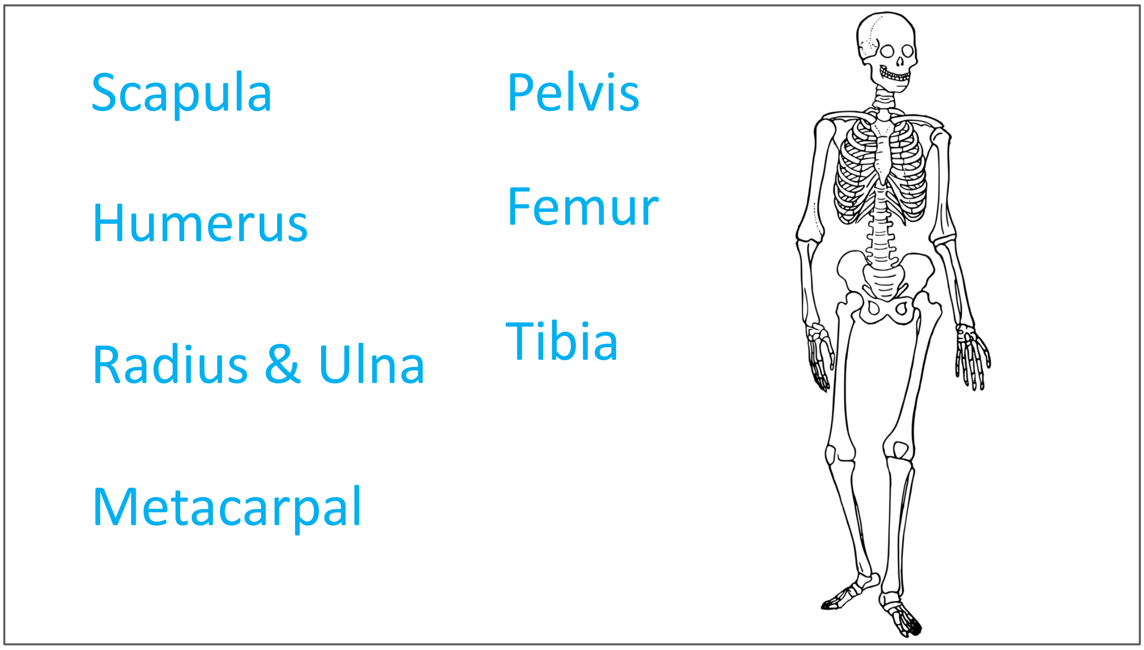


Figure 28.6: Slide 6 from faunal analysis PowerPoint.

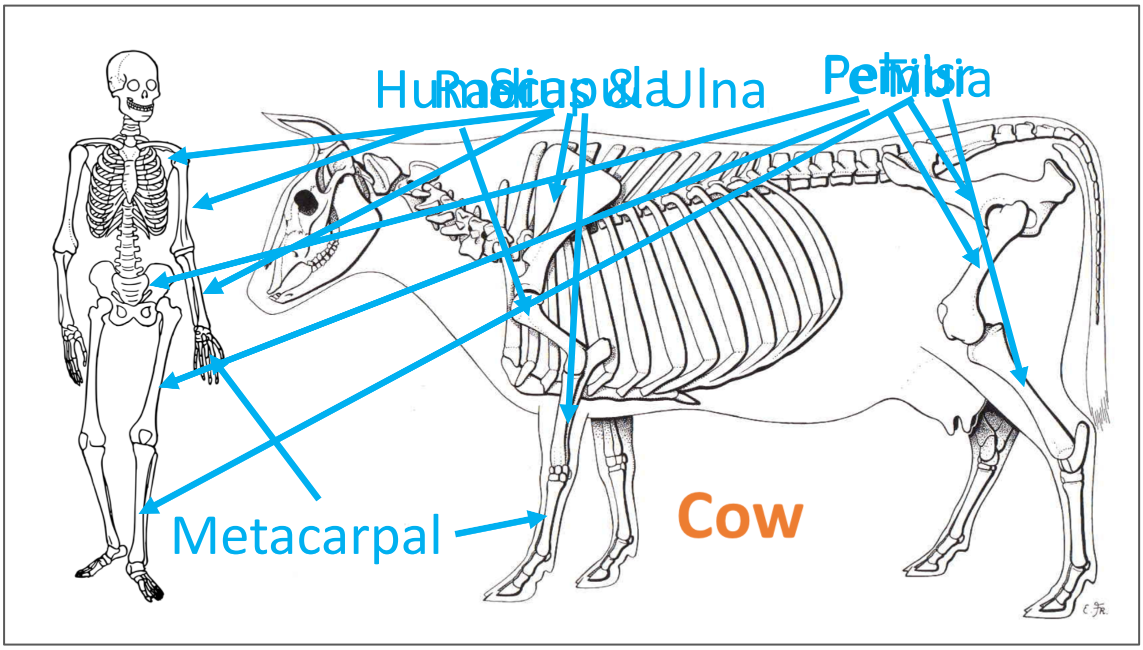


Figure 28.7: Slide 7 from faunal analysis PowerPoint. Anatomical words and arrows appeared/ disappeared as they were discussed.

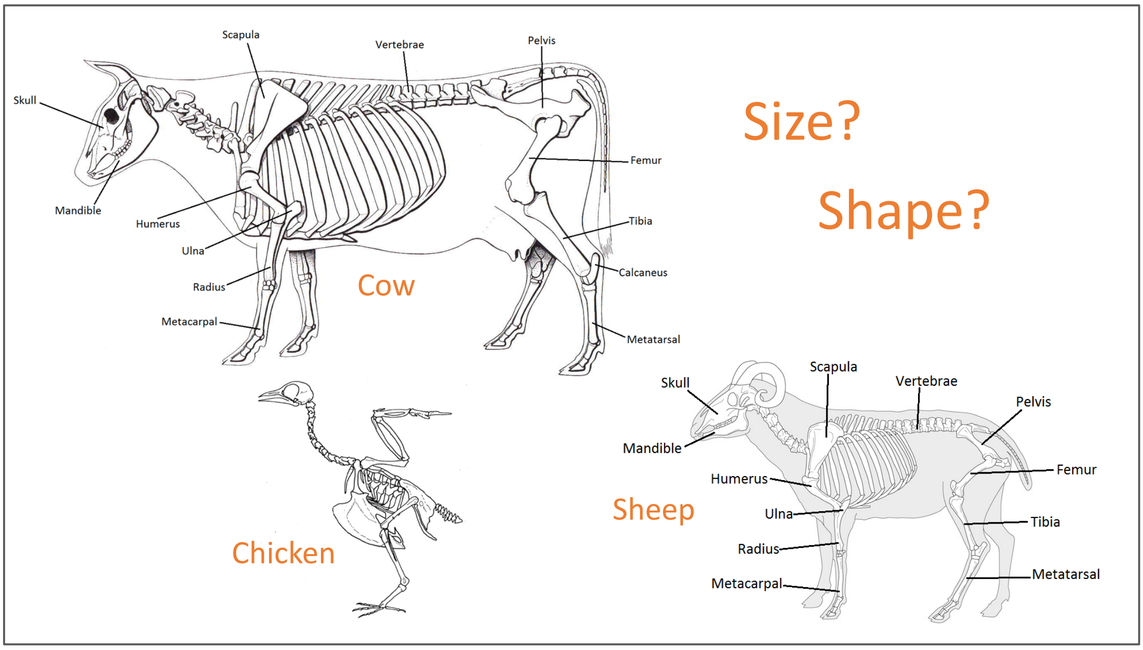


Figure 28.8: Slide 8 from faunal analysis PowerPoint.

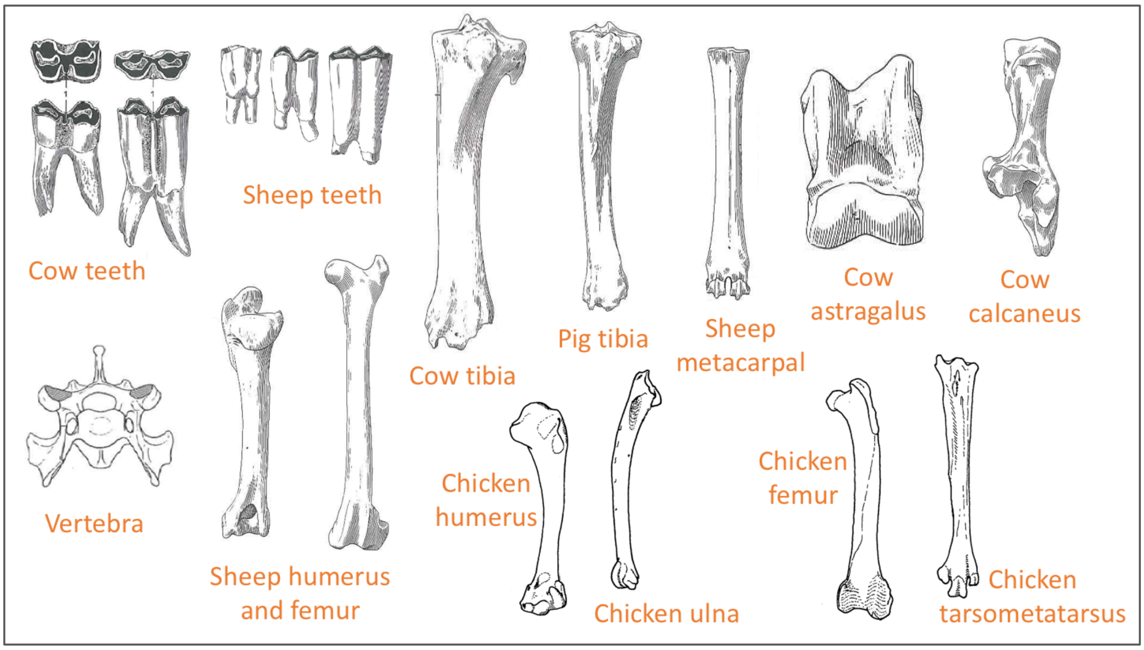


Figure 28.9: Slide 9 from faunal analysis PowerPoint. Images from Schmidt (1972) and Cohen and Serjeantson (1996).

Figure 28.10: Slide 10 from faunal analysis PowerPoint.

Figure 28.11: Slide 11 from faunal analysis PowerPoint. This slide was removed from the workshop following the first session in the research period.

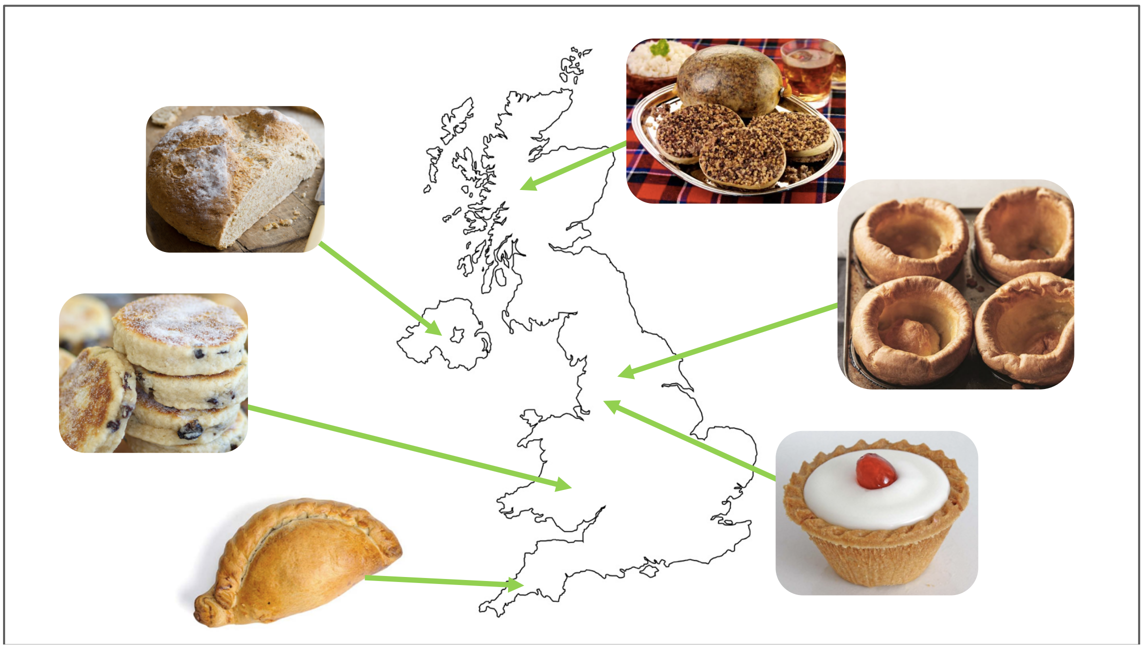


Figure 28.12: Slide 12 from faunal analysis PowerPoint. This slide was removed from the workshop following the first session in the research period.

Research Questions:

1. Which animals were eaten in our Roman town?
2. Could they eat secondary products (milk, eggs)?
3. How does our Roman town compare to other Roman sites?

Figure 28.13: Slide 13 from faunal analysis PowerPoint.

Animal	Bone

Figure 28.14: Slide 14 from faunal analysis PowerPoint.

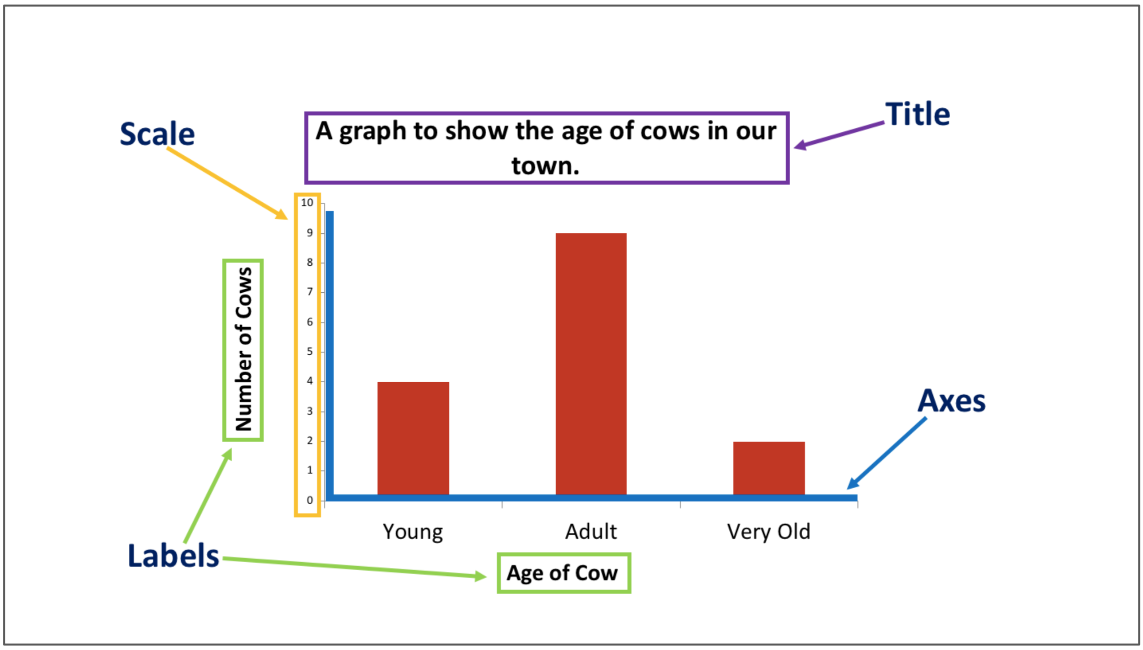


Figure 28.15: Slide 15 from faunal analysis PowerPoint.

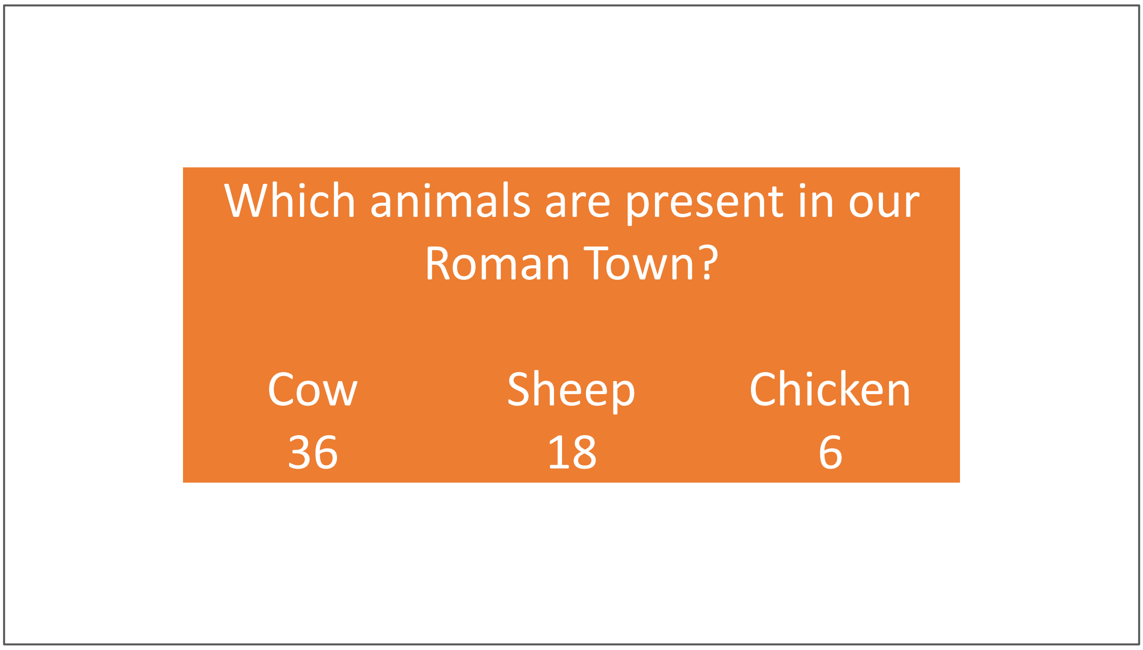


Figure 28.16: Slide 16 from faunal analysis PowerPoint.

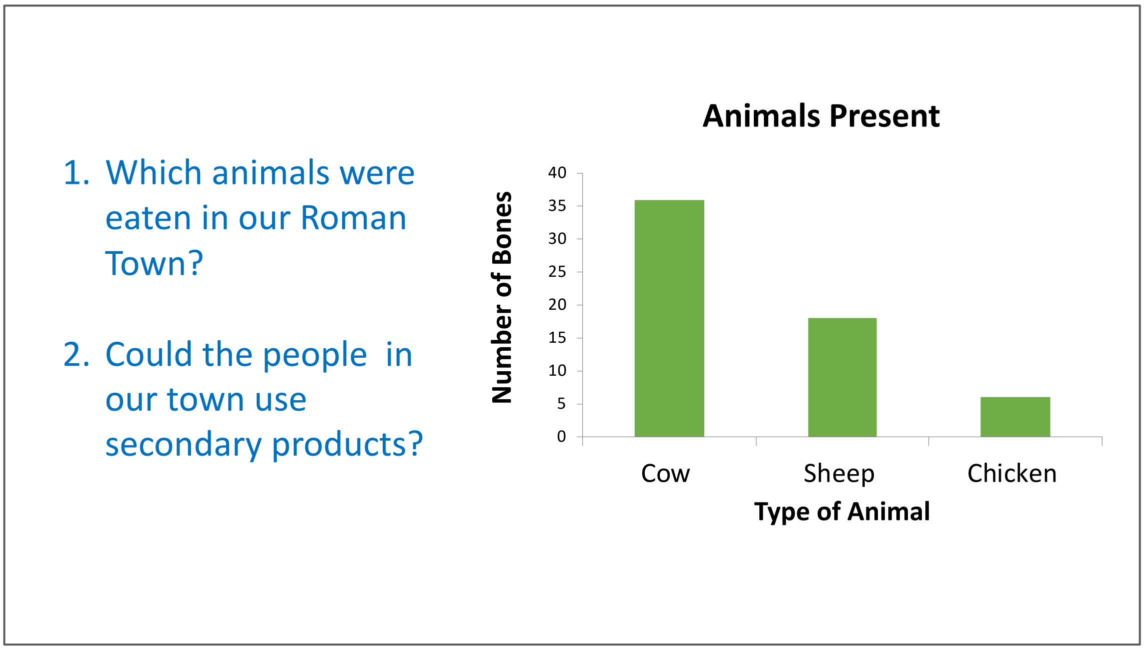


Figure 28.17: Slide 17 from faunal analysis PowerPoint.

Figure 28.18: Slide 18 from faunal analysis PowerPoint. Reconstruction of Caistor Roman Town, Norfolk: Illustration by Sue White. Reconstruction of Gargrave Villa, North Yorkshire: Illustration by Judith Dobie, English Heritage Photographic Library. This slide was removed from the workshop following the first session in the research period.

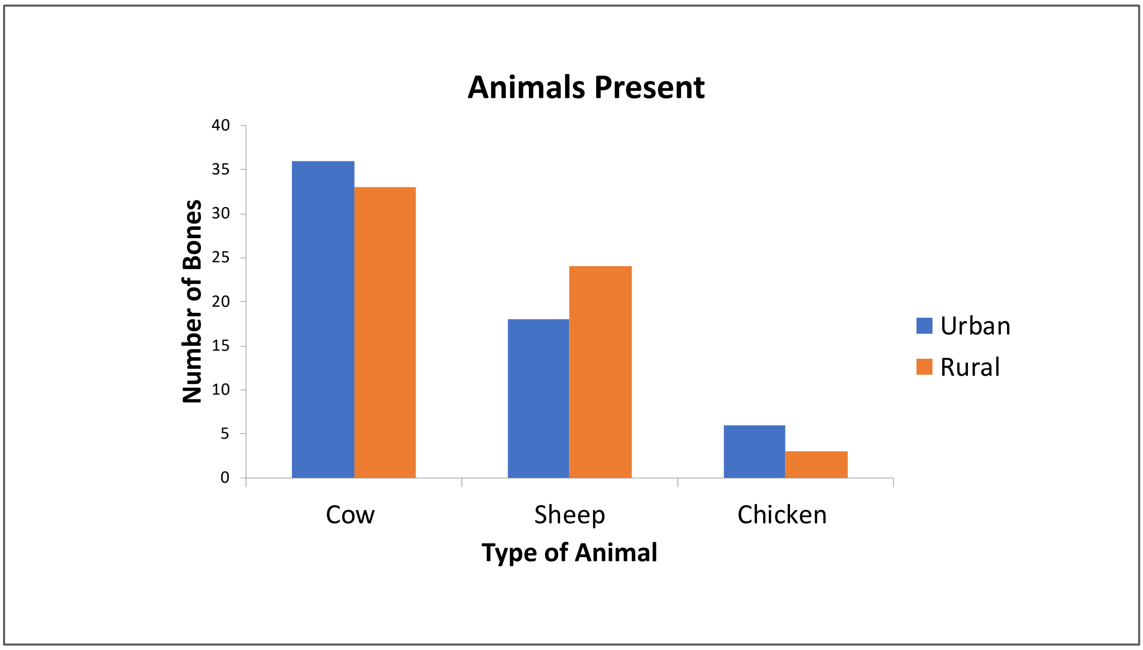


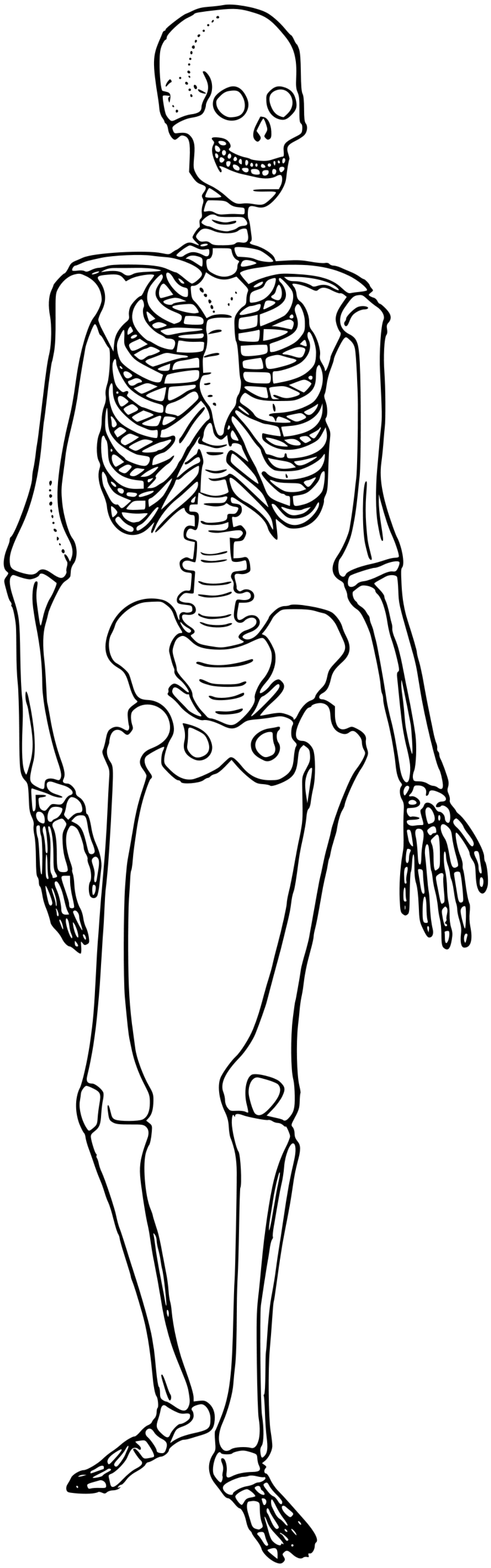
Figure 28.19: Slide 19 from faunal analysis PowerPoint. This slide was removed from the workshop following the first session in the research period.

Appendix 16 references

Cohen, A. and Serjeantson, D. 1996. *A manual for the identification of bird bones from archaeological sites*. Revised Edition. London: Archetype Press.

Schmidt, E. 1972. *Atlas of Animal Bones, for Prehistorians, Archaeologists and Quaternary Geologists.* Amsterdam: Elsevier Publishing Company.

29 Appendix 17: Faunal analysis intervention additional resources



Word bank:

Humerus

Radius & Ulna

Metacarpal

Vertebrae

Femur

Figure 29.1: Human skeleton diagram with anatomical word bank used in faunal analysis intervention.

Animal	Bone

Figure 29.2: Recording sheet used by pupils in faunal analysis intervention.

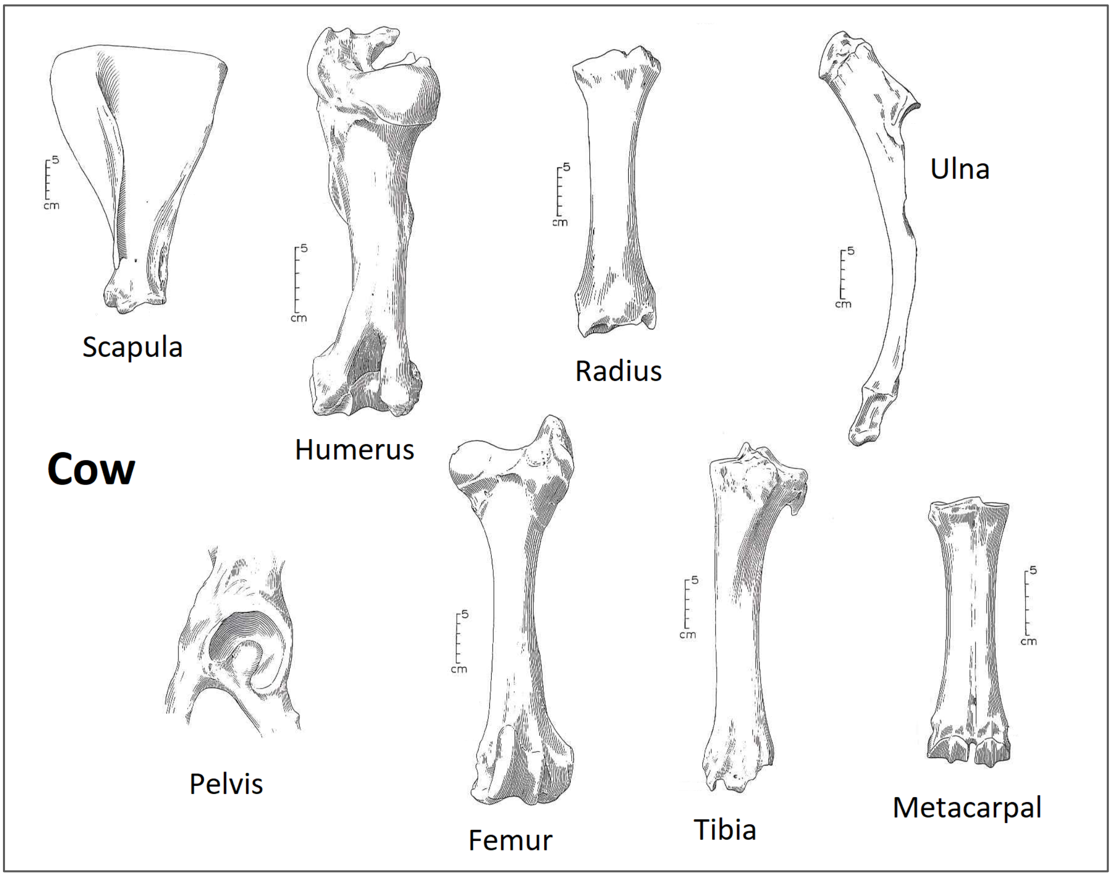


Figure 29.3: Simplified cattle specimen identification used by pupils in faunal analysis intervention. Adapted from Schmidt (1972).

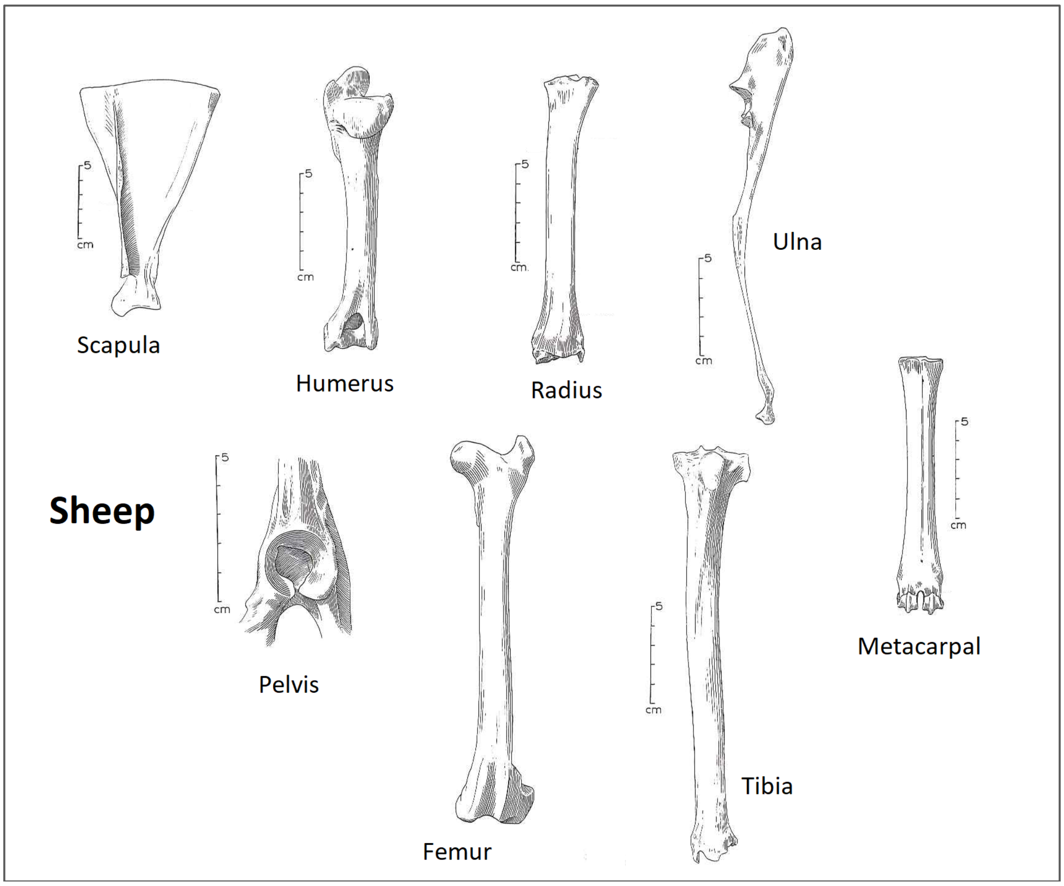


Figure 29.4: Simplified sheep specimen identification used by pupils in faunal analysis intervention. Adapted from Schmidt (1972).

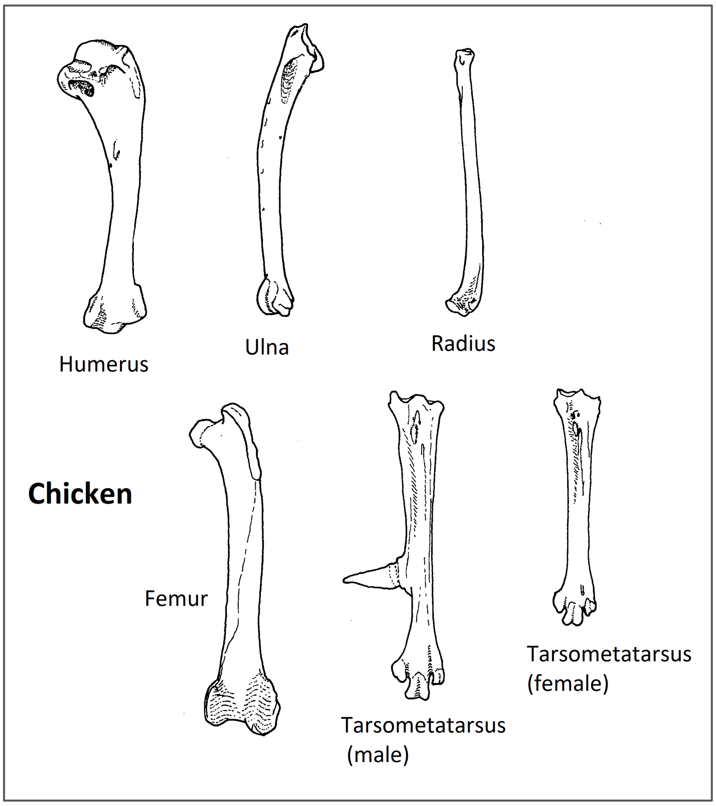


Figure 29.5: Simplified chicken specimen identification used by pupils in faunal analysis intervention. Adapted from Cohen & Serjeantson (1996).

Figure 29.6: Example of laminated animal bone images used by pupils in faunal analysis intervention. Images taken by Rachel Roberts of Cardiff Osteoarchaeology Research Group reference collection.

Appendix 17 references

Cohen, A. and Serjeantson, D. 1996. *A manual for the identification of bird bones from archaeological sites*. Revised Edition. London: Archetype Press.

Schmidt, E. 1972. *Atlas of Animal Bones, for Prehistorians, Archaeologists and Quaternary Geologists.* Amsterdam: Elsevier Publishing Company.

30 Appendix 18: Climate change intervention PowerPoint slides

Figure 30.1: Slide 1 from climate change PowerPoint.

Figure 30.2: Slide 2 from climate change PowerPoint.

Figure 30.3: Slide 3 from climate change PowerPoint.

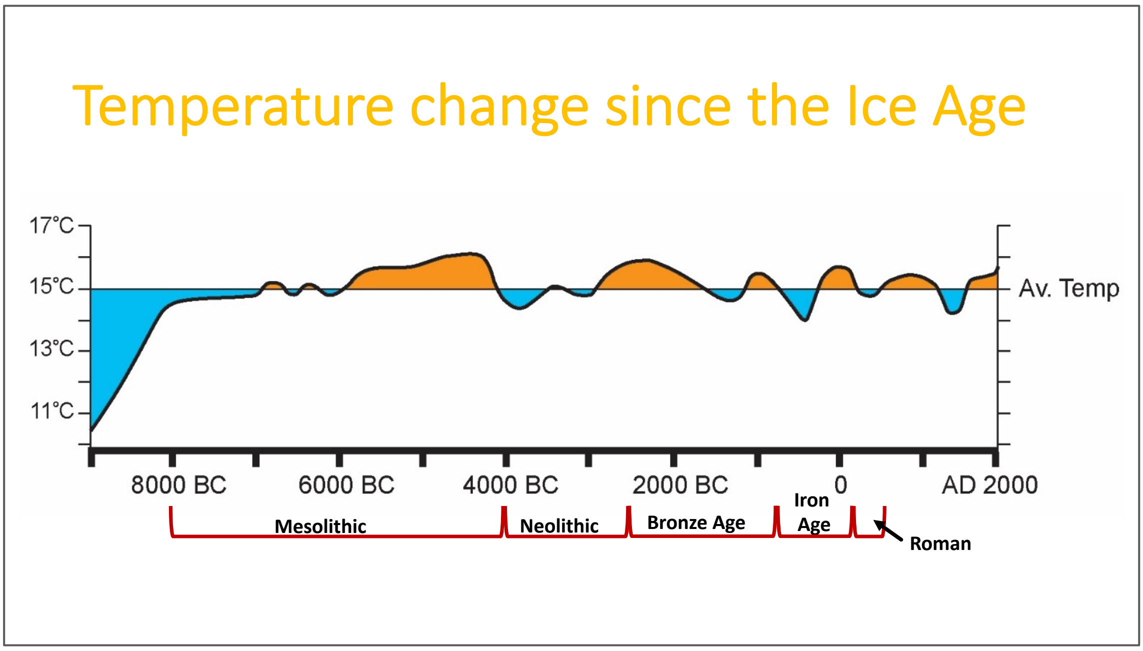


Figure 30.4: Slide 4 from climate change PowerPoint. Timeline adapted from the work of Dr Oliver Davies.

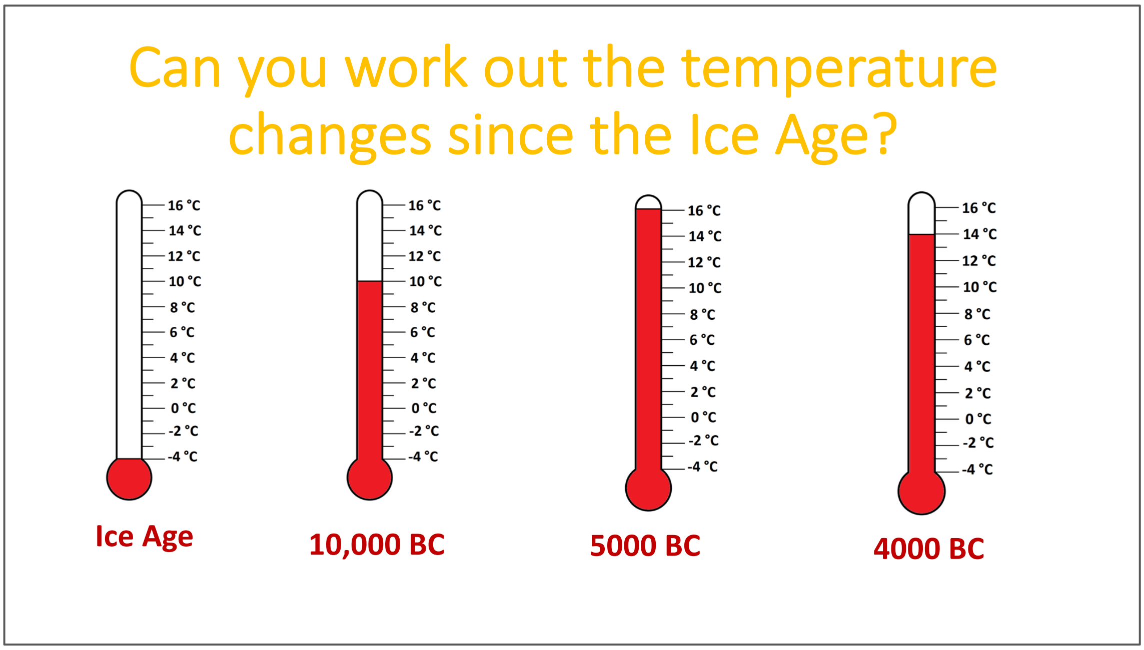


Figure 30.5: Slide 5 from climate change PowerPoint.

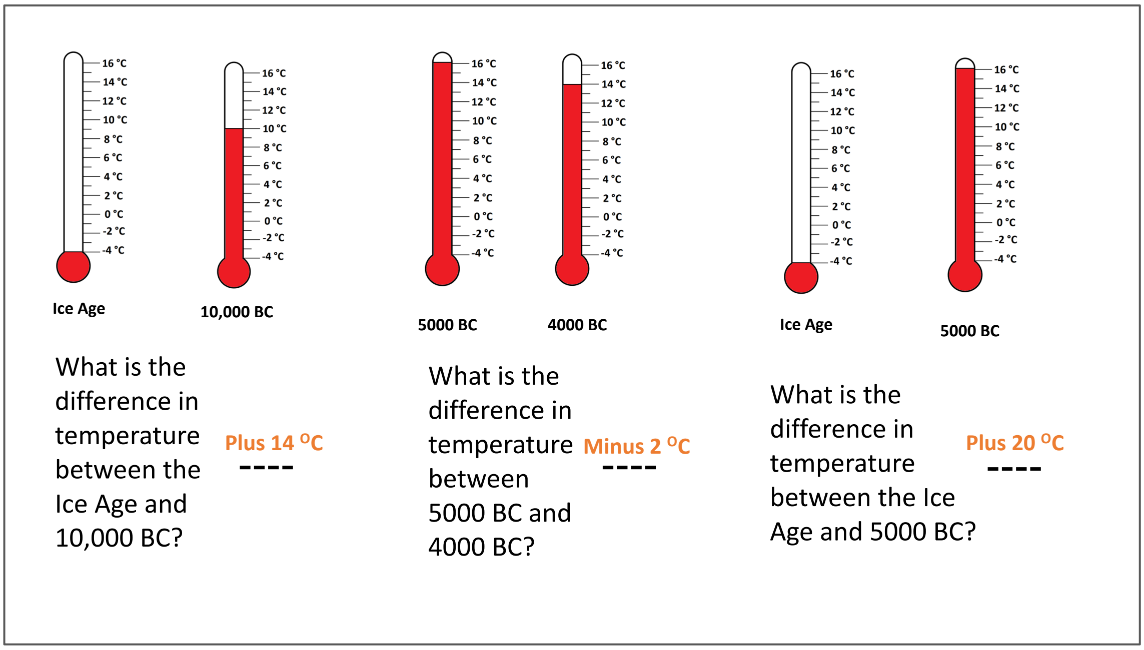


Figure 30.6: Slide 6 from climate change PowerPoint.

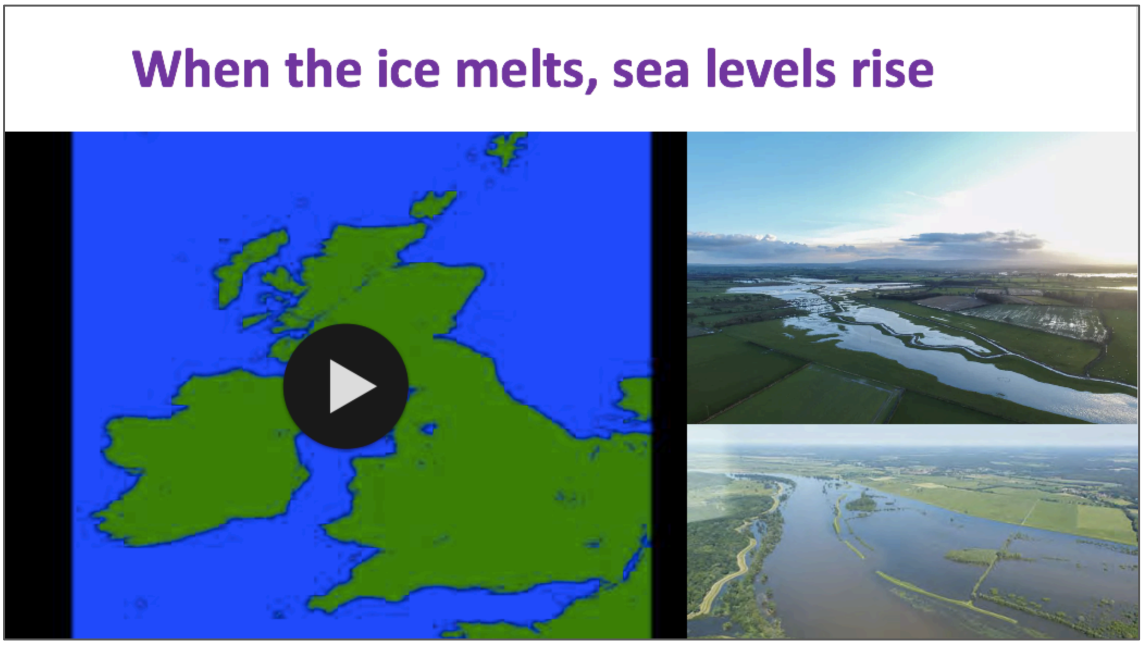


Figure 30.7: Slide 6 from climate change PowerPoint. Video: reconstruction of sea level change in British Isles, credit: Temporal Mapping.

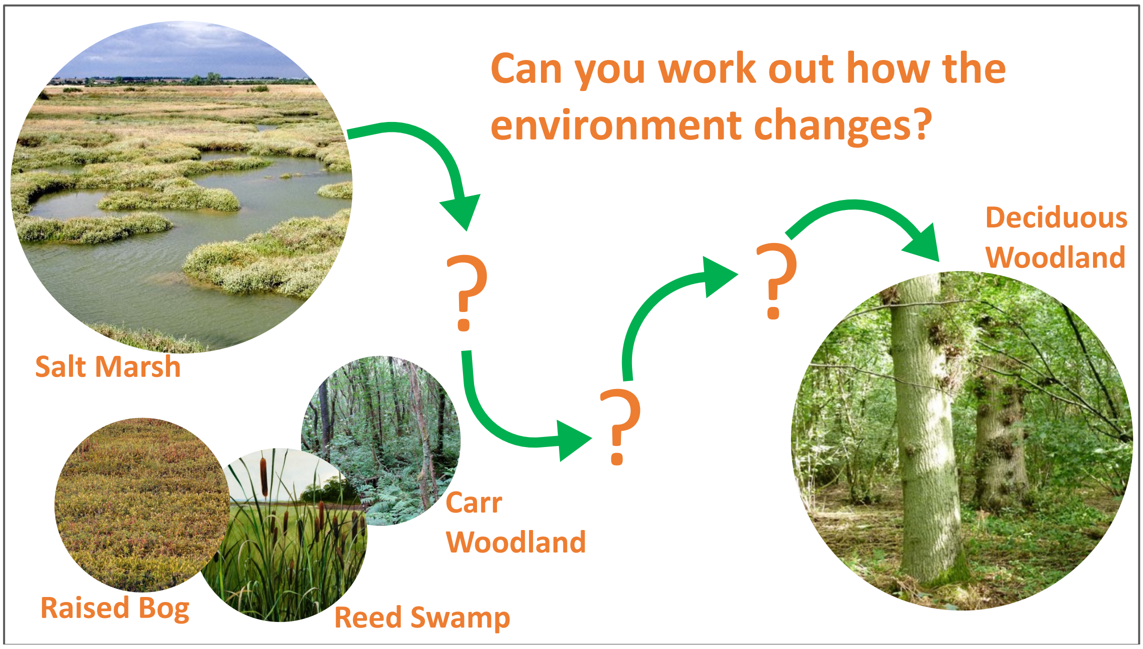


Figure 30.8: Slide 8 from climate change PowerPoint.

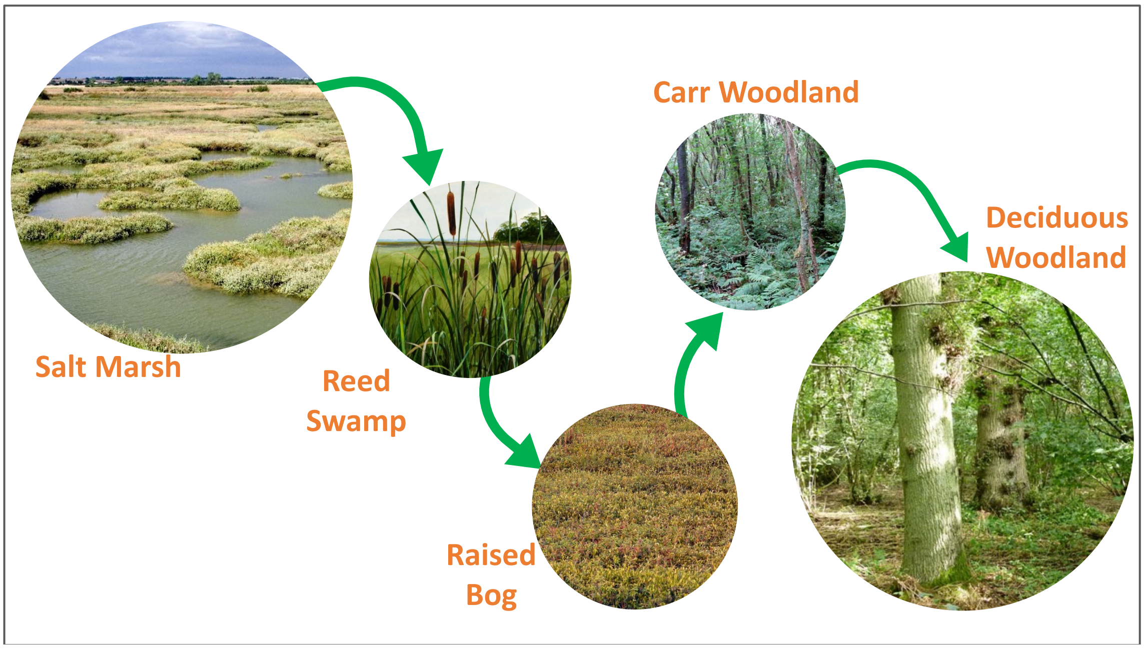


Figure 30.9: Slide 9 from climate change PowerPoint.

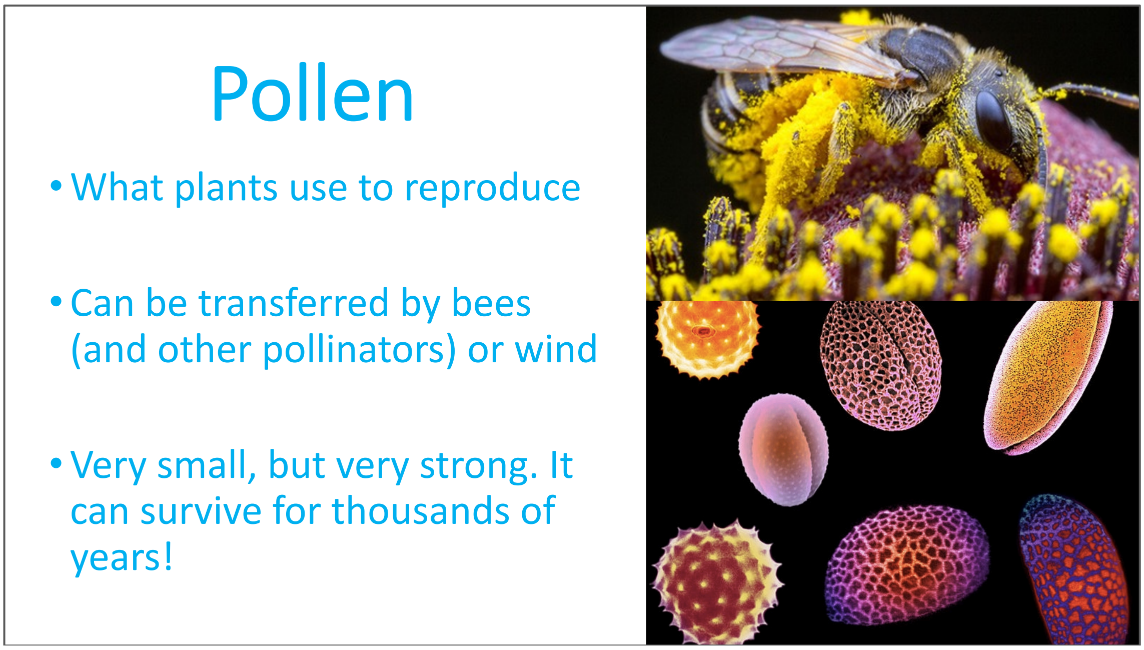


Figure 30.10: Slide 10 from climate change PowerPoint.

Figure 30.11: Slide 11 from climate change PowerPoint. Pollen illustrations by Dr Susan Stratton.

Figure 30.12: Slide 12 from climate change PowerPoint.

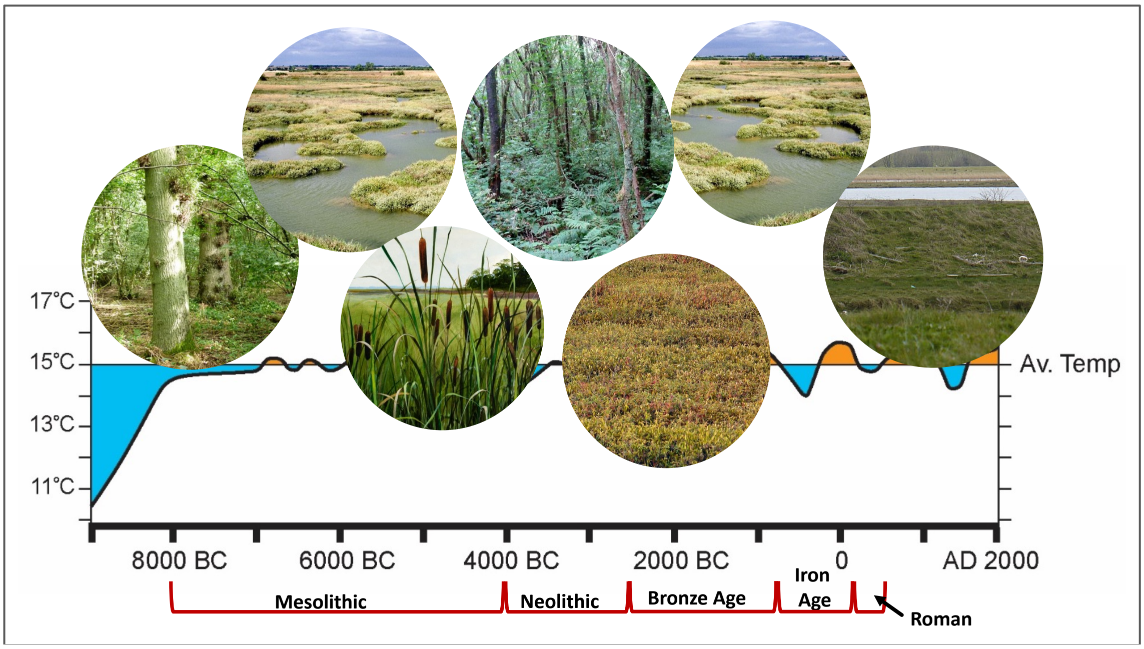


Figure 30.13: Slide 13 from climate change PowerPoint. Underneath each vegetation image is the pollen sample image, as pupils worked through the answers, each environment 'type' was revealed.

Appendix 18 references

Temporal Mapping. 2011. *Sea level rise animation, 130 meters, British Isles.* Online. [Accessed 12th February 2019] Available at: https://www.youtube.com/watch?v=krR20xUsew0&feature=emb_logo

31 Appendix 19: Climate change intervention additional resources

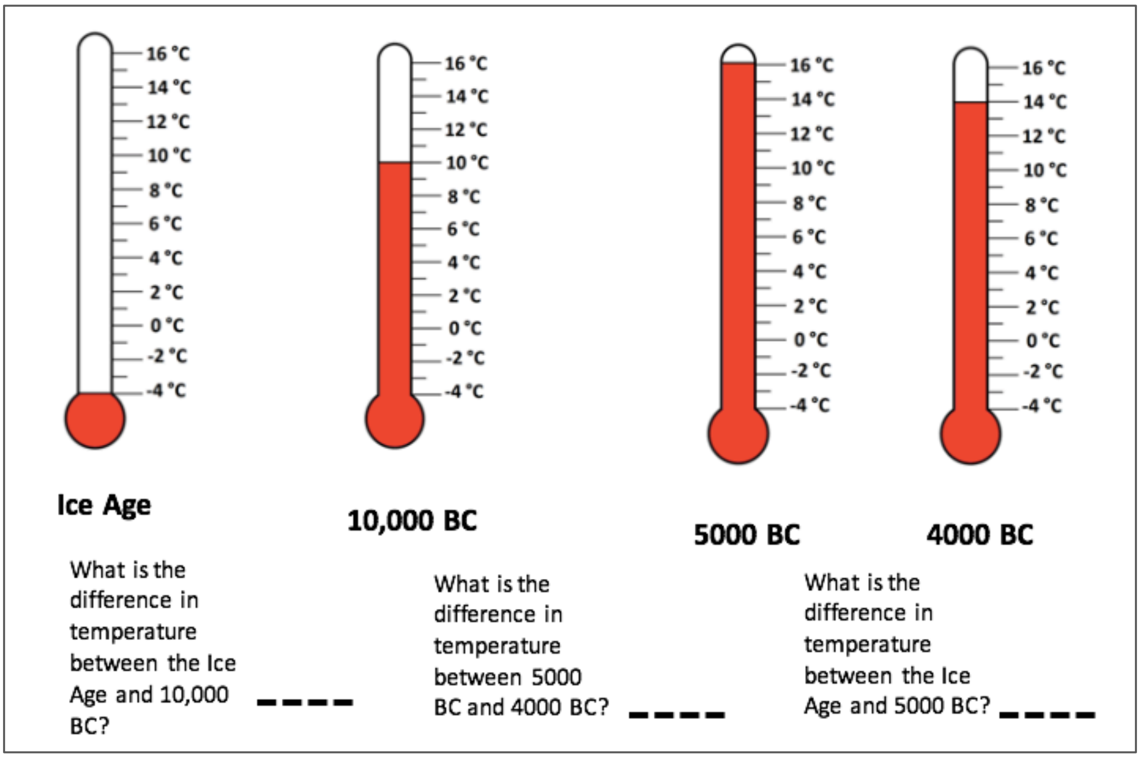


Figure 31.1: Global temperature change task used in Climate change intervention.

Salt Marsh:

These are found near the coast, where the sea has come inland. Lots of sandy mud builds up under the saltwater. Not much grows here, apart from grass and plants like goosefoot.

Figure 31.2: Vegetation environment type (saltmarsh) flash card used in Climate change intervention.

Reed Swamp:

These areas can have a mix of both salt and freshwater. The ground is always waterlogged here. Reeds and other plants like water lilies grow close together, and their roots trap sand and soil under the water.

Raised Bog:

The soil in a bog is raised above water level. This means that bogs rely on lots of rain to stay wet, rather than water from the sea. Peat moss grows here.

Figure 31.3: Vegetation environment type (reed swamp and raised bog) flash cards used in Climate change intervention.

Carr Woodland:

The soil in Carr woodland is damp. Trees like alder grow here, because they like this moist environment. There are also other low growing plants like ferns here.

Deciduous Woodland:

No water is trapped in the soil here, so it is very dry. The trees that grow here like a warm climate. Oak and hazel both grow in woodland like this.

Figure 31.4: Vegetation environment type (Carr woodland and deciduous woodland) flash card used in Climate change intervention.

Figure 31.5: 'Top Trump' style cards with information about plant growing requirements used in Climate change intervention. Oak, hazel, alder and fern. Cards adapted from an original concept developed by Dr Rhiannon Philp and Prof Jacqui Mulville, and in conjunction with Tidal Lagoon Power Ltd. for the Footprints in Time Project, funded by Cardiff University City Exchange Project 2016-17 (https://www.cardiff.ac.uk/city-region-exchange/our-work/funded-projects-2016-17/footprints-in-time?fbclid=IwAR1VfVdFz6aCW8I2H3_h_kaxaaYmoK0PBd38c-bGJgzjbwoFVwBEHwMqt2w). Pollen illustrations by Dr Susan Stratton.

Figure 31.6: 'Top Trump' style cards with information about plant growing requirements used in Climate change intervention. Water lily, goosefoot, reeds and grass. Cards adapted from an original concept developed by Dr Rhiannon Philp and Prof Jacqui Mulville, and in conjunction with Tidal Lagoon Power Ltd. for the Footprints in Time Project, funded by Cardiff University City Exchange Project 2016-17 (https://www.cardiff.ac.uk/city-region-exchange/our-work/funded-projects-2016-17/footprints-in-time?fbclid=IwAR1VfVdFz6aCW8I2H3_h_kaxaaYmoK0PBd38c-bGJqzjbwoFVwBEHwMqt2w). Pollen illustrations by Dr Susan Stratton.

Figure 31.8: 'Top Trump' style cards with information about plant growing requirements used in Climate change intervention. Peat moss. Cards adapted from an original concept developed by Dr Rhiannon Philp and Prof Jacqui Mulville, and in conjunction with Tidal Lagoon Power Ltd. for the Footprints in Time Project, funded by Cardiff University City Exchange Project 2016-17 (https://www.cardiff.ac.uk/city-region-exchange/our-work/funded-projects-2016-17/footprints-in-time?fbclid=IwAR1VfVdFz6aCW8I2H3_h_kaxaaYmoK0PBd38c-bGJgzjbwoFVwBEHwMqt2w). Pollen illustrations by Dr Susan Stratton.

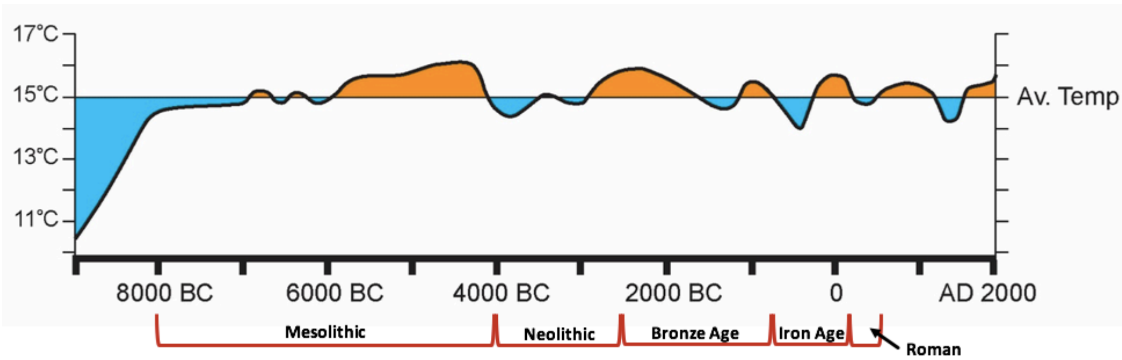


Figure 31.7: Timeline used in Climate change intervention. Adapted from the work of Dr Oliver Davies.

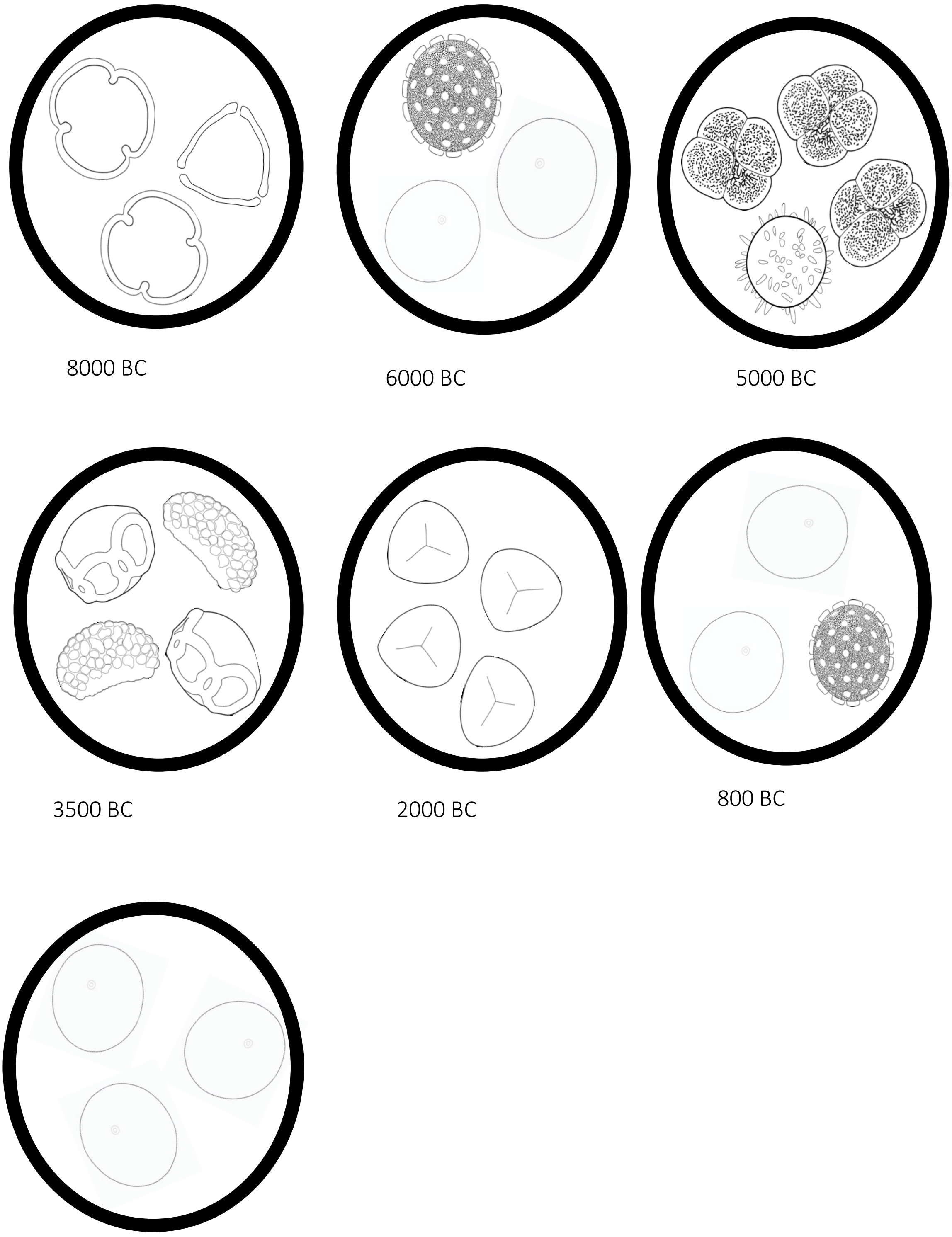


Figure 31.9: Images of 'pollen samples' used in Climate change intervention. Pollen illustrations by Dr Susan Stratton.

32 Appendix 20: Roman aqueduct intervention PowerPoint slides

Figure 32.1: Slide 1 from Roman aqueduct PowerPoint.

Figure 32.2: Slide 2 from Roman aqueduct PowerPoint. Video: Roman Aqueducts Digital Story, credit: Stephanie Larsan.

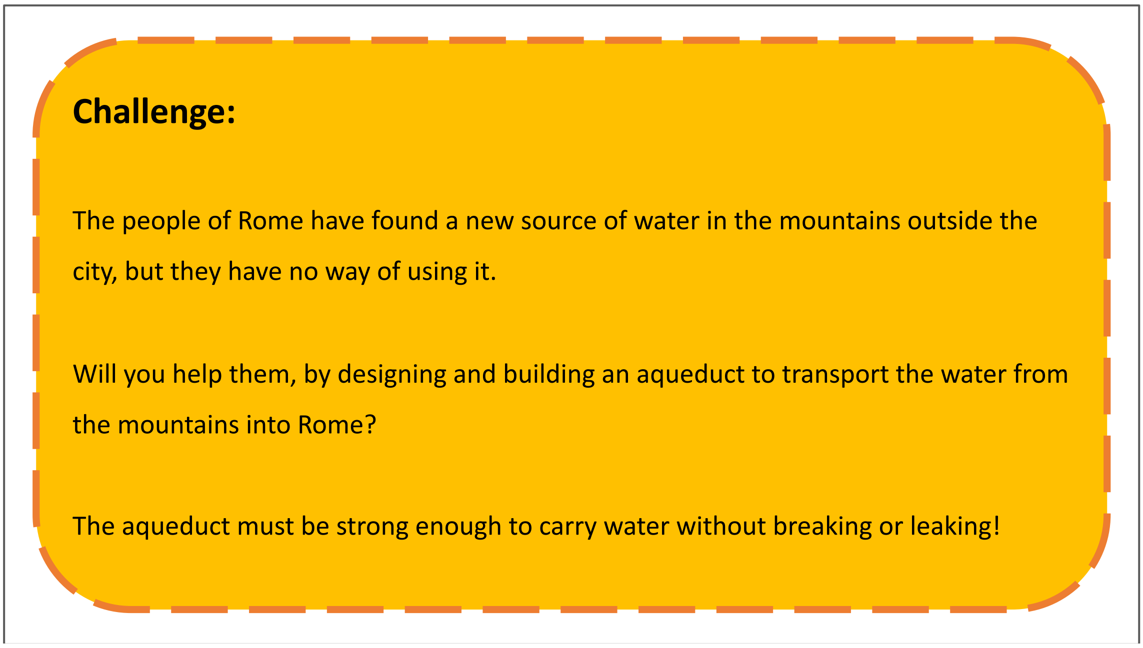


Figure 32.3: Slide 3 from Roman aqueduct PowerPoint.

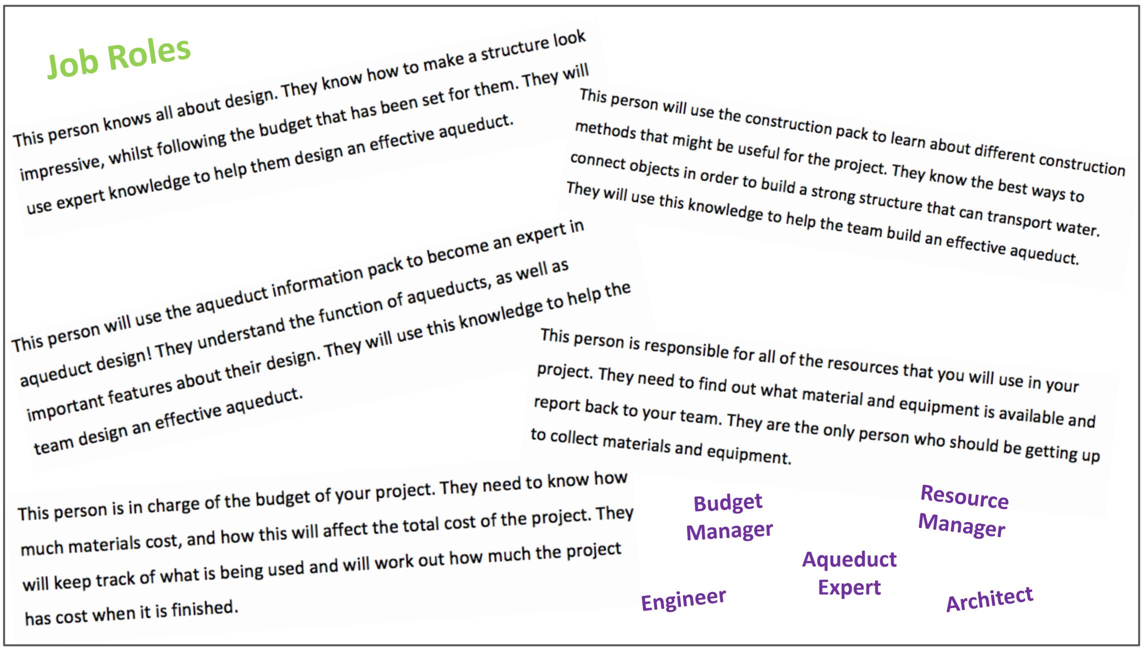


Figure 32.4: Slide 4 from Roman aqueduct PowerPoint. Purple job titles were animated to join the appropriate description as answers were discussed by each class.

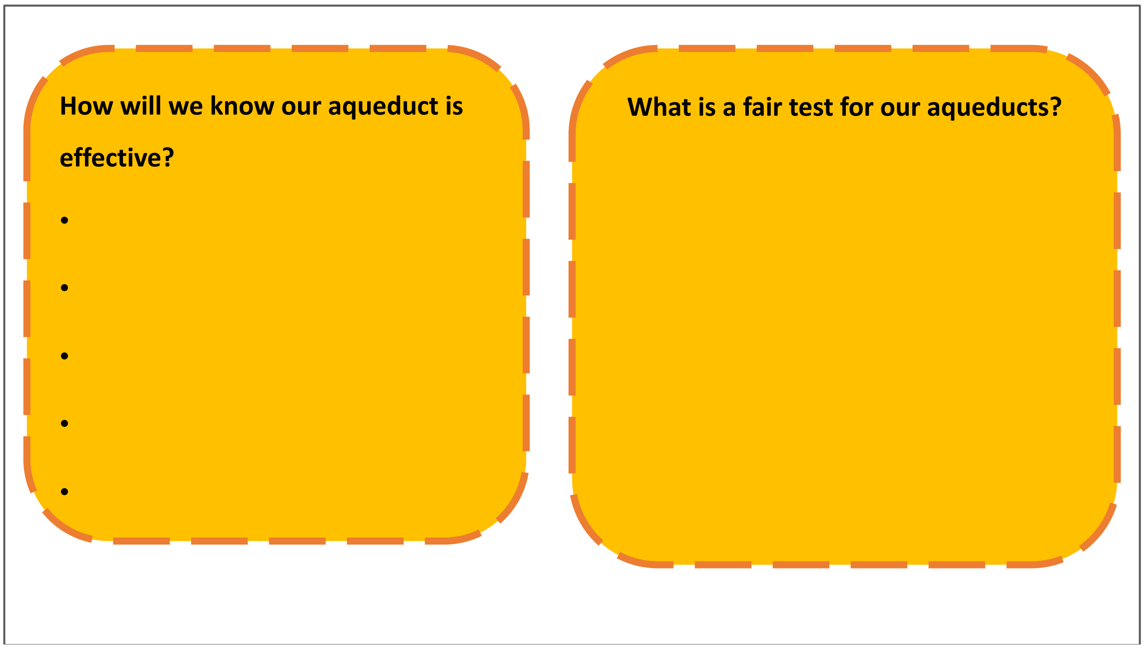


Figure 32.5: Slide 5 from Roman aqueduct PowerPoint. Empty sections to be filled in by each class

Item	Price
Milk or juice carton	£3
Cardboard tube	£1
Plastic bottle	£3
Cardboard box	£2
Egg box	£1
Take away cup	£2
Yoghurt pot	£2
Masking tape	£1 (for 50cm)

Figure 32.6: Slide 5 from Roman aqueduct PowerPoint.

Appendix 20 references

Larsan, S. 2013. *Roman Aqueducts Digital Story.* Online. [Accessed 9th May 2019] Available from: https://www.youtube.com/watch?v=0_E4tkZltP8&feature=emb_logo

33 Appendix 21: Roman aqueduct intervention additional resources

Dear Pupils, Parents and Carers,

[Insert class] will be taking part in an archaeology workshop, where they will be researching and designing Roman aqueducts. The Romans used aqueducts to transport water into their towns and cities, and so pupils will be challenged to design and build a structure that can move water from one end to the other without collapsing or leaking! The workshop will take place on [inset date].

To build the aqueducts, we will be using household recycled items such as: milk and juice cartons, plastic bottles, takeaway coffee cups, cereal boxes/ small cardboard boxes, yoghurt pots, and other similar items. To guarantee the success of this workshop, may I ask that pupils have a dig through the recycling and bring anything that they think will be useful into school. Pupils, please make sure that items have been rinsed out before bringing them to school.

Please do **not** bring: metal or glass, anything that has contained hazardous substances (e.g. bleach bottle), or the cardboard tubes from inside toilet paper.

Thank you for all of your help with this!

Best wishes,

P. Hodkinson

Poppy Hodkinson.

Aqueducts were used by the Romans to transport water into their cities.

Figure 33.1: Letter to pupils inviting them to collect recycling items for their Roman aqueduct intervention

Resource Manager
This person is responsible for all of the resources that you will use in your project. They need to find out what material and equipment is available and report back to your team. They are the only person who should be getting up to collect materials and equipment.

Budget Manager
This person is in charge of the budget of your project. They need to know how much materials cost, and how this will affect the total cost of the project. They will keep track of what is being used and will work out how much the project has cost when it is finished.

Aqueduct Expert
This person will use the aqueduct information pack to become an expert in aqueduct design! They understand the function of aqueducts, as well as important features about their design. They will use this knowledge to help the team design an effective aqueduct.

Engineer
This person will use the construction pack to learn about different construction methods that might be useful for the project. They know the best ways to connect objects in order to build a strong structure that can transport water. They will use this knowledge to help the team build an effective aqueduct.

Architect
This person knows all about design. They know how to make a structure look impressive, whilst following the budget that has been set for them. They will use expert knowledge to help them design an effective aqueduct.

Figure 33.2: Job role and description activity used in Roman Aqueducts intervention. Descriptions and titles were presented separately and pupils were asked to match each job description with the appropriate title.

NATIONAL GEOGRAPHIC

Built by Trajan in the second century A.D. to serve the colony of Emerita Augusta (modern-day Mérida), in Spain, the 100-foot-high Prosperina aqueduct is known locally as Los Milagros, "the miracles," for its breathtaking triple tier of arches.

PHOTOGRAPH BY JUERGEN RICHTER/GTRES

6. Aqueducts carried water, allowing large cities to grow

Photo by Benh Lieu Song via Wikimedia.

Rome itself was served by 11 aqueducts by the end of the third century, with nearly 800 km of artificial water courses in total. Cities freed people from subsistence agriculture, allowing them to indulge in art, politics, engineering and specialised crafts and industries. Constructing these systems that used gravity to move water over long distances down tiny inclines was an astounding feat.

Figure 33.3: Page 1 of Aqueduct information pack used in Roman Aqueduct intervention (National Geographic 2016; Ricketts 2018).

LIVESCIENCE

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MORE

The aqueducts of the Roma Vecchia delivered water to ancient Rome. A new analysis suggests the aqueduct carried less water than previously thought.

Credit: Bruce Fouke

The majestic aqueduct that fed water to ancient Rome carried less of the life-giving liquid than previously thought, new research suggests.

The Anio Novus aqueduct carried water from the mountains into Rome at a rate of about 370 gallons of water per second, said lead author Bruce Fouke, a geologist and microbiologist at the University of Illinois at Urbana-Champaign.

"That's enough water, per second, to take a three-hour shower or to take seven baths," Fouke said in a statement.

While that may sound like a lot, previous analyses had given a higher water flow, the researchers said. [Photos: Amazing Ruins of the Ancient World]

Aqueducts

Aqueducts were long channels that the Romans built to carry water into the cities. Many of the Roman aqueducts were below ground. The water that was carried into the cities was used for drinking water, baths, and sewers. It was generally carried to a public fountain where people could then use buckets to get their water. Roman plumbing became so advanced that many of the large wealthy houses had running water.

Roman Aqueduct. Photo by Bluedog423

Figure 33.4: Page 2 of Aqueduct information pack used in Roman Aqueduct intervention (Ghose 2015; Ducksters n.d.).

Roman Aqueducts: The Dawn of Plumbing

November 19, 2013 by *KIDS DISCOVER*

How did the ancient Romans deal with plumbing? They built huge and extensive aqueducts, which is Latin for waterway. These under- and aboveground channels, typically made of stone, brick, and volcanic cement, brought fresh water for drinking and bathing as much as 50 to 60 miles from springs or rivers. Aqueducts helped keep Romans healthy by carrying away used water and waste, and they also took water to farms for irrigation.

So how did aqueducts work? The engineers who designed them used gravity to keep the water moving. If the channel was too steep, water would run too quickly and wear out the surface. Too shallow, and water would stagnate and become undrinkable. The Romans built tunnels to get water through ridges, and bridges to cross valleys.

Aqueduct facts for kids

Kids Encyclopedia Facts

An **aqueduct** is a man-made channel that carries water from one place to another. Usually, they are used to supply water to cities and towns. They may also carry water for irrigation, or for hydroelectricity. Pipes, canals, tunnels, and bridges that serve this purpose are all called aqueducts. Some aqueducts carry a canal for boats and ships. The word "aqueduct" comes from the Latin words "aqua" (water) and "ducere" (to lead). Aqueducts have been used since ancient times.

The Roman aqueduct Pont du Gard, France. The upper tier encloses an aqueduct which carried water to Nimes in Roman times; its lower tier was expanded in the 1740s to carry a wide road across the river

Contents

Figure 33.5: Page 3 of Aqueduct information pack used in Roman Aqueduct intervention (Kids Discover 2013; Kiddle n.d.).

Map showing the location of some aqueducts across the Roman Empire.

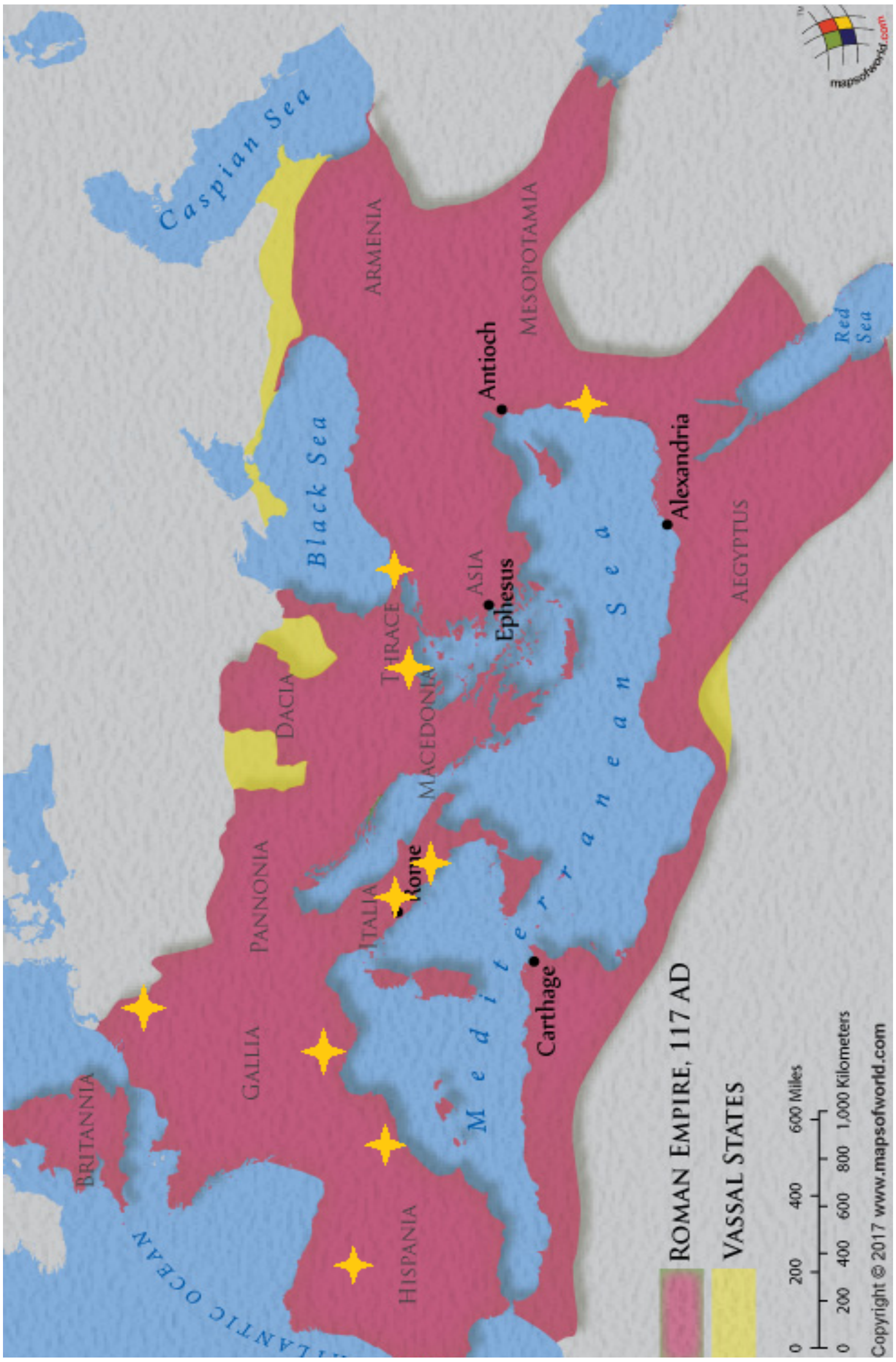
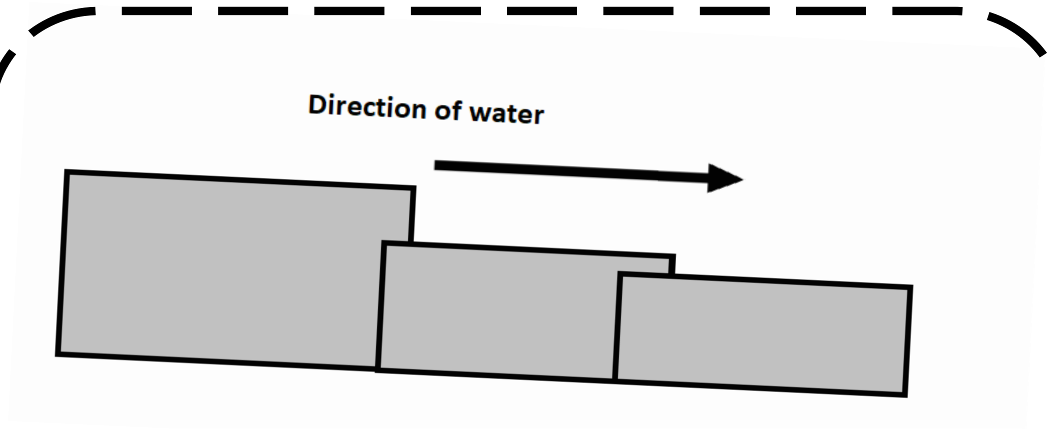


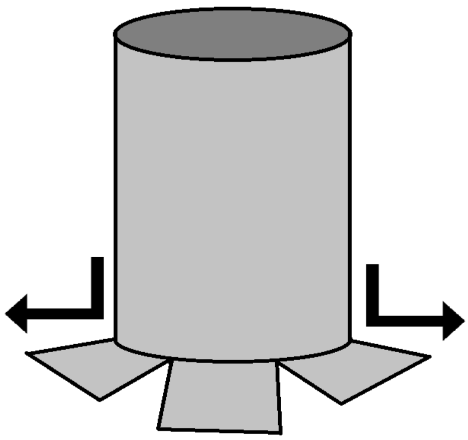
Figure 33.6: Page 4 of Aqueduct information pack used in Roman Aqueduct intervention. Map adapted from Maps of World (2018).

Construction methods for engineers



Overlapping sections

Make sure that each section overlaps so that there are no gaps in the structure. This will stop water from leaking out. By overlapping the sections in the direction of water flow, you will make it harder for water to leak out of any gaps – water cannot flow back uphill!



Connecting an object to a flat surface

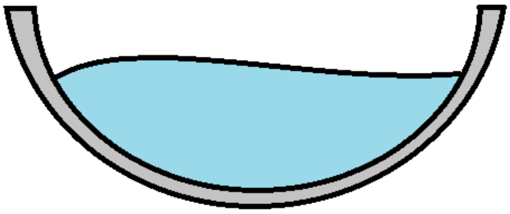
To be able to attach a 3D object (like a kitchen roll) to a flat surface, you will need to make some flaps at one end.

Do this by making small cuts (about 2cm) in the 3D object, and folding them out.

You can then stick the 3D object to a flat surface, using tape or glue.

Figure 33.7: Page 1 of construction pack used in Roman aqueduct intervention.

Construction methods for engineers

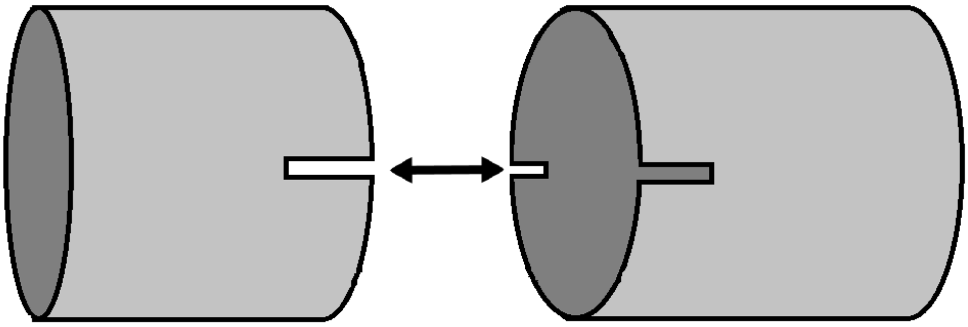


Waterproofing

How will you make sure that all of the water stays in your aqueduct? An effective aqueduct must be waterproof!

Think about the materials that you are using, are they already waterproof (like a milk carton or plastic bottle)?

Is there anything that you could add to your structure to make it more waterproof?

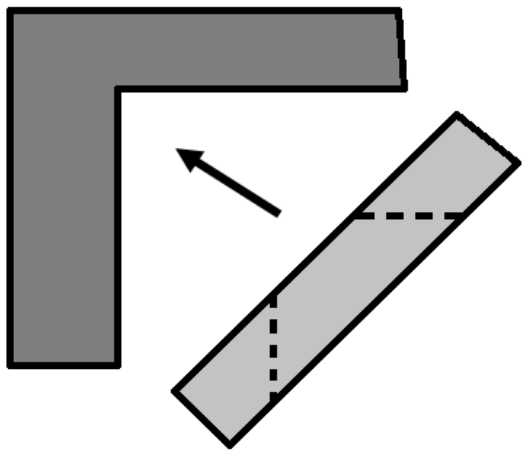


Connecting two 3D objects

To connect two object securely, it is important to make sure that they overlap. You can do this by making small cuts (about 1cm) in each of the objects and then pushing them together. Make sure that the cuts line up on each object, and remember that this will make the overall object slightly shorter!

Figure 33.8: Page 2 of construction pack used in Roman aqueduct intervention.

Construction methods for engineers

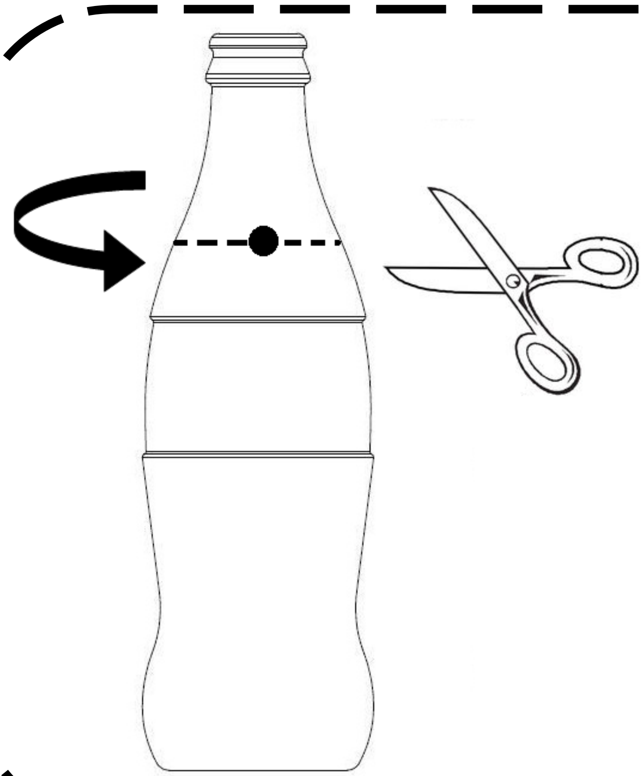


Strengthen a corner

You may want to make a corner stronger. You can do this by using triangles (the strongest shape!).

Cut a length of card, and fold corners to form a triangle shape (along the dotted lines). Make sure your triangle fits in the gap that you are trying to strengthen.

Tape or glue the corner flaps to the rest of the structure.



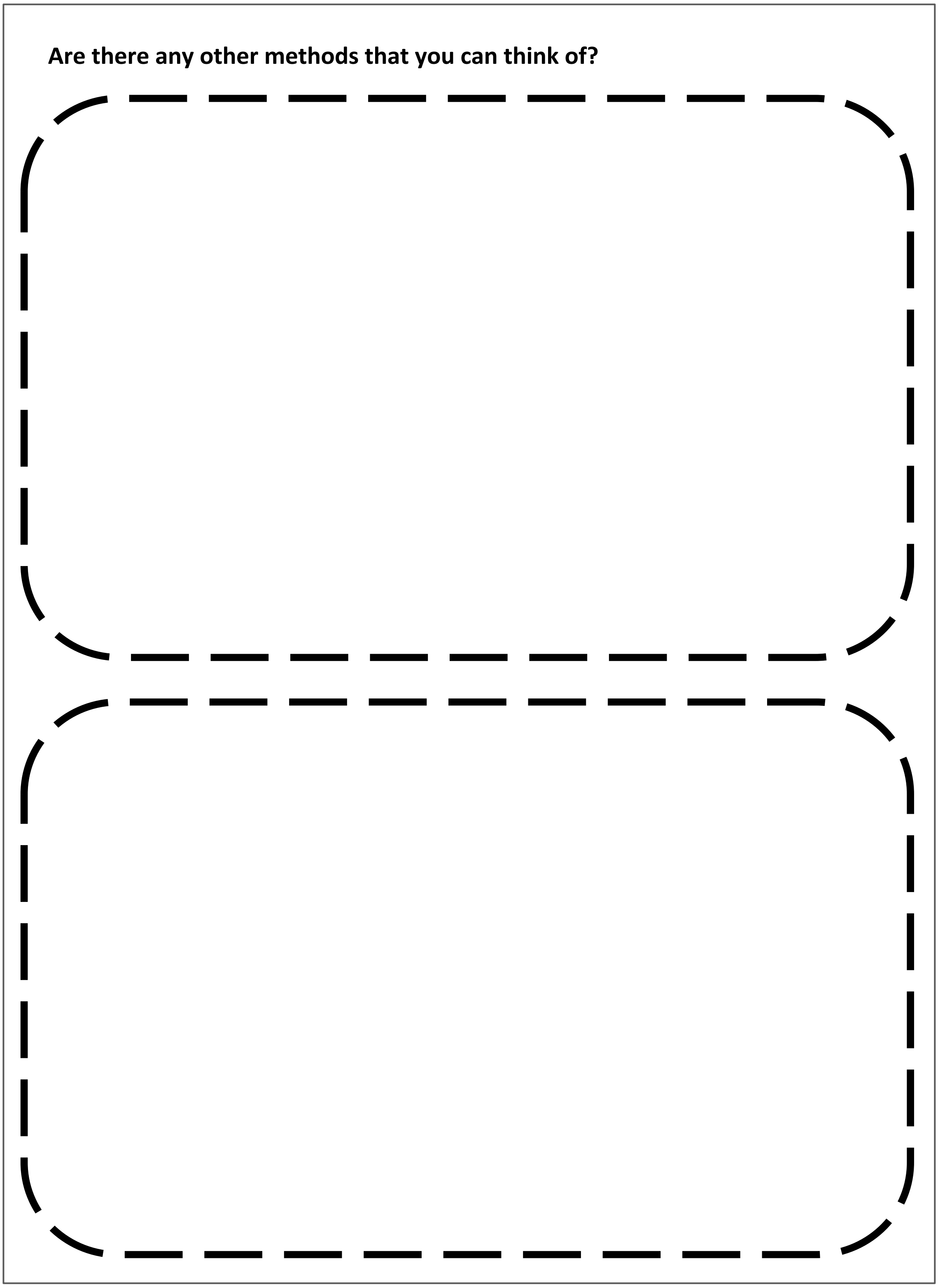
Cut a 3D object

The easiest way to cut a 3D object: First, draw a line marking where you'd like to cut.

You should ask an adult to help you with this part the first time you do it. Using scissors, pierce a hole very carefully in the object. This may require very sharp scissors if the object is made of plastic. Remember to be careful of where you put your fingers when you do this!

Finally, insert your scissors into the hole, and cut around the rest of the line. If the edges are sharp, you can cover them up with masking tape.

Figure 33.9: Page 3 of construction pack used in Roman aqueduct intervention.



Are there any other methods that you can think of?

Figure 33.10: Page 4 of construction pack used in Roman aqueduct intervention.

Design your aqueduct

What materials will you use?	How many will you use?	Cost:	Total cost of project:
______________________________	____________________	_____________	
______________________________	____________________	_____________	
______________________________	____________________	_____________	
______________________________	____________________	_____________	
______________________________	____________________	_____________	
______________________________	____________________	_____________	
______________________________	____________________	_____________	
______________________________	____________________	_____________	_____________

What equipment will you need?

____

____

____

Which construction methods will you use?

____

____

____

How will you make sure your design is waterproof?

____

____

____

How will you know if your design is successful?

____

____

____

Figure 33.11: Page 1 of planning pack used in Roman aqueduct intervention.

Plan your build in steps. **You may use more sheets if you'd like extra steps.**

What is happening in this step?

Step number: ______________

Who in the team will do this step?

Draw what this step will look like:

What is happening in this step?

Step number: ______________

Who in the team will do this step?

Draw what this step will look like:

What is happening in this step?

Step number: ______________

Who in the team will do this step?

Draw what this step will look like:

Figure 33.12: Page 2 of planning pack used in Roman aqueduct intervention.

Draw your aqueduct design here.

Remember to include notes with extra information. You can include things like:

- Parts of the design that are hidden from view
- Information about materials and size

Figure 33.13: Page 3 of planning pack used in Roman aqueduct intervention.

Peer assessment. **Use this table to record how you think other teams did.**

Give a mark out of 10 for the headings below (0 lowest and 10 highest).

Team name and total cost of project	How good was their choice of materials?	How good was their choice of structure?	How good is the overall design?	How did the structure do in the test?	Overall score (out of 40)

Figure 33.14: Page 1 of self-assessment evaluation pack used in Roman aqueduct intervention.

Self-assessment. **Use these questions to reflect on the work that you did today.**

What do you think went really well for your team?

____
____
____

Is there anything that you think another team did really well?

____
____
____

What might you improve if you did this project again?

____
____
____

Can you think of how you might use what you learned today in real life?

____
____
____

Figure 33.15: Page 2 of self-assessment evaluation pack used in Roman aqueduct intervention.

Appendix 21 references

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34 Appendix 22: Pupil task-based interview 1, YP

Title: Pupil interview 1

Date: 7th November 2018

Speakers: Poppy Hodkinson (interviewer), Molly, Pippin, Stanley and Barry

File Duration: 40 Minutes

Interview location: YP

Interviewer: can I get you to repeat what you said? [To Stanley] So your dad is…?

Stanley: an engineer

Interviewer: do you know what *kind* of engineer?

Stanley: he designs aeroplane wings

Interviewer: wow! How cool is that? Okay, [to Barry] and you're mum was…?

Barry: a science teacher

Interviewer: brilliant, do you know which school she teaches at?

Barry: this one

Interviewer: this one?! Ah okay

Barry: I have to wait, to go home

Interviewer: ah do you wait till she's finished?

Barry: yeah

Interviewer: ah, okay. So, like I said, we're going to be thinking a little bit about some of the people who work in STEM. So people like your dad, who's an engineer, or your mum, who's a science teacher. So people who work with science, technology, maths and engineering. And we're going to think about some of the *skills* and interests that they might have. And what might be useful to them. So I've got a collection of words here. If I spread those out over the table can everybody see those?

[children talking over each other, sound interested/ excited]

Interviewer: okay, so can we have a look at these guys, and as a group we're going to decide which we think are the *five* most important cards for somebody who works in STEM. So which five things are the most important things for them?

Molly: I think this one

Interviewer: that's a good one, what does it say?

Molly: it says listen to other people's opinion

Interviewer: okay, and why do you think that one?

Molly: because you've to got to listen to – you've got to listen because if you do it wrong, it could –

Stanley: it could go all wrong. If you're designing a plane and you don't know what to do and you design a wing

Pippin: and then once they take off, they crash.

Barry: like, if it's a lopsided wing, you might have one wing up here

Interviewer: mmm

Pippin: and then the tail's like

Interviewer: okay, so it's important to listen

Children: yeah

Interviewer: okay, so that's one of them. What's that one?

Pippin: logic

Interviewer: and why do you think that one's important?

Pippin: [pause]

Interviewer: do you want to think about it for a bit?

Pippin: yeah

Interviewer: okay, that's okay. So what have you got over there guys?

Barry: it says clever

Interviewer: and why is that one important?

Barry: because I think you have to be clever to design, and you have to be careful that they're the same size

Interviewer: oh, is that with

Barry: the wings

Interviewer: the wings

Barry: yeah

Interviewer: okay, so we're talking about the wings again, okay. And what other ones are there? Shall we start to make a pile of the ones we think are the most important?

Child: creative

[children talk over each other]

Pippin: this one is definitely not what you should do!

Interviewer: [laugh] okay?

Barry: what is it?

Pippin: likes computer games

[children laugh, one asks what a word means]

Interviewer: this one says inventive. Actually guys I've got a glossary here, so if there are any words that you're not sure what they mean, then they might be on this list here

Child: okay

Interviewer: where's our pile? So we've got 'clever', 'listens to other people's opinions', what was the one that you had?

[children discuss the need for clever, inventive]

Molly: can take risks

Stanley: artistic! I've got artistic

Barry: logical!

Interviewer: boys, you don't need to match them up, you just need to decide which ones you think are the most important

Pippin: I think sensible

Barry: hardworking

Interviewer: okay, so hold on one second

[children all talk]

Interviewer: it's really important that we all listen to what each other has to say as well. So you think 'logical' is important? Why do you think that?

Pippin: because you've got to know a lot of information about what you may be teaching or what you're doing

Interviewer: okay, so what is it that logical means? What does logical mean? You've got it on the sheet there

Pippin: is able to think clearly about facts and information

Interviewer: do you still think that that's really important?

Pippin: yeah

Interviewer: okay

Barry: I've got two. I've got one which is good and one which is bad. 'Take risks' = no

Interviewer: you don't think you should take risks?

Barry: no because it will maybe go wrong

Stanley: like, you've never ever

Barry: done before

Stanley: you've never ever drove a – car -

Barry: motorbike

Stanley: - yeah and then you do it and then, you're risking your life

Barry: it collapses

Interviewer: oh okay

Barry: but I think 'hard working'

Interviewer: 'hard working' yeah. Why do you think that one's important?

Barry: because then you work hard and you get more money

Interviewer: [laugh] you think it's important because you get more money? What was it that you said, because you held up one – which one did you have that you thought was important?

Molly: sensible?

Interviewer: Sensible. Why do you think that one's important?

Molly: I think it's important so you don't mess around

Interviewer: okay, okay. So put that on the pile as well

Stanley: inventive, creative

Interviewer: yep?

Stanley: and artistic

Interviewer: ooh, and why are those ones important for people who work in STEM?

Stanley: because if you're creative, you could make something up and it can be very clever to use

Interviewer: okay

Stanley: you could make anything, you could make up a new science thing

Interviewer: yeah? So creative is one

Barry: artistic, you can *do* something and do something very well

Interviewer: is that what artistic means?

Barry: no, you paint stuff

Interviewer: yeah, so maybe painting something. So you think it's important to be able to paint things?

Pippin: yeah, you could have a blueprint of what you were going to do

Interviewer: ahh

Pippin: like how far you were going to dig down

Interviewer: okay, so it's important to be able to draw things like that?

Pupils: yeah

Interviewer: okay

Stanley: and then my last one: inventive

Interviewer: uh huh

Stanley: because you have to be inventive to design an aeroplane and do everything - make a motor, which goes into the aeroplane. And you could invent new stuff, like new science stuff, you could invent

Interviewer: ah okay, so that's a good one. Thank you.

Barry: I have one

Interviewer: I think [Pippin], did you have one?

Pippin: um?

Interviewer: did you have one that you wanted to tell us?

Pippin: oh methodical

Interviewer: okay do you know what methodical means?

Molly: no, I have no idea

Pippin: follow a set of instructions carefully

Interviewer: and do you think that might be important?

Pippin: yeah

Interviewer: why do you think that one's…?

Pippin: because if you had instructions and you didn't follow them at all, you wouldn't be able to do what it says and you may get things wrong

Interviewer: okay

Stanley: what does this say?

Interviewer: that says 'organised'. Can we do [Barry's] one? And then we'll go to your one

Barry: I have one

Interviewer: go on [Barry]

Barry: can work like a team

Interviewer: can work in a team?

[pupils all agree]

Interviewer: why do you think that one's important?

Barry: because then everybody does everything right

Pippin: everybody works together

Interviewer: okay, and [Molly], what was you're one that you just said?

Molly: learn from their mistakes

Interviewer: ah okay

Pippin: oh yeah!

Interviewer: so why's that one important?

Molly: because if you made a mistake, and dug a little bit too far

Barry: next time you know

Molly: next time you know not to do it

Interviewer: okay

Barry: I have another one

Interviewer: you've got another one [Barry]?

Barry: likes helping others

Interviewer: why do you think that one's important?

Barry: because if they're stuck, you can help them

Pippin: ah this is what I do! I enjoy dancing

Interviewer: ah okay

Pippin: I'm a dancer

Barry: honest

Interviewer: honest, why's that one important?

Stanley: because you have to honest, you've got to do the right thing in your job, and do what the people – do what your boss tells you to do

Interviewer: [laugh] okay

Stanley: and you have to be honest that you'll stick with the job

Interviewer: okay, thank you [Stanley]. Are there any more in this big pile that you think we want to put on the small pile?

Stanley: enjoys building

Molly: being careful!

Interviewer: okay, so careful - why is careful important?

Molly: so you can be careful –

Pippin: do everything right

Molly: like learning from your mistakes, and after you've learnt from your mistakes you're gonna be careful

Interviewer: very good, okay

Barry: and when you're building a model, you'll be careful

Interviewer: okay and what was the one that you had there [Stanley]?

Stanley: enjoys building things

Interviewer: okay, cool - why do you think that one's important?

Stanley: because you can build things, aeroplanes, you could build cars,

Interviewer: yep

Stanley: you could build motorbikes, you could build bikes

Interviewer: okay

Stanley: and stuff like that

Interviewer: okay, fab put that one on. And your one [Barry]?

Barry: likes to learn new things, because if you like to learn new things, you can

Interviewer: okay

Stanley: I don't really think this is one, but 'enjoy reading'

Interviewer: Yeah? What do you think about that one?

Barry: you can learn from books!

Stanley: you *can* learn from a book, which tells you, it gives you instructions sometimes, to tell you what to do – when you're cooking, you have a recipe

Interviewer: yep

Stanley: and in the Great British Bake Off

Interviewer: [laugh] yeah

Stanley: they have a big piece of paper, and everybody tries to do the same thing?

Barry: kind of

Stanley: yeah, and there's a big sheet of paper with instructions

Interviewer: yeah?

Stanley: and you have to *read* it to do the right thing

Interviewer: ah, so you need to be able to *read* your instructions to do the right thing?

Stanley: yeah

Interviewer: very good, shall we put that one in the pile?

Molly: practical

Interviewer: okay, can you tell us why practical is important to you?

Molly: because they're good with their hands, and… that's what It says on the sheet!

Interviewer: okay, so why do you think being good with your hands important for someone working in STEM?

Molly: so you get it right? And not wrong

Interviewer: okay, so I think being practical means you could build something from scratch maybe?

Molly: yeah, like with no instructions

Interviewer: yeah, maybe. And why is that important for someone working in STEM?

Molly: because they can, be right and not wrong

Interviewer: okay

Molly: it's okay to be wrong sometimes

Interviewer: it is isn't it?

Molly: not every time though

Interviewer: okay

[Barry asks about a card]

Interviewer: it says 'discusses ideas with others'. I tell you what guys, we've got way more than [five] here, shall we have a look at this pile and see which we thing is the *most* important?

Barry: these are things we don't need *right now*

Interviewer: those are things you don't need? So are you happy -

Stanley: there might be good ones, but these are the ones

Barry: but we can't read them

Interviewer: well we can, we can go back to these ones if you think *none* of these are the most important. So how many have we got here?

[children count]

Pippin: we've got 18

Stanley: we have to take away 8

Interviewer: we don't have to take any away, but can we have a look, and can you guys decide in a group, which one of these you think

Child: five

Interviewer: yep – which are the most important do you think for someone working in STEM? Can you see there [Molly]? Do you need to move round?

Pippin: likes helping others

Interviewer: you can move your chair around if you want to, so you can read them all

Barry: do you want me to move my chair?

Interviewer: shall I move my chair around as well? I'll sit round here

[everyone moves their chairs around]

Pippin: so we have: learns from their mistakes.

Interviewer: yep

Pippin: Likes helping others. Logic.

Stanley: inventive, you have to be inventive

Barry: yeah

Pippin: hard working. Inventive. Methodical.

Children: Practical. Enjoys reading. Enjoys building things. Sensible. Likes to learn new things.

Careful. Clever. Listens to other people's opinions. Honest.

Pippin: Can work in a team.

Stanley: Artistic and creative

Interviewer: okay, so which *five* of those, do you think are the *most* important?

[children chatter]

Interviewer: they all might be useful, but which do you think are the *most* important?

Pippin: Okay, so do we think that 'learns from their mistakes'

Barry: yeah, that's important because if you don't learn

Stanley: there might be good ones, so if we make a 'good' pile, an 'okay' pile and a 'bad' pile

Interviewer: ah okay, that's a good way of doing it – so this is the 'medium' pile?

Stanley: Honest, you have to be honest

Children: [agreement]

Interviewer: why do you have to be honest guys?

Molly: so if you don't like something, you can be honest

Stanley: you have to be honest to do the right thing, when you're doing your job

Interviewer: so you have to make sure you do the *right* thing when you're doing your job?

Stanley: yeah

Interviewer: okay

Barry: because if you broke one of the tools, you have to be honest you broke them

Interviewer: ah okay

Pippin: creative – middle I think

Barry: middle, yeah

Interviewer: okay

Barry: can work in a team

Pippin: yeah. Listens to other people's opinions?

[children agree]

Pippin: clever

Stanley and Barry: yeah, you have to be clever

Pippin: we've only got one more

Barry: clever and sensible are a little bit of the same thing

Interviewer: why do you think clever and sensible are the same thing?

Stanley: some people are sensible, and you have to be clever, and sensible and clever – you are a little bit of the same. Because if you're sensible, that means you're quite clever. And if you're clever you *are* clever

Interviewer: so the way that you think about being sensible and being clever – you think they're similar?

Pippin: I think 'careful' middle

Children: middle

Pippin: likes to learn new things

Children: middle

Pippin: no, we're going to break it down I think

Children: middle

Pippin: I think it's best if we break it down

Barry: middle

Molly: put it in the middle for now

Pippin: sensible

Stanley: that's a little bit of the same thing as clever for me

Pippin: what if I put it here?

Child: yeah

Pippin: like middle of middle

Interviewer: Middle middle?

Pippin: enjoys building things

Stanley: that might be here

Molly: middle middle

Barry: middle middle

Pippin: enjoys reading

Stanley: you *can* do that

Pippin: middle

Stanley: you *can* do that because you have to listen to instructions

Children: middle middle

Interviewer: so you think enjoys reading is *less* important than the other ones?

Child: no no no

Stanley: it's very important, but you can do – you have to read, but you have to do the same – reading instructions – what you have to do today

Interviewer: okay

Stanley: you have different instructions every day – you might

Barry: but you don't *enjoy* it

Interviewer: but you don't *have* to enjoy it to be a STEM worker?

Barry: yeah. I say this is middle middle middle

Interviewer: okay. So 'not relevant' would be here, and then this is

Pippin: 'not relevant' middle, relevant middle and then relevant

Interviewer: okay, so shall we do 1-5 and then 1 is the most important and 5 is less important… so 1 means most important, 2 is *quite* important

Pippin: but not as important as number 1. Number 3 is 'slightly' less important.

[children talk]

Pippin: number 4 is not so important, number 5, not important

Barry: it's still important, but not *that* important

Interviewer: okay, that's a good way of doing it

Stanley: okay practical

Barry: No! well you *can* but

Pippin: I think about number three

Barry: read it here - what's practical?

Pippin: what about logical

Barry: wait, we're going to

Children: good with their hands, good at doing practical tasks like experiments

[children talk over each other]

Molly: I still don't know what practical means

Interviewer: so practical means that you like doing hands-on things. So maybe you like building things, so if you enjoyed – do any of your parents do DIY?

Pippin: my dad's doing the floor right now

Interviewer: your dad's doing the floor? So yeah, that's practical – to do your own floor, or maybe if you put together a bookcase

Stanley: my dad's building a corkboard

Molly: my dad helped my sister out with her homework and made a wind turbine

Barry: my dad and my dad's friend is going to build my sister's room

Interviewer: okay, cool. What's our next word that you've got?

Pippin: artistic

Interviewer: artistic, which one do you think that goes?

Pippin: four!

Stanley: I think that's number two

Interviewer: okay, so we've got two different opinions there – so why do you think it's number two [Stanley]?

Stanley: because you have to be artistic to do –

[children talk over]

Interviewer: can I hear your opinions please? So [Stanley] – you think that it's…

Stanley: you *can* do lots of stuff which [is] artistic, like you can design an aeroplane and you can colour the wings or something on it

Interviewer: okay

Stanley: and you can make pictures to stick on - in a museum [unclear]

Interviewer: okay and [Pippin] – why did you think that it was three?

Pippin: I think it's three because blueprints are important

Interviewer: uh huh

Pippin: but as well, artistic means painting – I'm not really sure that painting really goes with science or mathematics or something like that

Interviewer: okay, thank you. So we've got two different opinions on that one – that's okay so shall we put it halfway in between? And what about the other ones there guys?

Pippin: logic

Interviewer: logical, okay – what do we think about that one?

Barry: logical is able to think clearly about facts and information

Child: yes

Interviewer: how important is do you think that is?

Stanley: I think that's two

Pippin: two

Interviewer: why do you think that's a 2 guys?

Barry: it doesn't fit in 1

Interviewer: so you don't think it's the most important?

Stanley: no, it is *very* important to do your job and stuff

Molly: likes to help others

Interviewer: you think that's the *most* important?

Child: yeah

Barry: it is important

Interviewer: okay, explain that to me?

Stanley: because tell your friend you can do something, and they can't – but they *can* – but

Molly: they don't believe in themselves

Interviewer: so we're thinking about things that are the most important for somebody who works in STEM – so is that the most important for someone who's a scientist or makes technology -

Barry: I think if you're working together, you could help someone else in your team

Interviewer: okay

Stanley: and then you might do something different to your [gestures at another child] work then you could do something a little bit different and then when the boss comes in and he checks the work, his might be better, but you've helped!

Interviewer: okay

Stanley: then he might have to do a speech, of his thing of what he did and then somebody might make it

Interviewer: okay and what were our last words?

Barry: hardworking

Pippin: methodical

Molly: inventive

Barry: you have to be hardworking

Interviewer: what do we think about those ones? Which is the most important out of those?

Children: hard working

Interviewer: okay so hardworking is number 1?

Stanley: and I think inventive must be too

Barry: yeah

Interviewer: okay

Pippin: methodical – what does that one mean?

Molly: follows a set of instructions carefully

Interviewer: okay how important is that one?

Children: two

Interviewer: can someone explain to me why they think it's two?

[distraction]

Interviewer: okay so let's have a look at – so you guys have decided – does everyone agree with this? Does anyone have other thoughts? Does anyone think anything should be moved around?

Pippin: not really

Stanley: what about check some of those, because some of these might be better than what we have?

Interviewer: okay

Stanley: we have no number fives

Interviewer: [to Molly] are you happy with all of these

Molly: yeah, I'm happy with all of them

Interviewer: okay

Molly: I'm mostly of [Pippin's] opinion

Interviewer: right, okay. I just wanted to know which ones you thought were the *most* important? So it doesn't matter that there are no number 5s because I was interested in what you thought was the *most* important

Pippin: so honest, working with a team, clever, listens to other people's opinions, hardworking

Interviewer: there's a word in there that I want to pull out – so you guys… actually I'll talk about that with you at the end. So the next activity – the next thing that I was hoping we could do – can you do the same again – so we thought of the five most important things for someone who works in STEM. Can you guys now have a look and think 'which of these cards you think represent you'?

Molly: oh

Interviewer: so which of these five things do you identify, or think that represents *you* best?

Barry: of these?

Interviewer: of these, yeah – we can mix these up now that's fine

Pippin: oh wait! We didn't look at this one.

Interviewer: what is it?

Pippin: enjoys maths

Interviewer: do you think that's the *most* important thing?

Barry: no, I think that's 2

[children talk about the options on the table in front of them]

Barry: enjoys sport!

Interviewer: so make your own pile in front of you for the ones you think represent you

Barry: enjoys sport

Pippin: what does that say?

Interviewer: that says 'can work independently'

Pippin: enjoys drawing, that's a good one for me. Enjoys history, that's good

Barry: what does this one say?

Interviewer: curious

Barry: what does curious mean?

Interviewer: can you find it on the glossary?

Molly: what does this say? Likes com-

Interviewer: likes computer games

Stanley: [reading from glossary] can look back on things and think about what went well and

Pippin: have you got enjoys dancing

Interviewer: if there are some words that you think

Child: don't take mine!

Interviewer: It's okay, you can share. You three, are you listening? If there's something that two of you want the same word – that's okay, you can use each other's words

Interviewer: so can you tell me which ones you've got there [Molly]?

Molly: I've got clever, 'wants to understand how things work' because I ask my dad a lot

Interviewer: okay

Molly: can take risks

Interviewer: yeah

Molly: likes visiting other countries

Interviewer: okay

Molly: encourages others

Interviewer: yep

Molly: likes being outdoors

Interviewer: okay is that five?

Molly: yeah

Interviewer: [whisper] that's okay, you can have six

[children continue talking about their choices]

Interviewer: has everybody decided on their five words?

Stanley: I've only got three

Interviewer: okay, are there any other ones that you think describe you?

Pippin: hardworking, that's me

Barry: learns from their mistakes, likes to learn new things, can use computers

Molly: I cannot use computers!

[discussion about choices continues]

Interviewer: has everybody got their top five,

Pippin: wait

Interviewer: that they think represent them?

Pippin: where's that one? Okay, that one's dancing

Stanley: I have seven. Can I pick seven?

Interviewer: well [Molly has] six, so if [Molly] has six, you can have seven

[children count their cards]

Pippin: shares information, likes learning languages, imaginative

Interviewer: okay, has everyone got their five? Because you guys are going to need to go back to your classrooms soon

Barry: I've got six

Interviewer: okay, so we've all got six have we?

Stanley: or seven

Interviewer: or seven. So, starting at this end, can you please tell me which words you have and can you explain *why* you think that describes you as well? Why you chose that word?

Molly: Can take risks

Interviewer: Why did you choose that one?

Molly: I chose that one because I can be quite risky

Interviewer: okay

Pippin: and me

Molly: I know you can!

Barry: I can

Interviewer: are you all listening? It's really important to listen to each other's ideas as well

Molly: want's to understand how things work

Interviewer: okay

Molly: because I ask my dad a lot when we go places

Interviewer: okay

Molly: encourages others because I've got quite nice friends and I like them to be happy

Barry: she's sitting by one

Interviewer: okay are you guys friends?

Molly and Pippin: yep!

Interviewer: ah okay

Stanley: and us two [him and Barry]

Molly: likes being outdoors

Interviewer: yeah?

Molly: because I have a dog and I walk him a lot?

Pippin: and you like being in your kayak

Molly: yes, I do like being in my kayak

Interviewer: you have a kayak? Wow

Pippin: I have three kayaks

Interviewer: that's a lot of kayaks

Stanley: and I have a dog and [Barry] used to have a bunny but

Barry: but he died

Interviewer: that's sad

Stanley: a fox ate him

Barry: no!

Interviewer: are we listening to [Molly]? Because she's not finished yet – we still need to listen to the rest

Molly: clever

Interviewer: okay

Molly: and likes visiting other countries

Interviewer: ah, which other countries do you like visiting?

Molly: I've been to Italy twice

Interviewer: lovely! Okay is there anything else you want to tell us about why you chose those words?

Molly: umm, because it just represents me

Interviewer: okay, brilliant – thank you! And could you tell us your words now please [Pippin]?

Pippin: enjoys dancing

Interviewer: okay

Pippin: I *love* dancing

Barry: I *hate* it!

Stanley: I'm the opposite of that!

Molly: I also like that one!

Interviewer: okay and what other words did you choose?

Pippin: enjoys drawing – I'm very good at art

Interviewer: okay

Pippin: I love art. Enjoys science – I *love* science. It's because, me and my dad are always doing small experiments at home sometimes

Interviewer: okay, that's cool

Pippin: likes to learn new things

Interviewer: okay

Pippin: because at home, my mum and my brother and me – we are always going to different places and learning different things

Interviewer: okay, fab

Pippin: enjoys history – it's one of my favourite things in the whole world

Interviewer: okay

Pippin: History - I just love it – I don't know why

Interviewer: that's okay – so you love history

Pippin: imaginative

Interviewer: yep

Pippin: I make up a lot of things – I like making stories

Molly: yeah I remember in year 2 you said you were a robot!

Pippin: yes, I was a robot

Interviewer: so you like to imagine things? Yeah

Pippin: and hardworking. I like to think that I can do more than I *can* do

Interviewer: okay – you think you're very hardworking. [Barry] can you tell us – in fact sorry [Barry] – [to Pippin] was there anything else that you wanted to add to that?

Pippin: no

Interviewer: okay, thank you. [Barry] can you tell us yours?

Barry: I have can work in a team, I like to work in a team – with [Stanley]

Interviewer: with [Stanley]? okay

Barry: but if we don't work in a team, I will collapse. I enjoy sport – I always play sport.

Stanley: ah yeah, and me

Barry: Can use computers because sometimes at home work I use computers

Interviewer: okay

Barry: I like to be clever, because I'm trying to be really clever

Interviewer: okay

Pippin: yeah me and [Barry] sit next to each other and we're always going for the gold tasks

Interviewer: okay, so you like to work at a high level, okay

Barry: and I've got try new things

Interviewer: yep?

Barry: I like to make a cake, I like to try – because I didn't like pineapple and lemon, then I tried them and then I liked them!

Interviewer: okay, so you like to try new things

Barry: and the last one is like computer games

Interviewer: okay

Barry: because

Pippin: that's just him

Barry: yeah, that's just me

Interviewer: okay brilliant, is there anything that you wanted to tell us about those at all [Barry]?

Barry: at work in a team

Interviewer: uh huh

Barry: if we complain, I would just move to another group

Stanley: because what we did in year 3 – because we had such a big group

Barry: there was six of us

Stanley: we didn't agree so we split it up in twos

Barry: we split it up in twos to make one thing, but we're still in a group

Interviewer: okay. [Stanley] can you share your answers with us?

Stanley: comes up with lots of new ideas

Barry: yep, that's him

Interviewer: do you feel like you do that?

Stanley: yeah

Interviewer: okay

Stanley: enjoys maths

Barry: I enjoy maths! That's me [to Stanley] you stole that

Interviewer: it's not stealing because we're all using the cards together

Barry: I was going to say it, but I didn't have it

Interviewer: guys are you listening to [Stanley]?

Stanley: I don't usually play computer games, but I do like them

Interviewer: you like computer games, okay

Stanley: I like visiting other countries, I've just got that because I *love* visiting other countries

Interviewer: okay

Pippin: yeah because his dad comes from Mauritius

Stanley: I like to learn new things

Interviewer: you like to learn new things? Fab

Stanley: the same thing as him – I absolutely love sport

Interviewer: you love sport? Okay brilliant

Barry: my favourite sport is rugby

Interviewer: really? What else would it be in Wales? Okay

Child: what's yours?

Interviewer: My favourite sport? I don't think I have a favourite sport

Stanley: No

Barry: what about your opinion of these

Interviewer: oh which cards would I choose? I think that I would probably choose

Child: [whisper] clever

Interviewer: creative, because I like to be creative, and think I would also choose listen to other people's opinions.

Molly: you can choose any of those [gestures to own card]

Children: yeah you can use any of ours

Interviewer: thank you. I also enjoy history and I'm very determined and

Stanley: ooh there's more here

Interviewer: and

Stanley: Are you organised?

Interviewer: I think I would like to choose likes to learn new things – I think it's really important to learn new things. So can I ask you – all of you mentioned

[teacher comes into ask question]

Interviewer: so there's one last thing that I wanted to ask you about – because all of you thought being clever was very important

Child: yeah

Interviewer: so do you think that being clever – is just as important – hang on I had some other words

[looking for other cards]

Interviewer: a lot of the time, some of the reason why people think that they might not be very good at working in STEM, is because a lot of people don't think that they're clever enough to do it. Do you think that being clever is more important – or – how important is being clever compared to being hardworking, determined and learning from your mistakes?

[children pause]

Interviewer: it's okay if you're not sure of an answer

Molly: yeah I'm not sure

Interviewer: so is it more important to be clever, or to be hardworking, determined and learning from your mistakes?

Stanley: I think it's a little bit of the same, clever you can work very hard and you can learn from your mistakes and you have –

Interviewer: what was the last thing you were going to say?

Stanley: – determined – I'm not sure what it really means

Interviewer: determined? What does determined mean? Let's have a look at determined

Molly: doesn't give up, even if things become difficult

Interviewer: what do you think about that?

Molly: I think that these are more important

[children speak – unclear meaning]

Interviewer: so do you think that if you can do all of these three things

Barry: you're clever

Interviewer: ah okay

Child: I'm clever!

Interviewer: So one last example – have you heard of Albert Einstein?

Children: yes!

Barry: no

Stanley: I've not heard about Albert, but I have heard about Einstein

Barry: I've not

Interviewer: that's his name, so his whole name is Albert Einstein. He's a very famous scientist and mathematician – so he used a lot of maths in his science. But he always said, that even though he worked with maths every single day, he found it really difficult. But he was determined and hardworking, and he was able to learn from his mistakes. So it didn't matter that he found maths difficult, because he was still able to use it. Because he did those three things. Does that make sense?

Children: yes!

Interviewer: thank you so much for helping me out here guys. Does anyone have anything that they want to say just before we leave – about the stuff that we talked about?

Pippin: no

Stanley: can we stay here?

Interviewer: no, we have to go back to lessons!

Molly: thank you

Interviewer: thank *you!* [give instructions for recorder].

35 Appendix 23: Pupil task-based interview 1, SP

Title: Pupil interview 1

Date: 27th November 2018

Speakers: Poppy Hodkinson (interviewer), Blossom, Cupcake, NJ and Skull Trooper

Interview duration: 41 Minutes

Interview location: SP

Interviewer: So I thought the first thing that we could do is have a little think about – so we talked about STEM – and you guys told me what STEM means. What was it again?

Children: Science, technology, engineering and mathematics

NJ: I'm really good at mathematics

Interviewer: Are you? Is it your

NJ: hobby, it's my hobby

Interviewer: It's your hobby? Oh brilliant. Okay so if you were somebody who worked in STEM – so if you worked in science, technology, engineering and maths – what kind of jobs do you think you might do?

NJ: you could do architecture

Interviewer: yeah, you could do

Skull Trooper: fix things?

Interviewer: yeah? What kind of things might you fix?

Skull Trooper: cars?

Interviewer: cars maybe

Skull Trooper: I would be an engineer

Interviewer: yeah

Cupcake: computers

NJ: yeah you would fix computers – because mathematics, programming and…

Interviewer: yeah, so you might use maths to do programming. You said maths was your hobby, what kind of jobs might you use maths in?

Cupcake: well, if it's technology as well

Interviewer: yeah?

Cupcake: I would go to the bank – work in a bank because it's technology with computers

[Pupils agree]

NJ: and you can count the money so that's

Interviewer: yeah?

NJ: I can program, so I make a few apps and I like doing that

Interviewer: very cool! Do you think you could maybe do that as a job?

NJ: maybe

Interviewer: awesome! [to girls] Have you guys got any ideas about what sort of things you might do if you worked in STEM? What kind of jobs you might have?

[girls whisper]

Interviewer: what about science, are there any jobs in science maybe?

Blossom: I like mixing stuff together I do

Interviewer: mixing stuff together?

Cupcake: I've done this camp, which is a science camp all the way in [place]

Interviewer: oh okay

Cupcake: because my friend lives in [place] so I am best friends with him – so I have to – well I don't have to – but in the summers I usually go over there and do some science over there

Interviewer: lovely! Okay so are we all kind of happy that we know a *couple* of the jobs that you might do if you worked in STEM?

Children: yeah

Interviewer: or roughly some of sort of things you might do?

Child: yes

Interviewer: okay, fab. So I've got some words here – if I get them out. Can you see from over there, do you want to come and sit near here?

Child: yeah

Interviewer: in fact, you sit there and I'll perch in the corner, how about that? Then we can all see.

[children move around]

Interviewer: Okay so this is a group activity here – we've got loads and loads of cards. And on all the cards are different things – so different skills or different attributes or maybe different interests, so things you like doing. And I was wondering if you guys could tell me which you think are important for someone working in STEM? Or which are the *most* important?

Child: okay

Interviewer: When I did this with some children before, they decided that they wanted to grade them from one to five – so one was the most important, that they *had* to do. And five was the least important – it didn't really matter too much. Would you like to grade it [like this]?

Cupcake: I think we already know which one is last

Blossom: I don't

NJ: that's middle

Interviewer: okay, you think 'can use computers' is 3

Blossom: what about this one?

Interviewer: enjoys science? What do reckon, is that important for somebody working in STEM?

Blossom: agree

NJ: four. Four

Interviewer: okay so which one is most important? Which number are we doing for most important? This is most important?

Cupcake: and then that's least

Interviewer: okay so enjoys science is about 4?

Children: yeah

NJ: you need to enjoy science though to do it

Cupcake: yeah but

NJ: I don't know if it should be 2 or 4

Cupcake: I know, but it's not the *most* important thing is it?

NJ: technically yes

Cupcake: yeah but -

NJ: enjoy maths

Cupcake: oh yeah, 2

NJ: that's on 2 yeah

Interviewer: okay so enjoying maths is really important if you work in STEM?

Cupcake: yeah

Interviewer: why is enjoying science not as important?

Cupcake: because in STEM you usually mostly use maths probably

NJ: but then you need to know science as well

Interviewer: yeah, what does the 's' part of STEM stand for?

Blossom: science

NJ: maths, science, computers

Interviewer: okay so we've got 2 for enjoys maths, 3 enjoys science and 4 can use computers? Cool, okay – what other words do you want?

Cupcake: I feel like [unclear] should be at the end

NJ: nah. Five could be can work independently

Interviewer: can work independently?

Skull Trooper: what about this?

Interviewer: Is that most important or least important?

Blossom: what about hardworking?

Interviewer: shall we do one at a time? So shall we do 'enjoys history' – we'll go [Skull Trooper, Blossom, NJ] – so let's look at those words then [Cupcake] you choose a word as well

Skull Trooper: I think number 5

Interviewer: does everyone feel that for enjoys history?

Cupcake: no, because you don't need history

NJ: you sort of do because –

Skull Trooper: the bones

NJ: - if you're going to look at the bones

Interviewer: ah so if you were maybe an archaeologist?

Skull Trooper: yeah, you have to like – you have to *know* the bones

Child: my neighbour is an archaeologist

Interviewer: really?

NJ: I don't know if I should swap those two and then swap those two

Interviewer: I tell you what, shall we put them where we think at first and then we can revisit it if we think there's anything that needs to move around?

Cupcake: maybe hardworking can go on most important

Child: oh oh oh! I've got a good idea

Interviewer: so [Cupcake] and [Blossom] you both think hardworking is most important?

Girls: yeah

Interviewer: [to boys] do you guys agree?

Boys: yeah

Interviewer: brilliant

Blossom: comes up with -

NJ: lots of new ideas

Interviewer: comes up with lots of new ideas, how important is that?

NJ: I think that should go three, but then that needs to go

Interviewer: well we can have lots on the same one

Children: oh!

Interviewer: you can have as many as you want on the same one

Cupcake: oh okay

NJ: can work in a team

Interviewer: so comes up with lots of new ideas is 2

Cupcake: can work in a team is

NJ: clever, clever

Blossom: hardworking

Interviewer: what words did you have [NJ] before that you wanted to share with us?

NJ: I had, what was it?

Skull Trooper: what about likes visiting other countries

Cupcake: shares ideas with others

Child: The most important thing is…

Interviewer: okay, hold on – what have you got there [Cupcake]?

Cupcake: discusses ideas with others

Interviewer: what do you think – we've got a glossary here if there are any words you're not sure about. Discusses ideas with others – how important does everyone think that is?

NJ: that's really important

Interviewer: what do you think [Cupcake]?

Cupcake: I think –

NJ: you might need to help them look in the history and do science, do maths

Cupcake: likes computer games – that's the least important!

Interviewer: okay, so where would you like to put that one [Cupcake]? Pop that one where you'd like it to go

Cupcake: so I think [places card]

Interviewer: and you just put likes visiting other countries one 1 did you [Skull Trooper]?

Skull Trooper: yeah

Interviewer: what made you think that that one goes there?

Skull Trooper: because if you wouldn't then – what if your country had no bones, so there's basically no point of working

Interviewer: maybe, what if you're a different kind of scientist? An archaeologist is just one kind of scientist – what about all the other types of scientists as well?

NJ: I think that should go on 2 or 3

Cupcake: bone scientists?

NJ: that's an archaeologist

Interviewer: or a biologist

Blossom: what about enjoys reading?

Interviewer: enjoys reading that's a good one [Blossom]

NJ: oh yeah because you might need to look in a dictionary for things

Blossom: yeah

Interviewer: yeah, maybe - so where do you guys want that one to go?

NJ: three?

Interviewer: okay, put it where you think

Blossom: clever

NJ: logical

Cupcake: oh what is this?

Interviewer: which one have you got there [NJ]?

Cupcake: artistic

NJ: logical

Cupcake: artistic, what about artistic?

Interviewer: these are all good words, so: logical where does everyone think that needs to go?

NJ: two

Girls: yeah

Interviewer: 2? What does logical mean guys?

NJ: I think it means you can work with loads of different things and you're clever at stuff

Interviewer: okay, I tell you what we've got a description of logical

Skull Trooper: logical?

Interviewer: there's a description of logical on the glossary

Blossom: what about this? Can work in a team

NJ: is able to think clearly about facts and information. So they can think about things really easily?

Interviewer: okay

Skull Trooper: [NJ] what about artistic?

Interviewer: hang on guys, we're talking about logical at the moment – so [NJ] what was it that logical meant?

NJ: it meant that: logical is able to think clearly about facts and information

Interviewer: which one do we think that one is? Really really important, or not very important

Blossom: I think it's 4 or something

NJ: 4 yeah

Cupcake: oh I would say 2 maybe

Interviewer: why do you think that [Cupcake]?

Cupcake: it's because you have to – I don't know, but it just seems like a good one to have if you're going to be work in STEM

Interviewer: okay, yep – cool so which number would you like that to go on [Cupcake]? Logical was…

NJ: two or three or four

Interviewer: which one did you want it on?

NJ: four

Cupcake: I would say two

Interviewer: two? Okay. And what was the next one? Did you have artistic, what did you think for artistic [Skull Trooper]?

NJ: five

Skull Trooper: I think four or

NJ: I think four or five

Interviewer: okay, can you explain why you think that?

Skull Trooper: well artistic is really good for science, because if you weren't really artistic, then you wouldn't really want to be working with science. Because artistic is kind of just like, well [pause]

NJ: it's actually five, I would say five

Interviewer: okay, you think five and you thought

Skull Trooper: four

Interviewer: and you think?

Cupcake: I think five

Blossom: five

Interviewer: so you guys *don't* think it's important to be artistic?

Children: no

Interviewer: okay cool, and what have you got there [Blossom]?

Blossom: I got likes to try new things

NJ: actually no, it should be four because if you're an engineer you might need to

Cupcake: draw stuff!

Blossom: yeah

NJ: you might need to do work

Skull Trooper: that's why I was thinking four

Interviewer: okay, thanks – likes to try new things?

NJ: yes, definitely

Interviewer: what do you think about that one?

NJ: that's important

Child: yeah

NJ: I'd say one

Interviewer: you'd say one?

Girl: yeah one

Interviewer: one? We've got more votes for one – go on, pop it on one. Lovely, which word shall we look at next?

Cupcake: resourceful?

Blossom: enjoys drawing – because you may have to, say if you're building something, you may have to draw it, so you know what – so you can create your idea

Interviewer: yeah, definitely – so where do you think that one should go?

Children: there? There

NJ: no

Blossom: I would say 3

Interviewer: 3? Okay, thank you

Skull Trooper: inventive

Interviewer: inventive

Children: yeah!

Interviewer: how important do you think inventive is? It is on the sheet if you wanted to have a look – can someone read out the description of inventive?

Skull Trooper: inventive, where's inventive?

Cupcake: comes up with new ideas to solve puzzles or design new things

Interviewer: what do you reckon about that one?

NJ: I would say because it's inventive, you could be able to get something old and then make it into something new

Blossom: yeah

NJ: I would say three or two

Cupcake: three or two

Interviewer: three or two? What do we think? Is it a little bit important, or middle?

Skull Trooper: I would say

Cupcake: I would say three

Blossom: I would say three

Interviewer: okay

NJ: I'll go for three

Interviewer: you think it's three as well? So shall we have it on three, but poke a little bit into four?

NJ: yeah

Interviewer: okay, what was the word that you had there [Skull Trooper]?

Skull Trooper: resourceful

Interviewer: resourceful, do we know what that one means?

Skull Trooper: finds quick clever ways to get things done or to make things easier

Interviewer: what do you reckon about that one guys?

NJ: that should be 2, definitely 2

Girl: yeah

Children: yeah, 2

Interviewer: awesome, thank you – do you want to put that one on? What have you got there [Blossom]?

Blossom: creative

Interviewer: creative, what does creative mean?

Cupcake: one!

Blossom: creative is have ideas about how to present things or make something new

Interviewer: and what do we think [for] creative, how important is creative?

Cupcake: one

NJ: creative is 2

Blossom: I would say one

NJ: two or one. I'd say in the middle. Right in the middle

Girl: yeah

Interviewer: you guys think somewhere between 2 and 1?

Children: yeah

Interviewer: okay, brilliant. What word have we got next?

Cupcake: learns from their mistakes

Interviewer: that's a good one

NJ: that's really important

Cupcake: learns from their mistakes

Interviewer: I'm not sure learns from their mistakes is on that list, but that just means if you make a mistake, next time you know what to do differently.

Children: yeah

Interviewer: so how important is that if you work in STEM?

Cupcake: I would say one

Blossom: that is important

NJ: engineering, it's important, mathematics it's important

Interviewer: so do we all agree it's –

Cupcake: yes

Children: one, it's one

Interviewer: okay, thank you. What have you got there?

Blossom: I've got enjoys building things

NJ: that's a good one

Interviewer: oh okay, what do you think about that one?

Cupcake: that's kind of like creative I guess

Blossom: yeah

Interviewer: it is a little bit like creative isn't it? You might notice that some of these sort of mean the same thing

Children: yeah

Interviewer: some of them do. There's a little bit of overlap.

Children: yeah

Interviewer: So what do we think about enjoys building things?

NJ: that's quite important

Skull Trooper: I would say 2 or one

Cupcake: two or one

NJ: two or one because engineering and maths

Interviewer: okay, so does everyone think between two and one?

Skull Trooper: I've got one

Children: yeah

Interviewer: okay, lovely

Skull Trooper: I've got one

Interviewer: go on, which one have you got [Skull Trooper]?

Skull Trooper: listens to other people's opinions

Blossom: yeah

Interviewer: what do you think about that one?

Skull Trooper: I think that should actually be two

NJ: that should be two

Interviewer: does everyone agree?

Blossom: yeah, two

Interviewer: brilliant okay – go on [Cupcake], what have you got there?

Cupcake: wants to understand how things work

Interviewer: what do you think about that one?

Cupcake: that's a

NJ: that's like a three

Blossom: three yeah

Interviewer: okay, can you explain why you think that guys?

NJ: because

Skull Trooper: I would probably say two maybe

Cupcake: it's not really *really* important, it's like in the middle

NJ: so it is important, but then it's not important as other things

Cupcake: yeah, because it's not important in some science, but then it is important in others

Interviewer: okay so which number do you think is the right one?

Skull Trooper: I would say three

Cupcake: I'd say two

NJ: in the middle of two and three

Interviewer: well how many votes have we got for two?

NJ: one

Cupcake: in the middle

Interviewer: so we've got three votes for two, and which one do you think? Three so shall we pop it in 2 with a little bit edging into three?

Cupcake: I was thinking

Interviewer: are you ending up with all the tape I've stuck [on the back of the cards] all over you? They're all over you aren't they? Sorry guys

Girl: it's fine

Interviewer: it's so I can tell the difference, because I've got loads of versions of these and otherwise I end up mixing them all up and get really confused – which word have you got there [NJ]?

NJ: likes being outdoors

Interviewer: likes being outdoors – how important is that?

NJ: that's three

Interviewer: what does everyone think?

Girl: oh yeah, that's three

NJ: is that three [Skull Trooper]?

Skull Trooper: yeah that's three

Interviewer: okay, cool – which one have you got there [Skull Trooper]?

Skull Trooper: organised

Girl: yeah that's a good one

Skull Trooper: important

Interviewer: important?

Skull Trooper: yeah

Interviewer: Okay, does everyone agree? What number do you think for that one [Skull Trooper]?

Skull Trooper: one

Cupcake: I'd say in the middle of 1 and 2

Interviewer: okay

NJ: I'd say – what is it [Skull Trooper] again?

Skull Trooper: organised

NJ: you need to be quite organised. I'm saying the middle

Skull Trooper: middle

Interviewer: okay? Pop that one on then. What have you got there [Blossom]?

Blossom: careful?

Interviewer: careful, what do you think about that one?

NJ: five

Cupcake: no I wouldn't say that,

Skull Trooper: three

Cupcake: I would say about in the middle of two and three

NJ: I would say five

Interviewer: could you explain why you think that [Cupcake]? and then we'll ask [NJ]

Cupcake: what is it again?

Blossom: careful

Cupcake: because

Skull Trooper: I would say three

Cupcake: you have to get it correct,

Blossom: yes, if you don't you'll end up spilling all the things and then it will just end up going wrong

Cupcake: but but but

Skull Trooper: what if it's dangerous like hot stuff?

Interviewer: okay, so you guys think that's it's a bit important because you need to be careful so you [don't] spill things?

Children: yeah

Interviewer: [NJ] what did you think? Why did you think it might not be as important?

NJ: I thought it wouldn't be as important because if you're going to compare it to 'can use computers', it *is* important, but then it's not as important as 'can using computers', because you can go *really* wrong in computers

Interviewer: [laugh] do you think maybe 'can use computers' is in the wrong place then?

Girl: yeah

Interviewer: where do you think 'can use computers' should go?

Blossom: in between 2 and three

Interviewer: yeah? Okay, so shall we move that one, and then where do we think being careful goes?

Interviewer: is being careful as important as being 'able to use computers'?

Skull Trooper: I would say in between two and three?

NJ: I'm saying three and four or two and three

Skull Trooper: two and three, two and three

Interviewer: what do you think [Blossom]?

Blossom: I think two and three

Interviewer: okay, we've got lots of people saying two and three, is that what you think as well [Cupcake]?

Cupcake: I'm saying between two and one because you have to be careful

Blossom: yeah, true

Interviewer: what do we think then guys?

NJ: on two then

Interviewer: on two?

Child: two

NJ: on two

Interviewer: okay, that seems fair – thank you

Cupcake: I've got one: can take risks

Interviewer: what do you think about that one?

NJ: that's quite important yeah

Interviewer: can you explain why you think that?

Cupcake: I think it's in between one and two

Cupcake: I think it's important because if you do take a bad risk you will – you could die

Interviewer: yeah?

Skull Trooper: or you could hurt yourself!

Interviewer: true

NJ: the reason why I think it's quite important is because taking risks – the whole part of life is taking risks, and if you take risks and it actually works out, you'll be really happy with yourself

Interviewer: true, if it turns out to be a good shout, yeah

Cupcake: but if it turns out to be bad, then…

NJ: yeah, so it's two

Blossom: I would say two

Interviewer: shall we go between two and one, because you think it's one and you guys think it's two?

Children: yeah

Interviewer: okay, brilliant. Kind of one and a half?

Child: [laugh] yeah

Interviewer: okay, what have you got there [Cupcake]?

Cupcake: likes helping others

Interviewer: what do you think about that one everyone?

NJ: that's four or three. Four or three

Blossom: that's two

Cupcake: two

NJ: two?!

Blossom: no three

NJ: three or four. In the middle

Interviewer: what do you think [Cupcake]?

Skull Trooper: two and one

Cupcake: I would say one

Interviewer: one? Oh you think it's the most important?

Cupcake: because

Boy: one and two

Cupcake: if somebody needs help, you could go over and help

Boy: one and two

Cupcake: them if they're struggling to research something, you could help them.

Skull Trooper: yeah one and two is – I would say one and two

NJ: if you said that, I would say one

Girl: one

Interviewer: have you convinced us?

Cupcake: one

Interviewer: what do we think?

Children: one

Interviewer: one?

Girls: one

Interviewer: brilliant, okay thank you. What have you got there?

Blossom: enjoy dancing

Interviewer: enjoy dancing!

Skull Trooper: that's gonna be five

Interviewer: how important do you think that is for someone who works in STEM?

NJ: not important at all

Blossom: [laugh] five!

Interviewer: not that important okay

Cupcake: I've got two though

Interviewer: okay, which one would you like to do first?

Cupcake: I'll do this one first – likes to learn new things

Interviewer: what do you think about that guys?

NJ: two. Two. Definitely two

Cupcake: two, no one and a half

Children: one and a half

Interviewer: one and a half okay, cool

Cupcake: and then I've got this one: encourages [pronounce rages] others

Interviewer: that says encourages others,

Cupcake: oh, encourages

Interviewer: good effort though

Blossom: we've had this one before though

Skull Trooper: no we haven't

Blossom: we did

NJ: we had a similar one

Interviewer: there's likes to *try* new things and likes to *learn* new things

Blossom: ahhh

Interviewer: like I said, there are a couple that are similar – what do we think about *encouraging* others?

Skull Trooper: yeah I would say two

Cupcake: I would say about two or one

NJ: two

Blossom: two

Cupcake: one and a half

Blossom: yeah one and a half

Skull Trooper and NJ: two

[children continue to say "two" or "one and a half" back and forth to each other]

Interviewer: okay, shall we say, we'll put it halfway between one and a half and two – how about that?

Children: yeah

Interviewer: so shall we put it on the line because we know that you guys thought slightly different things. And remember because we're recording this, I can remember what you guys said so I'll know that people were split on that one

Blossom: I've got two

Interviewer: you've got two? Go on

Blossom: likes learning languages

Interviewer: what do we think about that one guys – likes learning languages?

Skull Trooper: I think one because if you're going to travel, you're going to need to know different languages

Interviewer: okay

Cupcake: I would say two

NJ: two

Interviewer: to work in STEM?

NJ: two, definitely two

Blossom: I've got another one

Interviewer: yeah?

Blossom: shares information with others

Interviewer: how important is that if you work in STEM?

Cupcake: I think that's, I would give that in between one and two

Interviewer: okay, what does everyone else think?

Children: yeah one and two

Interviewer: would anyone like to tell me why they think that? Go on [NJ]

NJ: that one should go one and two, and then [struggles to say methodical]

Children: [also attempting to pronounce methodical]

Interviewer: methodical, so we've got that one on the glossary

Cupcake: I've found it!

Interviewer: can you tell us what it means?

Skull Trooper: follows a set of instructions carefully

Cupcake: yeah

Interviewer: okay, how important is that if you work in STEM?

Children: that's really important

Cupcake: that's really important I would say

Interviewer: okay

Cupcake: because if you don't follow the instructions, it could go wrong

Blossom: yeah

Interviewer: okay

NJ: one

Interviewer: one, okay fab.

Skull Trooper: I've got two

Interviewer: So we'll do one of L's and then we'll do one of [Blossom's]

Skull Trooper: I've got a really not important one

Interviewer: go one, which is that

Skull Trooper: computer games

Interviewer: likes computer games? What do you think guys?

NJ: that's really important

Interviewer: you think that's really important?

Cupcake: oh yeah, yeah

Skull Trooper: that should go at five

NJ: if it's technology, you should be like

Cupcake: oh yeah, three – I think three

Blossom: I would say between three and four

Cupcake: yeah, if you know how to do it

Skull Trooper: four and five

Cupcake: it could be a game that helps you -

NJ: I feel like three

Cupcake: - helps you learn some more stuff

Skull Trooper: that's true

Interviewer: oh okay

NJ: yeah, three I think

Blossom: yeah three

Interviewer: okay is everybody happy with that?

Children: three

Interviewer: And which one did you have there [Blossom]?

Blossom: enjoys sports

NJ: that's five – I'd say it's five

Cupcake: yeah five

Interviewer: what do you think [Blossom]?

Blossom: I think four

Cupcake: actually I think in between four and five

Blossom: yeah

Interviewer: why do you think that?

Blossom: because when it's sports, it can help you with things and then you won't have run out of energy to do anything

Interviewer: ah okay

NJ: stamina

Cupcake: it can help you

Interviewer: so stamina might be important, that's a good word. Yeah okay put that on

Cupcake: I've got another one

Skull Trooper: I've got gets all of the answers right

Interviewer: is that important?

Girl: yeah, that's important

NJ: that's a bit cocky

Skull Trooper: two, I would say two

Cupcake: I would say about three because you don't *always* need to get the answers right

Blossom: because you learn by your mistakes

Cupcake: yeah

Interviewer: okay, yeah because we put learn from mistakes as the *most* important thing

Blossom: yeah, so that will be two

NJ: but

Cupcake: I would say two

NJ: I would say four, definitely four

Girls: two, two

NJ: because you don't always need to get things right

Interviewer: so [NJ] says you don't have to always get all the answers right to be able to work in STEM?

Cupcake: yeah, three maybe

Skull Trooper: three

Cupcake: you might *want* to get all the answers right, you might as well just try and then if you make a mistake, you learn from it

Interviewer: oh so do you think it's important to get all the answers right *or* is it important to *want* to get all the answers right?

Skull Trooper: yeah one

NJ: I think it's important to try your best, and then see what happens

Cupcake: three

Blossom: in between two and three

NJ: I would say three and four

Interviewer: I tell you what, because you guys disagree with each other quite a lot, you [N] think it's not as important, and you think it's quite important, shall we put it as a three because then it's sort of in the middle of what everybody thinks

Children: yeah

Girl: I would say two and a half

Interviewer: is that fair?

Children: yeah

Interviewer: okay, pop that one on there. And what have you got there?

Blossom: sensible

Interviewer: sensible, what do we think about that one?

Blossom: that's 2

Skull Trooper: yeah, that's two

NJ: two

Child: no, one and a half

Interviewer: what do we reckon guys?

NJ: two, done

Interviewer: you think two [NJ]? what did you think?

Girl: one and two

[children say "one and a half" and "two" back and forth]

Interviewer: okay, pop that one on there then. We're going to run out of space aren't we? We've just got a couple of words left now

NJ: one, two, three, four, five, six, seven

Blossom: I've got two I think

Cupcake: I've got one

Interviewer: okay, what have you got there?

Blossom: can work independently

Interviewer: what do we think about that one?

Cupcake: haven't we done that one?

Blossom: no

Interviewer: we did can work well with others

Cupcake: oh

Interviewer: so can work independently, how important is that if you work in STEM?

Skull Trooper: that's quite important

Interviewer: does everybody agree?

Cupcake: yeah it is

Blossom: well if you're doing a test, you have to work independently, because then if someone's copying you, you might have them wrong and then -

NJ: I would say two

Blossom: they've just got the same answers

NJ: maybe two?

Interviewer: okay, which number would you say that is?

NJ: two

Blossom: I would say between one and two

Cupcake: I would say maybe three

Interviewer: okay

NJ: two or three I would say – in between two and three

Blossom: yeah, between two and three

Interviewer: yeah? You're happy with that? Okay

Skull Trooper: I've got honest

Interviewer: okay, so we'll do [Skull Trooper's] word and then we'll do [NJ's] word, and then we'll do your word. So honest – what do you think?

NJ: that's really important, because you should always be honest

Girl: always be honest

NJ: one

Cupcake: one

Interviewer: okay

Girl: that was quite easy

Interviewer: okay, and what did you have there [NJ]?

NJ: I have two, I have imaginative and competitive

Interviewer: which one would you like to do first?

NJ: imaginative

Interviewer: okay, so how important is it to be imaginative if you work in STEM?

Cupcake: well –

NJ: it's quite important because you could think of something before you go there, or do something, you could plan something, or you can just have good thoughts of something that might happen

Interviewer: ah okay, so you could imagine…

NJ: that it's going to go well

Interviewer: okay, so which number do you think it belongs under?

NJ: in between three and four

Child: five

Interviewer: does everybody agree?

Girls: yeah

NJ: three or four

Interviewer: okay, what have you got there [Cupcake]?

Cupcake: I've got two

Interviewer: shall we do one of them?

Cupcake: so practical

Interviewer: yep, which number do you think that one belongs with? Do you know what practical means?

Cupcake: yeah

Interviewer: shall we read it off the thing?

Cupcake: good with their hands, good at doing practical tasks like experiments

Interviewer: what do you reckon, how important is that?

NJ: that's one again

Girl: one

Girl: yeah, one

Interviewer: one?

Children: one again

Interviewer: okay, and what have you got there [Blossom]?

Blossom: I think we've already had this

Interviewer: oh did that one just get knocked off?

Blossom: yeah

Interviewer: sensible, where did we think one that went before?

Blossom: that would be one

NJ: it went down the middle probably

Interviewer: oh did it go here?

NJ: it probably went down the middle

Interviewer: do we all still think it goes there?

Children: yeah

Interviewer: okay, go on [Skull Trooper]

Skull Trooper: I've got reliable

Interviewer: what does reliable mean?

Skull Trooper: two, two, two

Blossom: I've found it!

Interviewer: go on

Blossom: always does what they have promised and can be trusted

Interviewer: how important is that if you work in STEM?

Skull Trooper: two

NJ: three

Skull Trooper: two

NJ: three

Skull Trooper: two and a half

Interviewer: okay, so you think two, you think maybe two and a half – what do you guys think?

NJ: I would say three but then [Skull Trooper's] saying two, so let's just go two and a half – the easiest way

Girl: yeah, two and a half

Interviewer: do you guys all agree?

Children: yeah

Interviewer: okay, thank you [Skull Trooper]. And have we got any more words?

NJ: yep

Interviewer: go on [NJ], what have you got?

NJ: [to Blossom] you can go first

Interviewer: you sure? Okay

Blossom: curious

Interviewer: curious

Blossom: I don't know – curious is up here [on the glossary]

Interviewer: okay, what does curious mean?

Girls: keen to learn something new

Blossom: yeah, that would go one and a half

Cupcake: I would say one

Blossom: one and a half

Interviewer: one, one and a half – what do you guys think?

NJ: I would say one and a half

Skull Trooper: I'd say three

Girl: three?!

Skull Trooper: two

Cupcake: I think two

NJ: I would say two

Cupcake: two, some people are saying three and I was going to say three just then, but then if they're saying one and a half –

NJ: two, because that's in the middle

Interviewer: okay, do you agree with that – or do you still think?

Cupcake: I still think one and a half, maybe even one

Interviewer: you still think really important?

NJ: two, I'm going two

Cupcake: I'm going one and a half

NJ: one and a half, just go one and a half

Interviewer: okay one and a half – cool! And then have we got one more left? What was the last one?

NJ: competitive

Interviewer: competitive, what does competitive mean?

NJ: it means you're always eager to win

Cupcake: yeah

Interviewer: always eager to win

Cupcake: that's less [NJ], that's a five

Blossom: yeah, you don't really need to be competitive – you can do it as slow or as fast as you want

NJ: yeah that's five

Cupcake: it doesn't really matter

Interviewer: okay, does everybody agree with that?

Children: yeah

Interviewer: brilliant, okay. Thank you so much guys. Do you mind if I take a picture of this?

Children: yeah

Interviewer: so could you please pause the recording for a second [NJ]?

[paused for photo of word arrangement]

Interviewer: thank you [NJ]. So, one last activity and this one needs to be a little bit quicker, because [Teacher] is going to need us to go back to the classroom soon. Can you – and I've got other versions of the words so if you want to use the same words, that's okay because I've got other copies. Can you guys look through all of these words and choose five that you think *best* represent you?

Child: me?

Interviewer: So what sums you up best? And as I said, if there are any that you want to share, I've got other packs of the words

Child: enjoys sports

NJ: can use a computer – I can use a computer!

Skull Trooper: where's the computer games? [NJ], don't tell me you've got the computer games -

Girl: wants to understand how things work

Skull Trooper: – I'm taking that!

Cupcake: I need one more

Blossom: I need two more

Skull Trooper: I've got mine

Cupcake: I've got mine

NJ: I've got

Skull Trooper: [NJ] look, I've got the best ones

NJ: have you got five [Skull Trooper]?

Cupcake: I've got five

Interviewer: is everyone happy that they've got the words that best represent them?

Blossom: I need one more

Interviewer: okay, we'll give you a couple more minutes to have think about that

Boy: two more minutes

Blossom: I'm going to say this

Interviewer: yeah? Okay, are we all happy that we've got all the words?

Children: yes

Interviewer: okay, so can we please go round the table and tell everyone, which words you have and why you've chosen them? Can we start with –

NJ: [Skull Trooper], [Cupcake]?

Interviewer: who would like to start?

Skull Trooper: I will then

NJ: [Cupcake]

Interviewer: Two people want to start?

NJ: [Cupcake], because [Skull Trooper's] started all the time

Blossom: I would say [Cupcake]

Interviewer: Is that okay if [Cupcake] starts [Skull Trooper]?

Skull Trooper: yeah

Interviewer: okay, thank you, go on [Cupcake] – what have you got?

Cupcake: my first one is enjoys dance

Interviewer: enjoys dancing – why have you chosen that one?

Cupcake: I just like dancing

NJ: I was going to choose that one

Interviewer: you can have that as well if you want

Cupcake: comes up with lots of new ideas

[other children talking]

Interviewer: are you listening to what [Cupcake] has to say?

Cupcake: because sometimes I work – well, I work with my [friend] she sits next to me and also [child] – and I also help her and I also help [Blossom].

Interviewer: okay, so you help them to come up with new ideas?

Cupcake: yeah, and help them answer questions

Interviewer: ah okay

Cupcake: then creative – I like drawing and painting

Interviewer: okay, brilliant. What else?

Cupcake: I like shares information with others

Interviewer: can you explain that one to us?

Cupcake: I don't know, but I like telling people what I've researched and what I've found out

Interviewer: lovely, okay

Cupcake: enjoys history [long pause]

Interviewer: okay cool, and you just like history?

Cupcake: mmm

Interviewer: okay, brilliant – thank you. [Skull Trooper] since you waited so patiently, would you like to tell us your words?

Skull Trooper: well curious. I am quite curious sometimes about – when – because my mum always hides stuff, not *hides* hides stuff, but she hides stuff from me what happens to her and then she just cries at the end of the day and I'm like "what's wrong?" and she just doesn't tell me anything

Interviewer: ah, so you're curious to find out?

Skull Trooper: yeah

Interviewer: okay, what other words have you got?

Skull Trooper: I do learn from my own mistakes, because a lot of the time, I do make a lot – well not a lot but – a couple of mistakes with my English because English isn't really what I'm good at

Interviewer: okay. But when you make those mistakes?

Skull Trooper: yeah

Interviewer: you're able to learn from them?

Skull Trooper: yeah

Interviewer: Okay

Skull Trooper: I like helping others, because when I was in London once, with my friend – me and my friend were sleeping and then we woke up and then that night we went to have a pizza in Pizza Hut

Interviewer: lovely

Skull Trooper: and then we saw a homeless guy outside

Interviewer: yeah

Skull Trooper: and then when we saw him, we gave him a slice of pizza

Interviewer: that was nice of you

Skull Trooper: yeah we helped him

Interviewer: okay, brilliant and what were your other words? Have you dropped one?

Skull Trooper: likes playing computer games

Interviewer: okay, which computer games do you like?

Skull Trooper: fortnite

Interviewer: fortnite? Everyone likes fortnite! Do you guys all like fortnite?

NJ: yeah

Cupcake: I like Roblox

Blossom: I don't like any of them

Interviewer: you don't like any of them?

Blossom: no

NJ: I love fortnite, I love fortnite

Interviewer: and what was your last word? Have you dropped it? Oh, you've got it

Skull Trooper: honest. I like to be honest a lot, but sometimes I just get bored and then when I get bored I get, I don't get hungry and then my mum's like "do you wanna eat?" and I'm like "no" but I do

Interviewer: okay

NJ: you're hangry?

Skull Trooper: I just don't feel like eating, but I am hungry

Interviewer: okay

Blossom: yeah, that's what happens to me sometimes

Interviewer: sometimes you just don't fancy anything to eat?

Skull Trooper: when I feel ill I don't want to eat at all

Interviewer: yeah, if you feel poorly? Fair enough, and can you tell us any more about being honest?

Skull Trooper: I sometimes do not be honest with my mum, not my mum, my friend – my best friend because sometimes – not sometimes – he never [is] honest with me

Interviewer: okay, so you think it's important for people to be honest with each other?

Skull Trooper: yeah

Interviewer: okay

Skull Trooper: I'm like if he [isn't] honest with me, then why should I be honest with him though?

Interviewer: but it's important to be honest, even if someone isn't with you, it's always good to know that you did the right thing

Skull Trooper: yeah, I am being honest though

NJ: I'm the same

Interviewer: thank you very much for sharing those with us [Skull Trooper]. Who would like to talk about their words next

Blossom: [NJ] can

NJ: okay, can I [have] that word there. I really like maths

Interviewer: okay

Skull Trooper: wait [NJ], did you have the mathematic one?

NJ: I enjoy maths because I just find it the funnest bit of [what] I can do in school

Interviewer: okay

NJ: and then I enjoy sports because I do rugby, football and tennis

Interviewer: that's a lot of sports!

NJ: yeah, and I play a year in football, so I play under tens. I like being outdoors, because I like camping, I like making – I've got a caravan in west Wales and there's activities you can book in the pool

Interviewer: uh huh

NJ: I always book the outdoor one

Interviewer: oh cool

NJ: and we've got a ranger who does wild cooking, and I've always done wild cooking, camping

Interviewer: that sounds really interesting

NJ: and then, I can use computers because my dad taught me how to code last year

Interviewer: ah cool okay

NJ: and then I enjoy dancing because I used to do hip hop, street dance, break dance

Skull Trooper: I used to street dance

Interviewer: you do street dance as well?

Skull Trooper: I used to do street dance and break dance

NJ: I used to do it for Cardiff, but now I've stopped

Interviewer: you're a very active person aren't you?

Cupcake: my friend does

Interviewer: You do all sorts!

Skull Trooper: I go to [NJ's] rugby too

Interviewer: oh you guys play rugby together? If you'd seen enjoy sport, would you have put that one your one maybe?

Skull Trooper: yeah

Interviewer: are there any others of those that you would have chosen [Skull Trooper]?

NJ: enjoy maths, he would have chosen

Skull Trooper: all of them – I would have chosen all of them, I would take one out [of NJ's?] and put computer games in

Interviewer: okay

NJ: because it wasn't on here, I wanted to say I really enjoy playing the piano and drums

Interviewer: ah I didn't put a musical one in did I?

NJ: because I play piano and drums

Cupcake: I play guitar

Blossom: I play flute

Cupcake: I'm the best in my group

Interviewer: I should put a musical one in shouldn't I? Thank you for telling me about that, I'll think about that one for next time

NJ: because in my house, I've got a piano and a drum kit

Child: You've got a piano?!

Interviewer: okay, are we ready to listen to which words [Blossom] chose?

Blossom: can work independently

Interviewer: Yeah okay

Blossom: because I don't really like people copying me. I like –

NJ: you like keeping your answers

Blossom: yeah

Interviewer: okay

Skull Trooper: I tell [friend] my answers a lot, when I do clockwork and time

Interviewer: are we listening to the ones that [Blossom] is telling us about?

Blossom: wants to understand how things work

Interviewer: oh yeah? Can you tell us more about that?

Blossom: because I really like [pause] because

Interviewer: do you want to tell us more about that one at the end? Do you want to come back to that one?

Blossom: yeah

Interviewer: okay

Blossom: now I've got enjoy drawing

Interviewer: enjoys drawing, yeah

Blossom: because my friends have got really good drawing, but I think I've good drawing as well, but I don't know

Interviewer: okay, that's fine

NJ: Do you want to be as good as them? And you want to be better than them?

Blossom: no!

[children talk over each other]

Interviewer: and what's the next word that you chose?

Blossom: hard work

Interviewer: hard working yeah?

Blossom: because I always work hard, but I help people as well with my work

Interviewer: okay, lovely – what was your next one?

Blossom: like to try new things

Interviewer: okay?

Blossom: I really want to be a scientist when I grow up because I really like to try new things

Interviewer: okay – and did you want to tell us more about 'wants to understand how things work?'

Blossom: yep

Interviewer: yeah?

Child: maybe computers or something?

Blossom: yeah – I really want to know how things work, how computers work

Interviewer: ah okay, thank you so much for sharing all of that with me guys. Is there anything else that anyone wants to add before we stop the recording?

[children decline]

36 Appendix 24: Pupil task-based interview 1, BG

Title: Pupil interview 1

Date: 3rd December 2018

Speakers: Poppy Hodkinson (interviewer), Pasta, Videogame Guy, Blackjack and Buster

Interview duration: 36 Minutes

Interview location: BG

Interviewer: Which are some of the words here that you think are the most important for people working in STEM?

Pasta: enjoys science

Interviewer: enjoys science okay

Blackjack: sensible?

Interviewer: sensible, why do you think sensible? Oh, and I've got a list here of what some of the words mean, if you're not sure

Pasta: creative

Interviewer: creative, so shall we talk about creative in a second – why sensible?

Blackjack: because if you [are] silly, something could go wrong

Interviewer: okay, and why creative [Pasta]?

Pasta: because science is creative

Interviewer: ah okay, what about science is creative?

Pasta: [pause]

Interviewer: do you want to have a think about it?

[Pasta indicates yes]

Interviewer: Okay. Are there any other words on there that you think are important for somebody who works in STEM?

Pasta: enjoy maths

Interviewer: enjoy maths? Why is that one important?

Blackjack: because if they don't, they basically won't enjoy STEM, because there's maths in STEM

Interviewer: okay

Pasta: enjoys history and can work in a team

Interviewer: okay, can you explain those ones to us?

Pasta: when you're doing science, you can work as a team?

Interviewer: okay [pause] and enjoys history, why's that one important?

Pasta: actually, it's not important

Interviewer: oh, you've changed your mind? You don't think it is?

[teacher comes in with other participants]

Interviewer: oh, hi Miss!

Teacher: hello!

Interviewer: do you want to pause [the recording] a sec [Blackjack]?

[discussion about workshops that will take place later in the day]

Interviewer: [to new participants] hey guys, do you want to come and sit down? So we've actually started without you, because we weren't sure if you knew you were coming or not. So my name is Poppy, what are your names?

Buster: my name is [Buster]

Interviewer: hi [Buster

[recording cuts out for a few minutes, while interviewer explains the task]

Interviewer: okay, so some of the words that we thought might be quite important are these ones here. Could you tell us what they were [Pasta]?

Pasta: enjoy maths, enjoying science, creative, sensible and can work in a team

Interviewer: do you guys agree – what do you think about that?

Buster: I think that's okay

Interviewer: you're happy with that?

Videogame Guy: I think they're important for STEM

Interviewer: okay, shall we have a think about some of the other words. Are there any other words on here that you think might be important for someone who works in STEM?

[pause]

Interviewer: [turning cards] shall I turn some of these around for you?

[long pause]

Interviewer: okay [Pasta], what's this one?

Pasta: likes learning languages

Interviewer: okay, and what do you think is important about that? Can you explain?

Pasta: you can learn different languages?

Interviewer: uh huh

Pasta: and [pause] I don't know

Interviewer: okay, that's fine – you can tell us more in a second. Go on [Buster]

Buster: I've got reliable

Interviewer: reliable, okay so why is it important that someone who works in STEM is reliable?

Buster: if someone says to look after the bones

Interviewer: uh huh

Buster: then if you stayed then that means you're reliable, but if you went and [did] something else, then that's not being reliable

Interviewer: okay, so it's doing the things you said you were going to do? Okay, shall we pop that on there? What have you got there [Videogame Guy]?

Videogame Guy: can use computers

Interviewer: oh, can you explain that one to us?

Videogame Guy: well, because of the T is technology

Interviewer: yeah?

Videogame Guy: and technology is computers, and to be able to use technology, one of those things are to be able to use computers

Interviewer: okay, thank you. Do you guys agree?

Pasta: yeah

Interviewer: in fact, shall we say – at the moment, we've just got a load of words that we think are important, shall we – I've got some numbers here, and some of the other children that I worked with have put them as: one is the most important, and then five is the least important, and then they're ranked them as how important they think they are. Shall we do that?

Child: okay

Interviewer: so on there, which of the words that we've chosen already that we think are important, so where do you think can use computers would go? Is it most important, quite important, a bit medium, not very, or really really not important?

[pause]

Videogame Guy: I think it goes here

Interviewer: okay, so kind of a bit important – middle of the road? Okay, fab. So where do you think sensible should go [Pasta]?

[pause, Pasta places card in 2 column]

Interviewer: what do you guys reckon, are you happy with that on 2? Okay fab, which other ones have we got there?

[pause]

Interviewer: reliable? Okay, where do you think reliable should go [Buster]?

[pause]

Interviewer: on one? Does everyone think that reliable is the most important thing?

Pasta: it's not really

Interviewer: what do you reckon guys?

[pause]

Interviewer: Is everyone happy with reliable going on number one?

Child: yes

Interviewer: yeah? You all happy with that? So you just likes learning languages on four, can you explain that one to us?

Pasta: I can't think of it

Interviewer: you can't really think of it, but you don't think it's that important?

Pasta: yeah

Interviewer: okay, and you put clever on number five, can you explain that one to us?

Pasta: it's about clever of science and maths

Interviewer: okay, five is not very important, and you think it's not very important. Could you explain why you think that?

Pasta: because you don't have to be clever

Interviewer: okay, what do you guys reckon? Everyone happy with that?

Children: yeah

Interviewer: okay, what else have we got here? Which other ones do we think are important?

Blackjack: enjoys science

[phone rings]

Interviewer: oh that's an interesting sound

Blackjack: sounds like a phone

Interviewer: it does, doesn't it? Maybe there's a phone in one of those bags? Okay, so what have we got here? Can work in a team, and you've put that at number one, what do you guys reckon?

Blackjack: yeah

Interviewer: yeah? [Videogame Guy] can you explain why you think it's number one?

Videogame Guy: no, I can't

Interviewer: okay, and enjoys maths on number four, why do you reckon that is?

Buster: because you don't need to be good at maths, to do it

Interviewer: okay, and then did you just put one on as well [Blackjack]? Did I see you put one on? Enjoys science, you think that goes on number one?

Blackjack: yeah

Interviewer: could you explain that for us?

Blackjack: because that's mostly what you're going to be doing

Interviewer: if you work in science?

Blackjack: and [pause] yeah I don't know

Interviewer: okay, thank you. And creative on number 1 as well [Pasta]? Could you explain that?

Pasta: because you can be creative, very creative when doing science, maths and [pause]

Interviewer: and the rest of it?

Pasta: yeah

Interviewer: thank you, and what does everyone else think? Happy with that? Because we're allowed to disagree with each other, so if there's one that you think, actually I'm not sure about that – you can have a chat about it and say "actually I'm not happy about that" and you can talk about why you think that. Which one have you got there [Buster]?

Buster: I've got honest

Interviewer: honest, brilliant. Okay, so where do you think honest goes?

Buster: there

Interviewer: on two, cool – how come?

Buster: because [pause]

[teacher enters room to deliver completed questionnaires]

Buster: because if you're not honest, then you might get into trouble.

Interviewer: okay, are there any other words that you think are important if you work in STEM? If you're a scientist, or you work with technology, or an engineer or a mathematician. What other words have we got on there?

[pause]

Interviewer: are there any others on here?

[pause]

Interviewer: okay, [Videogame Guy] learns from their mistakes on number two – what does everybody think about that?

Blackjack: yeah

Interviewer: yeah? What were you thinking about when you put learns from their mistakes on number two?

Videogame Guy: because if you made a mistake, in science

Interviewer: yeah

Videogame Guy: then you'd know not to do it again, because it could be dangerous if you did it again

Interviewer: okay, great thank you. What other words have we got on here? What do we think about some of these?

[pause]

Interviewer: yeah [Buster]? Gets all of the answers right = number five. Could you explain that to us?

Buster: because you don't need to get all the answers right, if you got an answer wrong then you can have another go

Interviewer: absolutely, yeah brilliant. Hardworking, number 2 [Pasta]?

Pasta: actually, that's going on number five

Interviewer: you want to put it on number 5? You don't think it's important to be hardworking? How come? What does everybody think about that one?

Pasta: because you don't have to be hardworking

Interviewer: you don't have to work hard? Does everyone think that?

Buster: I think it should go there or there

Interviewer: you think three or two – what do you guys reckon?

Blackjack: yeah, two or three

Interviewer: yeah? Do you want to talk about why you think that?

Blackjack: because – I'm not sure, but I think it should just go on number three

Interviewer: you think number three because everyone isn't quite sure, because we've got some different opinions?

Blackjack: yeah

Interviewer: you happy with that [Pasta]? For it to go on number three?

[Pasta indicates yes]

Interviewer: okay, thank you. What one have you got there [Blackjack]?

Blackjack: comes up with lots of new ideas

Interviewer: ooh okay

[teacher enters]

Interviewer: hello miss!

[discussion about workshop that will be taking place that day]

Interviewer: comes up with lots of new ideas, what do we think about that one guys?

Blackjack: I think it should go on number 4

Interviewer: number 4? What does everybody else think?

Pasta: number three

Videogame Guy: number three

Interviewer: number three? Why do we think that?

Videogame Guy: because you don't need to [pause] come up with lots of good ideas, but you don't have to always, but it would be good to?

Interviewer: okay, what does everybody else think?

[pause]

Interviewer: what did you think [Blackjack]? when you picked it up?

Blackjack: yeah, I was thinking… [indicates 3]

Interviewer: you were thinking three?

Blackjack: yeah?

Interviewer: does everybody agree on three? Is that what you thought?

Child: yep

Interviewer: cracking, okay. What have you got there [Buster]?

Buster: I've got listens to other people's opinion

Interviewer: ah listen to other people's opinions. What do we think about that one?

[pause]

Interviewer: very important? A bit important? Or not at all important? What do we think?

Pasta: I think number three or two

Interviewer: okay

Blackjack: I agree with [Pasta]

Interviewer: okay? What do you reckon?

Videogame Guy: yeah

Buster: I think it's number three

Interviewer: number three, okay. Is everybody happy with that one? Why do we think it's number three?

Buster: because you can listen to other people's opinions

Interviewer: uh huh

Buster: but if you think that something's a really good idea then you don't *need* to

Interviewer: okay. What other words have we got? What other words do you think should go on there?

[pause]

Interviewer: is there anything else on there, or any of these other words that you think are really important? Or maybe *aren't* really important? Are there any that you look at and you think "that's not important *at all*"?

Blackjack: not that, that one is not important

Interviewer: enjoys dancing? You think not important? Does everyone agree?

Videogame Guy: not at all important

Interviewer: not at all important [laugh] okay. It's nice to enjoy dancing

Blackjack: but you're not going to be doing it

Interviewer: maybe, not if you work in a laboratory, you might not be doing that much dancing

Blackjack: [laughs] yeah

Interviewer: okay. What have you got there [Blackjack]?

Blackjack: likes visiting other countries

Interviewer: oh okay, what do you reckon about that one?

Blackjack: [pause] four?

Interviewer: what does everybody else think?

Pasta: yeah

Buster: yeah

Interviewer: yeah? A bit? Why might it be a little bit important, but not really that important?

[pause]

Interviewer: that's okay, just put it on – does everyone think it goes on four?

Child: yeah

Interviewer: And just then we had likes to learn new things put on three. Why do we think that that [goes on that] one? Does everyone agree with that one? Likes to learn new things? A bit important?

Child: yeah

Interviewer: yeah? Why do you think it's not very important? What made you put it on three

Pasta: because you probably wouldn't like to learn new things or you might want to learn new things

Interviewer: okay, so it could be either and you'd still be able to do your STEM job?

[Pasta indicates yes]

Interviewer: okay, and we've got enjoys history on three as well, what did you think about that one [Videogame Guy]?

Videogame Guy: I just think it should go on three

Interviewer: what does everybody else think? [pause] Happy with that? Fab, okay what have you got there [Blackjack]?

Blackjack: artistic

Interviewer: artistic. Okay where do you reckon that one goes guys?

[Pasta gestures 2]

Interviewer: on number two? Okay, why's artistic on number two if you work in STEM?

Blackjack: because [pause]

Interviewer: does anybody else think anything about that one?

[pause]

Interviewer: are you all happy with it on number two? Yeah? Okay, what have you got there [Buster]?

Buster: organised

Interviewer: organised, okay how important is being organised?

[Buster indicates 4]

Interviewer: number four? Okay – how come you've put it on there?

Buster: because you can be organised, but you don't need to be organised all the time

Interviewer: all the time? So sometimes you can be a bit less organised? Okay, does everyone agree with that one?

Child: uh huh

Interviewer: [Pasta] just put can work independently on number 2, what do we think about that one?

[pause]

Interviewer: working by yourself, is that quite important?

Pasta: actually, definitely not

Interviewer: you don't think it's important at all? I wasn't asking because I thought you were wrong, I just was interested to know why you thought that. But you've changed your mind? You don't think you need to work independently?

[Pasta is quiet]

Interviewer: what does everybody else think? Do you think working independently is not at all important if you work in STEM?

Child: no

Interviewer: do you think something different?

Blackjack: I think number four

Interviewer: you think number four, [Videogame Guy] what do you reckon?

Videogame Guy: number four

Interviewer: number four. [Buster]?

Buster: yeah

Interviewer: yeah? What do you reckon [Pasta]?

[Pasta indicates no]

Interviewer: so you don't think it's massively important? Okay fine. Competitive number five, can you explain that for us [Buster]?

Buster: because if you're competitive then that means you can't work in a group

Interviewer: ah okay, so you think being competitive would make it hard to work in a team?

Buster: yeah

Interviewer: okay, and curious on number 2 [Videogame Guy]? Is everyone happy with curious on number two?

[pause]

Interviewer: what *is* being curious? We've got it written down there

Blackjack: it's keen to learn something new

Interviewer: okay, and that's number two? Is everyone happy that it's quite important?

[children indicate yes]

Interviewer: Okay, fab. Would you like to choose another one [Pasta]? Is there any on here that you think you'd like to do?

[Pasta indicates a card]

Interviewer: can take risks, number four, okay. Is everyone happy with that?

Children: yep

Interviewer: okay, go on [Buster]

Buster: I think methodical can go on [pause] I'm not sure which one it can go on

Interviewer: you're not sure about that one? Okay, so we've just had enjoys drawing put on number five. What does everyone reckon for that one? Happy with that?

Pasta: number five I think

Interviewer: you agree number 5? Okay and methodical, what do we think about that one? So what does methodical mean? We've got it on here

Buster: it means follows a set of instructions carefully

Interviewer: okay and what do we think about that then? How important is it to be able to follow instructions carefully?

[Buster indicates 3]

Interviewer: three?

Buster: yeah

Interviewer: everyone happy with that? And [Pasta] which one did you just put on number four there? Enjoys building things. What made you choose number four?

Pasta: enjoying, sorry, no no no

Interviewer: no? oh, number one! Okay, what makes you put it on number one?

Pasta: because you could enjoy building more buildings?

Interviewer: oh yeah, that would be what an engineer does wouldn't it? What does everyone else think, happy with that?

Children: yes

Interviewer: okay, what have you got there [Buster]?

Buster: enjoys reading

Interviewer: okay, enjoys reading – how important do you think enjoys reading is?

Buster: I think it's not very important

Interviewer: okay, what does everybody else think?

Pasta: yeah

Interviewer: okay, happy with that?

Videogame Guy: actually, it should go there

Interviewer: why do you think that [Videogame Guy]?

Videogame Guy: because you could read about things to learn about stuff?

Interviewer: okay, is everyone happy with that?

[children indicate yes]

Interviewer: fab, what other words have we got there? What word have you got there [Pasta]?

Pasta: I didn't pick that one

Interviewer: you didn't pick that one, it's just ended up by you?

Pasta: yep

Interviewer: okay, shall we have a think about that one? Resourceful, what does that mean?

Children: [reading from glossary] finds quick clever ways to get things done or to make things easier

Interviewer: okay, what do we reckon about that one?

Videogame Guy: I think here

Interviewer: number two, what does everybody else think? Do you agree?

[children indicate yes]

Interviewer: fabulous, which other words have we got? We've not got many left now, shall we go through them?

[child indicates card]

Interviewer: enjoys sport, number five – does everyone agree with that?

Pasta: likes to try new things?

Interviewer: likes to try new things? What do you reckon for that one? How important is that one?

[children indicate 'medium']

Interviewer: medium, okay and discusses ideas with others – so you think that's a two? Quite important. What do you guys reckon?

[pause]

Interviewer: discussing ideas with others? How important is that if you work in STEM?

[pause]

Blackjack: yeah

Interviewer: two? Okay cool, which one have you got there [Buster]?

Buster: reflective

Interviewer: reflective, what does reflective mean?

Buster: can look back on work and think about what went well and what can be improved

Interviewer: okay, and how important is that for someone who works in STEM? To be able to look back on their work and think about what they've done?

[Buster indicates 1]

Interviewer: number one? Oh that's a different one, that says likes helping others. Is that the one you meant to put there?

Buster: no

Interviewer: did you mean to put that one? So reflective, number one. Sorry [Buster] what were you going to say?

Buster: because… it should be there because if you done a mistake in the past, then you can reflect on that and say what went well, and next time you could do something better

Interviewer: great, okay. And we've got inventive on one as well now – what made you choose that one [Pasta]?

Pasta: because it's comes up with new ideas to solve puzzles or design new things

Interviewer: and you think that's really important? What does everybody else think?

Blackjack: yeah

Interviewer: happy? Fab okay, have you got one over there [Blackjack]? which one have you got over there?

Blackjack: careful

Interviewer: careful, okay. How important do we think that one is?

[pause]

Interviewer: where do you reckon that one goes?

[pause]

Interviewer: careful on number two?

Blackjack: yeah

Interviewer: okay, and you've just put likes helping others on number two as well [Videogame Guy]. Does everyone think that one's appropriate?

[children indicate yes]

Interviewer: yep? Okay, which one have you got there [Buster]?

Buster: determined

Interviewer: determined, okay what does determined mean?

Buster: it means doesn't give up, even if things become difficult

Interviewer: okay, so how important is it to be determined if you work in STEM? Or if you're doing STEM?

[Buster indicates 2]

Interviewer: number two, could you explain why you thought that?

Buster: because if you're not determined then that means you'll just give up, but if you're determined then you'll try it again

Interviewer: okay

Videogame Guy: like if you're doing science

Interviewer: yeah?

Videogame Guy: and you're determined to do the experiment

Interviewer: mhmm

Videogame Guy: or something

Interviewer: okay

[pause]

Interviewer: which other words have we got now? What do we reckon for… go on [Blackjack], which one's that?

Blackjack: like being outdoors

Interviewer: what do you reckon for that one?

Blackjack: they might be building a house, when they're an engineer, so they might

Interviewer: yeah, well if you're building a house, you're definitely outdoors aren't you? What do you guys think?

[child indicates 2]

Interviewer: Number two?

Child: yeah

Interviewer: yeah? Happy? Fab, we've got likes computer games – number five?

[children laugh]

Pasta: nah

Videogame Guy: yeah

Pasta: you do not need to do that!

Interviewer: okay, and then imaginative, which one's imaginative? Number three? Does everyone agree with that one?

Blackjack: yeah

Interviewer: yeah? Why do you think imaginative is number three guys?

[pause]

Buster: because if you're an engineer then you have to be imaginative about what you make

Interviewer: ah great, yeah okay. And which one have you got there [Videogame Guy]?

Videogame Guy: shares information with others

Interviewer: what do we think about that one guys? Number one? What does everybody think? What do you reckon [Pasta]?

Pasta: yeah

Interviewer: yeah, number one? You've put number 2 [Videogame Guy] – what do you think [Buster]? Shares information with others?

Buster: I think [pause]

Interviewer: is it most important, a bit important…? Kind of medium?

Buster: I think it should go on two

Interviewer: you think it should go on two? So that's three votes for two? Or two votes for two.

Children: two

Interviewer: okay, so whose going to decide which one it goes on? Two or one?

Pasta: two

Interviewer: two?

Children: two

Interviewer: are you happy with it on two?

Buster: yeah

Interviewer: and what's that one there?

Buster: encourages others

Interviewer: encourages others. Where does encourages others go everyone?

Buster: on number three

Interviewer: okay. Happy with that everybody?

[children yawn]

Interviewer: is everyone a little bit sleepy?

[children laugh]

Interviewer: okay, is that two more now? Just two left. What are the last two?

Blackjack: practical

Interviewer: uh huh

Blackjack: and wants to understand how things work

Interviewer: okay, what do we reckon about those ones guys?

[pause]

Interviewer: do we know what practical means?

Buster: no

Interviewer: let's have a look

Buster: good with their hands, good at doing practical tasks like experiments

Interviewer: oh okay, so how important is it to be practical?

[pause]

Interviewer: to be good at working with yours hands and doing practical tasks?

[pause]

Interviewer: any thoughts?

Buster: there

Interviewer: two? Everyone happy with that? Brilliant. And the last one [Pasta], go on – what do you reckon for the last one? Wants to understand how things work

Pasta: I don't know

Interviewer: you don't know? What does everybody else think?

Buster: I think it should go on number one

Interviewer: number one?

Videogame Guy: I think it should go on number three

Interviewer: okay, do you want to explain your thoughts on that? Why do you think number one?

Buster: because if you're working with a machine, then you have to know how to work it

Interviewer: okay, and what did you think [Videogame Guy]?

Videogame Guy: I think one now

Interviewer: you think one now as well? Okay. So have we done all of them now?

Children: yep

Interviewer: is everyone happy with the placement of all of those?

[Children indicate yes]

Interviewer: is it okay if I take a picture? So I can remember them later – which order we put them in.

Children: yeah

Interviewer: yeah? Okay

[recording is paused while photo is taken of word sort]

Interviewer: okay, so we're just going to do one last thing now guys – if that's alright? Are we all still happy? Are you happy [Pasta]?

[Pasta indicates yes]

Interviewer: okay, good

[children laugh]

Interviewer: okay so for the last activity, we've thought about all the different skills that you think are important for somebody working in STEM, but I wondered if you guys could choose five words that you think describe yourself.

Child: ooh

Interviewer: And if there's one card that two people want, that's okay because I've got spare cards. So you can have the same answers if you want to. Okay?

[children mumble]

Interviewer: so if you choose five words that you think best describe yourself.

Pasta: I know which one, I know which one

Blackjack: clever

[pause while children consider and select cards]

Interviewer: you got five? Fabulous. You've got five? Brilliant, thanks guys.

[pause while children continue to select cards]

Interviewer: And have you got five now [Buster?

Buster: I need one more

Interviewer: you just need one more? Okay. Lovely, is it okay if we go around the table and tell everybody what we've chosen and why we've chosen it? Who would like to start?

[boys hands up]

Interviewer: your hand went up a *little* bit faster [Pasta], shall we start with you? Is that alright [Videogame Guy]? Go on [Pasta]

Pasta: comes up with lots of new ideas, can work in a team, learns from their mistakes, enjoys science, can use computers.

Interviewer: fabulous, and why did you choose those words? Can you tell us a little bit about that?

Pasta: because when you're stuck you can come up with lots of ideas using the computer

Interviewer: oh okay, so you would use those together? Brilliant

Pasta: if you made a mistake, you can call your friends to come and help you

Interviewer: ah okay, so that's work in a team and learn from your mistakes? Okay

Pasta: and I enjoy science

Interviewer: you just like science? Fab okay, thank you. [Videogame Guy] would you like to go next?

Videogame Guy: I have enjoys maths, sensible, likes being outdoors, enjoys drawing, likes computer games

Interviewer: fab, and why did you choose those ones?

Videogame Guy: enjoy maths because I do

Interviewer: okay

Videogame Guy: sensible, because I think I'm quite sensible

Interviewer: okay

Videogame Guy: likes being outdoors, because I like to play with my outdoor toys

Interviewer: okay

Videogame Guy: outside

Interviewer: what kind of outdoor toys do you have?

Videogame Guy: balls, cones [pause] something that's still up is stuff to play 'the floor is lava'

Interviewer: ooh that sounds like a good one

Videogame Guy: you have to jump over them

Interviewer: oh okay, and the other words?

Videogame Guy: enjoys drawing, because I like drawing

Interviewer: yep

Videogame Guy: likes computer games because I like computer games

Interviewer: brilliant, thank you. Is there anything else that you want to say about that?

Videogame Guy: …no

Interviewer: no? Cool, okay. Who would like to go next? Okay [Blackjack]

Blackjack: like helping others

Interviewer: okay

Blackjack: clever

Interviewer: okay

Blackjack: imaginative

Interviewer: yep

Blackjack: artistic and enjoys dancing

Interviewer: lovely, okay and can you explain why you chose those words for us?

Blackjack: artistic because I really like making things

Interviewer: okay fab

Blackjack: [pause] I don't know why clever [laughs]

Interviewer: okay, that's fine

Blackjack: [pause] if someone's stuck, I don't know why, but I just like to help them

Interviewer: okay, so you like helping others

Blackjack: yeah

Interviewer: fab

Blackjack: sometimes I think of very good things, so…

Interviewer: so imaginative?

Blackjack: yeah. I don't know why, I just like dancing

Interviewer: you just like dancing, okay brilliant thank you. Could you tell us about your words [Buster]?

Buster: creative, organised, inventive, reliable and enjoys reading

Interviewer: okay, fab. And why have you chosen those words?

Buster: creative because I like drawing and doing, and making stuff

Interviewer: okay

Buster: organised because I'm very neat

Interviewer: okay

Buster: my bedroom's very neat and organised

Interviewer: brilliant, okay

Buster: inventive because – I'm not sure why

Interviewer: okay

Buster: reliable because [pause] if my parents ask me to do something then I would do it.

Interviewer: okay

Buster: enjoys reading because I just like reading

Interviewer: you just like reading? Okay, fab. Thank you so much guys. Is that everything that everybody wanted to say? Is there anything else that you wanted to let me know before you go? Any other thoughts about STEM or about the words we've chosen?

Blackjack: no

Interviewer: no? everybody happy?

Children: yeah

Interviewer: wonderful, okay so we can pause that recording now [Buster]

37 Appendix 25: Pupil task-based interview 1, BF

Title: Pupil interview 1

Date: 6th December 2018

Speakers: Poppy Hodkinson (interviewer), Black Cat, Olivia, Bluebell, Bumble

Interview duration: 44 Minutes

Interview location: BF

Interviewer: So we've got lots of words here that I'm going to lay out on the table. And do you remember what we were just talking about in the classroom?

Black Cat: STEM

Interviewer: STEM, what does STEM stand for again?

Children: science, technology, engineering and mathematics [some say maths]

Interviewer: you can say maths or mathematics, that's fine

Black Cat: mathematics and engineering

Interviewer: brilliant, okay. So I mentioned that you might want to use STEM in your job when you're older, and some people might do jobs in STEM now. Can you think of any people who might do a job in STEM? So they might work in science, technology, engineering or maths.

Olivia: scientists?

Interviewer: yeah, scientists

Black Cat: people that do… maybe electricians because they could use technology?

Interviewer: yeah, electricians? What was it that you said?

Olivia: I can't remember but it was something – it's like an archaeologist, but they do the dinosaur thing

Interviewer: ah a palaeontologist

Bumble: you know how in the future, they're going be all electric cars?

Interviewer: yeah?

Bumble: it will take a lot of time to measure them and see how much [unclear] they need to be

Interviewer: yeah? Absolutely, so someone who builds electric cars, yeah definitely

Black Cat: and maybe people who do maths problems – big maths problems

Interviewer: [To Bluebell] can you think of any?

Bluebell: …no

Interviewer: that's okay. May I ask, is your name [Bluebell]?

[goes around group, all children state their name]

Interviewer: so what we've got here are skills and attributes and interests that people might have. And I'm interested to know which of these you think are important for somebody who works in STEM. So maybe someone who is scientist, or who works in maths, or builds electric cars, or designing a bridge, or building an aeroplane – that kind of thing – which of these skills do you think would be important for somebody who does those kinds of jobs? Before we start, some of the other children that I've done this with decided that they wanted to rank them. They wanted to organise them one to five, so five is the least important, and one is the most important

Bumble: maybe working in a team

Interviewer: are you happy to rank them like this? So these are the ones that are most important, these are quite important, that's kind of a bit

Bumble: yes, you can use computers

Interviewer: not very

Black Cat: likes being outdoors is good for science because then you can look for things that might be interesting

Interviewer: okay, so shall we talk about that one first? Likes being outdoors – how important do you think that one is?

Black Cat: should be a number two

Olivia: maybe a two?

Interviewer: do you guys agree? Likes being outdoor number two?

Bumble: is five the most important?

Interviewer: five is the *least* important

Bumble: I think it should be a two

Olivia: I think this was number two

Black Cat: two

Interviewer: okay, so two or three? [to Bluebell] What do you reckon?

[Bluebell indicates 4]

Interviewer: you think four?

Bluebell: three

Interviewer: oh we've got a split vote

Black Cat: in the middle

Interviewer: do you think it's a medium amount of important, or maybe a bit more important

Black Cat: maybe medium, because you can also be inside to – being inside is also important because then you can find out what it is

Interviewer: okay

Bumble: I think actually being outdoors is quite important

Interviewer: ooh you've changed your mind?

Bumble: because [you might see] how a bird looks – how they fly, you can use that to make an aeroplane and they'd fly better

Interviewer: oh cool, yes, so you could get some ideas for your science or for something you're building -

Bumble: so maybe it could be two

Interviewer: - from outdoors. Okay. Nice one guys. Who would like to do the next word? Which word would you like to choose? Shall we do the one you've got?

Bluebell: this one?

Interviewer: yeah, what does that say?

Bluebell: can use computers

Interviewer: cool, okay so how important do you think it is to be able to use computers?

Olivia: number three maybe?

Black Cat: Because then

Olivia: yeah number three

Black Cat: three

Interviewer: what was it that you thought?

Bumble: I think it's quite important, well you can't really do anything without computers

Black Cat: I think maybe number four or number three

Bumble: so all it is is just – just a thing that's not working

Black Cat: because then you can find out what it is – that thing

Olivia: I think maybe number three

Interviewer: okay, so you think kind of a bit important

Black Cat: yeah

Interviewer: did you think it was *quite* important?

Bumble: because you can't really do anything [unclear]

Black Cat: I think at least two, yeah

Interviewer: yeah?

Olivia: I think it's two now

Black Cat: two

Interviewer: two, okay so we think it's quite important to be able to use computers. Okay, would you like to choose the next one Bumble? [pause] yep, enjoys reading, how important do you think that is?

Bumble: you can get things out of the things that you read, like a made up story, you can design what it sounds like, and you can… [pause]

Interviewer: okay, so you might get ideas from the reading that you do? How important do you think it is?

Bumble: quite important

Interviewer: Quite important? What do you guys reckon?

Bumble: I reckon three

Black Cat: I think three

Olivia: three

Interviewer: what do you think [Bluebell]?

Bluebell: three

Interviewer: three, awesome put it on three! [pause] Okay, would you like to do one [Black Cat]?

Black Cat: you should be sensible because then if you accidentally break a bone. You're not being sensible if you find one and then you break it. And you need to be sensible to have – so you can hold a bone and not drop it

Interviewer: okay, what does everybody else think? [pause] do you think it's important to be sensible if you work in science, technology, engineering –

Children: yes

Interviewer: okay, which number do you reckon then [Black Cat]?

Black Cat: maybe two?

Interviewer: two?

Olivia: yeah

Interviewer: is everyone happy with that?

Olivia: yeah

Interviewer: so it is *quite* important, yeah? Go on [Olivia], what does that one say?

Olivia: listen to other peoples options

Interviewer: what's that last word?

Olivia: options

Interviewer: shall we have a look at it again? So that says opinion

Olivia: oh opinion

Interviewer: yeah, so listens to other people's opinion. What do you think about that one?

Olivia: I think it's quite important to take each other's opinion

Interviewer: okay, what does everybody else think? Shall we listen to everybody else's opinion? [laugh]

Black Cat: I think that it's good because then you have lots of options of what it could be and then you might have a good chance of getting the answer

Interviewer: ah so if you listen to everybody's opinion, you have a lot more answers to choose from?

Black Cat: yeah

Interviewer: okay – what do you guys think?

Bumble: if you have something really strong in your mind that you think will work, and you test it out with a piece of paper or something, and maybe something did work and you had that in your mind *a lot*, maybe you should listen to what *you* think

Interviewer: ah so you think it's important to listen to other people's opinions, but also to follow your own ideas if you believe in them? [pause] okay, so which number do we think it is? What do you reckon [Bluebell]?

Bluebell: three?

Black Cat: yeah, three I was going to say that

Olivia: maybe about two

Interviewer: oh you think two, you think three? What did you think? You think two as well? Okay so were split between two and three again? So do we think it's quite important or just a bit important?

Black Cat: yeah, I'm going to go with two

Interviewer: you think two as well? Okay, let's pop it on two then. Are you happy with that one Bumble? What have you got there [Bluebell]?

Bluebell: learning from their mistakes

Interviewer: oh okay, learning from your mistakes. How important is that?

Black Cat: very important

Olivia: very

Black Cat: because if you learn from your mistakes

Olivia: it helps you

Black Cat: it helps you, and that means you're being resilient too, instead of

Olivia: giving up

Black Cat: giving up, and that's not being resilient

Interviewer: okay, would you guys agree?

Olivia: I think maybe number one or number two

Interviewer: okay

Black Cat: yeah number one

Interviewer: what does everyone else think?

Olivia: number one

Bumble: I think number two

Black Cat: I think number one

Bluebell: one

Interviewer: you think one? How many people think one?

Black Cat: three

Interviewer: three people think one, are you happy for it to go on one Bumble?

Bumble: yeah

Interviewer: yeah? Okay, so learning from your mistakes is one of the *most* important things

Black Cat: resilient is one of our learning values

Interviewer: it is isn't it? [refers to board behind with learning values] ah I thought it was the frog, I was trying to remember which one it was. Is it - Fraser the frog is resilient?

Black Cat: yeah

Interviewer: did somebody in the school draw those?

Black Cat: yeah

[discussion about who drew the animals that embody BF's learning values]

Interviewer: okay, who's going to do the next word? Who'd like to do the next one?

Olivia: me!

Interviewer: is it [Olivia's] turn again?

Black Cat: yeah

Interviewer: yep? Okay

[Olivia chooses a card]

Interviewer: okay, so some of the words – if you're not sure what they mean, do you remember you had a glossary on the back of the questionnaire? I've got another glossary here, so you guys can have a look at that. So what's this word that you've chosen [Olivia]?

Olivia: resourceful… I think…

Interviewer: could you read out what resourceful means?

Olivia: it means finds quick clever ways to get things done or to make things easier

Interviewer: okay, so what do we think about being resourceful?

Bumble: finds quick clever ways to get things done or to make things easier

Interviewer: okay, so how important is it to be resourceful if you work in STEM?

Black Cat: quite resourceful

Olivia: quite important

Black Cat: because then you get equipment to help you, then if you can't do it maybe your friend could be equipment – because if you can't do it on your own then you can ask them to help

Interviewer: mhhmm

Olivia: and also our teacher went on a course and she said we could work things out by 'brain, buddy, boss'

Interviewer: ah okay

Black Cat: and brain is our brain

Olivia: brain

Black Cat: buddy is our friend

Olivia: friend

Black Cat: and boss is the teacher

Interviewer: ah so those are three resources that you can use

Girls: yeah

Interviewer: so how important do you guys think it is to be resourceful

Black Cat: number one

Olivia: number one

Bumble: number two

Interviewer: [Bumble] thinks number two, what do you think [Bluebell]?

Bluebell: number two

Interviewer: number two – ah we're split again guys!

Olivia: I think one

Black Cat: actually, I think it might be number two

Interviewer: okay [Bumble] would you like to do a word?

Bumble: likes visiting other countries. If other countries have ideas, you could be a spy and go steal their ideas

Interviewer: steal their ideas?

Black Cat: which one's that one?

Interviewer: so that's not on [the glossary] because it's just a sentence by itself, likes visiting other countries. What if, instead of s*tealing* ideas off other countries – here's an example, I went to Turkey in the summer and lots of other zooarchaeologists were there, and I didn't steal any of their ideas, but I listened to lots of their opinions and that taught me new things. [pause] perhaps that's a nicer way of doing it that just stealing other ideas? [laughs]

Bumble: I didn't actually mean stealing, you could go and see what they're doing and how they're actually building it

Interviewer: ah okay, so you can learn lots from different people in different countries? I like that. What do you reckon for that one guys? How important is that?

Black Cat: maybe number three

Olivia: I would say number three

Interviewer: number three? What do you think Bumble?

Bumble: I think number two

Interviewer: you think number two? What do you reckon [Bluebell]? If you're a scientist, an engineer, you work with technology or you work with maths, how important is it to like visiting other countries?

Bluebell: maybe number three?

Interviewer: okay, so that's three for three? Okay. Go on [Bluebell], what have you got?

Bluebell: gets all of the answers right

Interviewer: okay, what do you think about that one guys? How important is it to get all of your answers right?

Black Cat: not very important

Bumble: not that important

Olivia: I would say number four or number five

Bumble: I think number four

Olivia: yeah

Black Cat: number four because it's like learning from your mistakes, if you don't get them all right and you wanted to get them all right on the first try, it doesn't matter

Interviewer: okay, fab so what do we think number four was it?

Black Cat: yeah

Interviewer: okay, put that one on number four [Bluebell] thank you. [Black Cat] what have you got there?

Black Cat: enjoys maths

Interviewer: enjoys maths, okay how important is that one?

Black Cat: it's very important because then if you have tricky sums to do, you can find them out in different methods. If you know the different methods like grid or others like that

Interviewer: okay, what does everybody else think?

Bumble: I think it's quite important because in STEM there's maths

Interviewer: okay. What do you reckon [Olivia] and [Bluebell]?

Olivia: I think it's number one

Black Cat: I think it's number one

Bumble: number two

Interviewer: what do you reckon [Bluebell]?

Bluebell: three

Interviewer: okay, so we've got two ones a two and a three. Where do we reckon that goes down – can you decide together?

Black Cat: maybe it is number two

Olivia: number two

Interviewer: is everyone happy for it to be number two?

Children: yeah

Interviewer: who's go is it now?

Black Cat: I don't know

Bumble: I think it's [Bluebell's]

Interviewer: okay, let's see [Bluebell] what have you got there?

Bluebell: hard work

Interviewer: hard working. How important is it to be hardworking [Bluebell]?

Olivia: maybe number…

Black Cat: kind of

Olivia: kind of, it says

Bluebell: it's good to be hard working

Interviewer: you think it's good to be hardworking?

Olivia: it says here [on the glossary]

Black Cat: always tries their best. Always works well and tries their best

Interviewer: okay and [Bluebell] thinks that's quite important

Black Cat: I think it's quite important

Olivia: yeah

Interviewer: yeah? Bumble?

Bumble: yes

Interviewer: okay, which number would you like to put that on [Bluebell]?

Bluebell: maybe two or one

Interviewer: two or one? Okay, what does everybody else think?

Black Cat: two

Olivia: I think one

Bumble: I think one

Interviewer: three for one? Pop it on one. Okay, who's turn is it now?

Bumble: [Black Cat], not [Olivia]

Interviewer: [Olivia]? Okay [Olivia's] turn is it?

Black Cat: no [Olivia] just had a go

Interviewer: oh you just had a go? Shall we go in a circle like that?

Black Cat: [Bumble's] turn

Bumble: likes to try new things

Interviewer: ah okay what do you think about that one [Bumble]?

Bumble: I think it's quite important

Interviewer: yeah?

Bumble: because if you just do one thing, it might not work. And then you do it again and again and get more frustrated and then you might stop doing it

Interviewer: so it's important to – do you mean trying different approaches?

Bumble: yeah

Black Cat: like different methods and strategies

Interviewer: okay, so where do you think that goes then [Bumble]? How important is that?

Bumble: I think [pause] two

Interviewer: two? What does everybody else think?

Black Cat: two

Olivia: two

Interviewer: [Bluebell]?

Bluebell: two

Interviewer: cool, okay put it on two. [Black Cat] what have you got there?

Black Cat: enjoys science

Interviewer: what do you think about that one?

Black Cat: I think it's very important because that's in STEM.

Interviewer: okay

Black Cat: and if you do science, you will know a lot of things and then you can answer your friend's questions

Interviewer: okay, does everybody else agree?

Olivia: yes

Bumble: I think it's quite important because that's your job

Interviewer: okay yeah

Bumble: [unclear] your job if you didn't do that

Interviewer: okay so where do you think it needs to go

Bumble: I think it would be one

Black Cat: two

Interviewer: two or one? What do you guys reckon?

Child: one

Interviewer: three for one? Okay

Black Cat: [Olivia]?

Olivia: encourages others

Interviewer: okay, how important is that if you work in STEM?

Olivia: maybe if someone didn't – I'm not quite – if someone didn't think, if someone didn't want to do it, but then someone encourages them, they might want to do it? So I think it's maybe a bit important, but not really important.

Interviewer: okay

Black Cat: maybe a three

Olivia: maybe number three or four

Black Cat: three or four

Interviewer: three or four. What do you guys reckon?

Bumble: four

Bluebell: I think three

Black Cat: I think four

Bumble: four

Black Cat: four

Bluebell: three

Interviewer: ooh okay – got three for four? Is that alright if we pop it on four?

[pause]

Interviewer: go on [Bluebell]

Bluebell: comes up with lots of new ideas

Interviewer: okay, so how important is it, if you work in STEM, to come up with lots of new ideas?

Bluebell: quite important maybe I would say?

Interviewer: okay!

Black Cat: quite important

Olivia: yeah

Bluebell: quite important because otherwise you'll just be making the same thing over and over again

Bumble: if it works well,

Bluebell: it might not work and then

Olivia: then you just keep on doing it and then you get really annoyed

Bluebell: the new idea might be quicker to do something

Interviewer: ah so you might have an idea that's speeds something up? I like that. Okay, which one do we think?

Bumble: I think one

Children: yeah one

Interviewer: okay brilliant. What have we got next [Bumble]?

Bumble: I think we need to go down to a five there – enjoys sport

Interviewer: enjoys sport, okay. So how important do you think it is to enjoy sport if you work in STEM?

Bumble: five

Olivia: five

Black Cat: enjoys sport? Then you won't be able to do your job – you have a job and then every day you're off doing sport, then you won't be able to do your job

Interviewer: okay

Olivia: unless you're someone who works for sport

Interviewer: yeah, maybe you have a job in sport

Bumble: I think some people [unclear] because all you can do is time how fast you go and see how fast the other things go. That's all the thing [unclear]

Interviewer: okay you think five

Black Cat: I think five

Olivia: five

Interviewer: what do you reckon [Bluebell]? Enjoys sport?

Black Cat: five

Bluebell: four?

Interviewer: four? Do most people think five?

Black Cat: three [votes for] five

Children: yeah

Interviewer: okay, cool. What have you got there [Black Cat]? we might need to be a *little* bit quicker now because it's going to be break time soon

Black Cat: wants to understand how things work

[pause in conversation while Yr 5/6 walk through hall]

Interviewer: okay, wants to understand how things work

Black Cat: maybe a one because if you don't get it, then you could try and see how you could solve it and then you're trying to understand it

Interviewer: yeah, okay. Anyone else want to add to that?

Bumble: you need to know how things work, but I don't think it's actually that important.

Interviewer: okay

Black Cat: I think it's very important

Bluebell: I think it is so you can make…

Olivia: maybe two

Black Cat: maybe one

Bumble: you need to be able to do a few things

Black Cat: one

Bumble: with that, you need to know how to do things or you can't really

Bluebell: do anything

Interviewer: okay

Black Cat: I think maybe one

Bumble: like a laptop

Olivia: one

Interviewer: the computer one? We put that one two. So everyone thinks one for wants to understand how things work. Go on [Olivia]

Olivia: I think this might be five

Interviewer: go on

Olivia: likes computer games

Interviewer: likes computer games, what do you reckon guys?

[children laugh]

Black Cat: no!

Olivia: no

Interviewer: no? Shall I put that on for you?

Black Cat: five yeah

Interviewer: what have you got there [Bluebell]?

Bluebell: likes to learn new things

Black Cat: yes

Interviewer: what do you reckon [Bluebell]?

Bluebell: [pause]

Interviewer: shall we see what other people think as well? What does everybody else think? So likes to learn new things? How important do we think that is?

Black Cat: that's very important

Olivia: I think that's important

Black Cat: I think one because then you get somewhere

Interviewer: okay

Black Cat: then you learn things

Bumble: I think we did this one before

Interviewer: yeah, it's very similar to – there's one: likes to try new things, this one is likes to learn new things – so they're quite similar

Black Cat: I think maybe it should go on number one

Olivia: yeah

Interviewer: what do you think?

Bumble: it's not really, it's kind of there, but I think two

Black Cat: yeah two

Interviewer: two? Okay, what have you got there Bumble?

Bumble: I think practical

Interviewer: practical, yep what does practical mean?

Bumble: it means you need certain things that will actually work

Interviewer: okay

Bumble: you need practical machinery

Interviewer: okay, we've got practical on the glossary

Black Cat: good with their hands, good at doing practical tasks like experiments

Bumble: yes, then I think it's number two or number one

Black Cat: number two

Olivia: I think maybe number one

Black Cat: I think it's maybe in between number and number two

Interviewer: okay

Bumble: what do you think [Bluebell]?

Black Cat: I think maybe one actually

Bluebell: one

Children: one

Interviewer: okay, cool

Black Cat: enjoys dancing

[children laugh]

Olivia: five

Interviewer: okay, does everyone agree with that one

Bumble: maybe four

Interviewer: why maybe four?

Bumble: because something that somebody enjoys – I think you need to be clever to do the footwork when you do [unclear]. If you have strings around where you're working, you can jump over the strings, then you can go over stuff

Interviewer: maybe

Olivia: number five, I'm guessing number five

Interviewer: you think number five still

Black Cat: I think maybe four

Interviewer: you think maybe four?

Olivia: four

Interviewer: four? Okay, we'll pop it on four then. What have you got there [Olivia]?

Olivia: enjoys history

Interviewer: enjoys history, what do you reckon?

Girl: yes, number one

Olivia: number one maybe

Black Cat: because if you enjoy it – if there are animals which are extinct, they're in history?

Interviewer: ah okay

Black Cat: and then you want to find out about them

Bluebell: I think that might go in number three or number two

Black Cat: I think number one

Bumble: actually, because you must enjoy history because that's the stuff that you dig up

Interviewer: if you're an archaeologist yeah, what about other kinds of scientists and engineers?

Olivia: what's it called again pale…

Interviewer: palaeontologists? That's a different kind of scientist

Olivia: and maybe about zoo…

Interviewer: zooarchaeologists?

Black Cat: If you have maybe a digger with you, and you go and you find a bone where you're digging, then maybe you could give it to an archaeologist so they can find it out?

Interviewer: okay

Black Cat: and you like history kind of

Interviewer: okay, where do you want to put that one then?

Black Cat: number one

Olivia: I think maybe number three

Bumble: what are we doing?

Interviewer: this is enjoys history

Bumble: yes number one

Interviewer: what about the people who work in engineering and science, but they don't use any history at all?

Bumble: ah then four

Black Cat: ah, then maybe number three?

Bumble: I think four if they're the people who use *no* history

Interviewer: okay, we've got quite a split opinion here haven't we?

Child: yeah

Bumble: I think number one if they're people who dig up the bones

Interviewer: uh huh

Bumble: and number four just for the scientists

Olivia: I think maybe number one

Black Cat: number one

Bluebell: I think, yeah maybe number one

Interviewer: okay, pop it on there now. We need to be a little bit quicker because it's break time in fifteen minutes

Bumble: 16

Interviewer: 16 minutes

Bluebell: likes learning…

Interviewer: likes learning languages

Black Cat: yes

Olivia: I think that's maybe number three or two

Black Cat: because if you go to another country, and you don't know their language, then that's a problem because if you have a question to ask about what you're doing then you might need to speak the language

Bluebell: it's kind of important to know it if you go to a country with another language

Black Cat: maybe number three

Olivia: number three

Bluebell: I think that's four

Black Cat: number three, because if you like visiting other countries, then you need to know their language

Interviewer: ah okay

Olivia: I think number two

Black Cat: think number three

Interviewer: so we've got two people saying…

Bluebell: I think four

Interviewer: you think four

Bumble: I think four

Children: three

Interviewer: three. Okay, so we've got two threes and two fours, where are we going to go guys?

Black Cat: three

Olivia: three

Black Cat: what do you think [Bumble]?

Bumble: I think four

Olivia: I think three

Black Cat: I'm actually maybe going to go for four as well

Interviewer: yeah? Okay. Pop it on there then. [Bumble] what's your word?

Black Cat: it actually doesn't make a lot of difference because if you – maybe somebody else might go and work with you and help you like your agent or something

Interviewer: okay [Bumble] do you want to choose a word?

Bumble: this one?

[discuss range of words still left to choose]

Bumble: I think can work independently

Interviewer: okay, how important is that one?

Black Cat: very important because if you don't have a team with you, then you can find it out on your own

Interviewer: okay, what does everybody else think?

Bumble: I think it's quite important

Interviewer: okay, we've got can work in a team and can work independently there

Bumble: I think it's quite important

Interviewer: quite important?

Olivia: maybe not very important

Interviewer: you don't think it's very important to work independently?

Olivia: because I think if you're in a team – if you're working independently and you find something [and] you don't really know what it is

Black Cat: yeah if you don't know

Olivia: if you're not so good on that subject, about that animal or something, you might need some help

Black Cat: If you find something like a bone, and you don't know which type of animal it is, I think it's better to work in a team

Interviewer: you think it's better to work in a team?

Black Cat: yeah

Olivia: actually, I don't think it's that important

Black Cat: maybe number three, maybe number four

Child: four, four

Bumble: maybe if you have gone to a different country sometimes and you're stuck somewhere on your own, you wouldn't be able to find your way back – because there are no mobile phones, well there are but… [unclear]

Interviewer: okay, so number four cool. What have you got there [Black Cat]?

Black Cat: determined

Interviewer: determined, how important is it to be determined? [pause] do we know what it means?

Children: it means doesn't give up even if things become difficult

Interviewer: what do we think? How important is that?

Black Cat: important because then you want to find out more things and you don't give up

Interviewer: okay, what does everybody else think?

Black Cat: number one

Bumble: it's quite important, number one maybe

Bluebell: what does this one say?

Interviewer: it says determined

Black Cat: determined

Olivia: number one maybe

Bluebell: I think number two

Bumble: I think number two or one

Olivia: I think number one

Black Cat: I think number one

Bumble: I'm not sure

Interviewer: you're not sure. Two or one, what do you reckon [Bluebell]?

Bluebell: two

Interviewer: two, deciding vote [Bumble]? Two or one?

Bumble: one

Interviewer: one. Lovely. [Olivia]?

Olivia: inventive

Interviewer: inventive, how important is it to be inventive?

Black Cat: that is *very* important

Bumble: thinks of new and exciting ideas

Black Cat: no, that's imaginative

Olivia: oh, inventive: comes up with new ideas to solve puzzles or design new things

Interviewer: do we all agree?

Child: I think two

Child: I think one

Child: One

Interviewer: [Bluebell]?

Bluebell: one

Black Cat: three ones

Interviewer: three ones okay, what have you got there [Bluebell]?

Bluebell: can work in a team

Interviewer: how important is that one guys? Can work in a team?

Black Cat: very important

Olivia: very

Interviewer: can work in a team

Black Cat: actually I think *kind* of important

Olivia: I think very important

Bumble: I think two or three

Bluebell: I think two or one

Black Cat: because if you want to work on your own then maybe then you can work on your own, you don't have to always work in a team

Interviewer: okay so we've got two or one.

Bumble: two or three

Interviewer: two or three

Olivia: I think two

Interviewer: two

Black Cat: one

Interviewer: okay, well that was a lot of twos wasn't it that people just said? Shall we put it on two?

Black Cat: yeah

Interviewer: yeah? Go on [Bluebell]. What have you got [Bumble]?

Bumble: curious

Interviewer: curious, what's curious mean?

Olivia: it means is keen to learn something new.

Black Cat: I think that's actually important

Olivia: I think it's very important.

Black Cat: If you found a bone of this animal and you haven't found the last bone, then you're curious to find it?

Interviewer: uh huh okay. So you guys think it's quite important. What do you think guys?

Bumble: I think it's quite important

Interviewer: quite important?

Bumble: maybe two

Interviewer: what do you think?

Child: two

Interviewer: what do you reckon [Bluebell]?

Bluebell: maybe two or three?

Black Cat: lots of twos

Interviewer: lots of twos, shall we put it on two?

Bluebell: I think three

Interviewer: okay, we've only got ten minutes left guys, so we need to go a little bit faster now – because there's another bit to this activity as well. So which words have you got there Bumble?

Bumble: I'm not sure what this says

Interviewer: methodical. What does that one mean? It's on the sheet

Black Cat: where is it?

Children: follows a set of instructions carefully

Interviewer: what do you reckon? important?

Black Cat: quite

Olivia: maybe number three

Interviewer: okay

Bumble: actually because follows instructions carefully, you don't *actually* have to do that, so I think four

Black Cat: I think four as well

Olivia: four

Interviewer: okay

Olivia: shares information with others

Interviewer: okay, so sharing information with other people

Black Cat: I think that's important

Olivia: number one

Black Cat: because then if they don't get it, then you can help them

Interviewer: okay, everyone happy with that?

Children: yes

Interviewer: [Olivia]?

Olivia: artistic

Interviewer: artistic? What do we reckon?

Child: yes

Interviewer: really important?

Children: two

Bluebell: I think three

Bumble: two or one

Black Cat: I think two

Bumble: if you draw what you're going to make, if you lose it then you'll just forget what you were going to make

Interviewer: okay

Bumble: so I think that one

Black Cat: I think two

Interviewer: two? One? What do you reckon [Bluebell]?

Bluebell: three

Interviewer: three, okay so we've got some ones and three – shall we put it on two?

Girls: yeah

Interviewer: Because that's in the middle? Okay, go on [Black Cat]

Black Cat: discusses ideas with others

Interviewer: what do you reckon?

Black Cat: that's like this [indicates another card]

Interviewer: you think it's similar?

Black Cat: yeah

Interviewer: okay, does everyone agree it's kind of the same?

Bumble: I think that goes on three

Interviewer: so shares information with others, and discusses ideas with others

Bumble: that's two or three

Interviewer: you think it's two or three?

Black Cat: I think it's one

Interviewer: you think one?

Black Cat: because it's very important to share your ideas, and to discuss it like we're doing now

Interviewer: yeah? Yeah okay

Black Cat: so I think it's quite important

Interviewer: okay, so I tell you what – the boys think that it's three, and you guys think it's one. So shall we put it on…?

Black Cat: two

Interviewer: two, so it's in the middle of what everybody thinks?

Black Cat: yeah

Interviewer: okay. Go on [Olivia]

Olivia: logical is able to think carefully – clearly about facts and information. I think that's maybe a two

Interviewer: okay, what does everybody else think?

Bumble: facts and information?

Olivia: yeah, facts and information. I think two

Interviewer: [Bluebell]?

Bluebell: [pause] one?

Black Cat: I actually think one

Interviewer: so we've got two twos and two ones?

Black Cat: actually, I might think it's two

Interviewer: okay, so is that three twos? Go on [Bluebell], what have you got?

Bluebell: enjoy building things?

Interviewer: enjoy building things

Bumble: that's kind of important

Black Cat: that's three

Olivia: I think three

Child: that's four

Olivia: I think three

Bumble: because

Children: three

Interviewer: three?

Bumble: actually, I think that should go on four because I think that you don't really do building

Interviewer: okay?

Children: four

Interviewer: okay, what do you reckon [Bluebell]?

Bluebell: four

Interviewer: okay, go on [Bumble] you've got one?

Bumble: imaginative

Black Cat: *that's* important because then you can get somewhere and then you can get the stuff and you can just build and make something really nice

Bumble: instead of doing it on bits of paper you can have it in your mind

Interviewer: oh okay what do you reckon?

Bumble: one

Olivia: one

Black Cat: one

Interviewer: okay, pop that on one. So I tell you what. So the next thing I was going to ask you, was to choose some of these words that you think are similar to yourself? So is it okay if – I'm not sure we're going to have time, because you need to go to break – is it okay if I take a picture of what you've got already, and then if you guys choose some words that you think reflect yourself?

Black Cat: I think I

Olivia: I think

Interviewer: go on then, we'll do that last one – competitive, what do you reckon?

Black Cat: five because if you do that and you win and you boast then

Olivia: that's not very nice

Interviewer: do you guys agree?

Boys: yeah

Olivia: yeah five

Interviewer: okay

[recording paused to take photo of word sort]

Interviewer: okay, so if someone else has a word that you want to use, that's okay you can share the words. So which five of these words do you think describes you the best?

Olivia: this one

Black Cat: I've already got my five

Interviewer: okay

Bumble: likes computer games

Interviewer: you guys can share that one if you want. Are there any other words that describe yourself [Bluebell]?

Bluebell: no, I don't want to

Interviewer: you don't want to? Okay

Bumble: I don't think anybody should pick that one

Interviewer: so you've got five, you've got your five? Are you not choosing any [Bluebell]?

Bluebell: no

Interviewer: okay, that's fine.

Black Cat: no actually I enjoy dancing

[girls chat about dancing]

Interviewer: So can you tell me which words you've chosen and why you've chosen them please? Can I start with [Olivia]?

Olivia: I've got reflective, can work in a team, likes to learn new things, enjoys history and enjoys dancing

Interviewer: okay, and why have you chosen those words?

Olivia: dancing is because I'm in a dancing family – down my family we've been doing all different types of dancing

Interviewer: oh okay cool

Olivia: and I actually go to dance lessons, and I really enjoy it

Interviewer: okay, brilliant

Olivia: and I've chosen can work in a team because I'm in a dancing team and I think it's really good to work in a team because some people might think – if some people are in a team, my mum says there's no 'I' in team

Interviewer: okay, and the other words?

Olivia: I enjoy my history because my family is quite good with history

Interviewer: okay

Olivia: my cousin is in Bournemouth University and she does history and I really enjoy it

Interviewer: okay

Olivia: and reflective because I always looks back on what I've done and I always look back at what I've done

Interviewer: okay and what was your last one?

Olivia: I think I've done all of them

Interviewer: you've done them all? Okay

Olivia: oh have I done…?

Interviewer: likes to learn new things, go on why did you choose that one?

Olivia: because I like learning new things

Interviewer: okay, brilliant thank you. [Black Cat]?

Black Cat: I enjoyed science because we do at home, we do these experiments and I really enjoy doing them

Interviewer: okay, that sounds cool

Black Cat: I always enjoy maths because I like all the different strategies, which you can do sums in

Interviewer: okay

Black Cat: imaginative because I like doing drawings and I imagine them in my head first

Interviewer: okay

Black Cat: enjoys reading because I like reading about different types of things and what they are

Interviewer: okay

Black Cat: enjoys building things because [brother] and me right now are building this little cart

Interviewer: cool

Black Cat: and I'm really enjoying it

Interviewer: okay, brilliant. Is that everything?

Black Cat: yeah

Interviewer: fab, okay thank you – and [Bumble]? Which words did you choose?

Bumble: I like drawing because I like the history drawing that we do

Interviewer: brilliant, okay

Bumble: I like doing this because I can use my mind to do that

Interviewer: okay, so you chose creative because what sorry?

Bumble: creative because I like using my mind to do that

Interviewer: okay

Bumble: I don't want that

Interviewer: resourceful?

Bumble: I don't want that

Interviewer: you don't want to choose that one?

Bumble: I don't really know about that one

Interviewer: okay, so what's the other one that you've got there?

Bumble: helping others

Interviewer: okay and can you tell us about that one?

Bumble: I'm not really sure, but I know I have done it before

Black Cat: yeah he has

Interviewer: you like helping others? Brilliant thank you guys – [Bluebell] did you want to tell us anything? [Pause] No? fab, thank you so much for that guys.

38 Appendix 26: Pupil task-based interview 1, NB

Title: Pupil interview 1

Date: 25th January 2019

Speakers: Poppy Hodkinson (interviewer), Jelly, Apple, Cleo and Pepperoni

Interview duration: 29 Minutes

Interview location: NB

Interviewer: okay, so we've got a lot of words on the table in front of us here, and I thought it would be interesting to see which of these words you think would be important for somebody who works in STEM. So [Cleo] do you remember what STEM stands for?

Cleo: Science, technology, engineering and mathematics

Interviewer: brilliant, okay so imagine [you're grown up] and you've decided to get a job in STEM, so you're a scientist, you work in technology, maybe you decide to be an engineer or a mathematician – what kinds of skills to do you think it would be really important for you to have?

[Jelly holds up a card]

Interviewer: yep, which one's that [Jelly]?

Jelly: methodical

Interviewer: methodical, and what does methodical mean [Jelly]?

Jelly: good at maths, because if you're a scientist, you do need to be good at maths

Interviewer: okay, any words that you're not quite sure of, we've got a little glossary there, that you can share between you. And that has some of the words on there. So methodical, part of that might be being good at maths – what does it say on there?

Apple: follows a set of instructions carefully

Interviewer: yeah, so you can follow sets of instructions carefully, you can work through something in a careful way

Jelly: yeah because if you don't do something correctly, you can end up getting hurt or –

Apple: this could also be another good one

Interviewer: okay, so methodical we think is important – shall we pop that one in the middle? And what do you have there [Pepperoni]?

Pepperoni: can use computers, because you might have to – if you work in STEM club, you might have to scan the bones and stuff to see what bone it is?

Interviewer: ah cool, yeah, pop that one on there. What did you have there?

Apple: can work in a team

Interviewer: can work in a team, and why do you think that one might be important [Apple]?

Apple: because if you're told to work in a team, and you're not very good at it, then everything's going to go wrong

Interviewer: okay, does anyone else have any thoughts about that one as well?

[pause]

Interviewer: what do you reckon, is it important to work in a team?

Pepperoni: I'm not sure

Interviewer: you're not sure? Tell you what, shall we put that one in the middle and have a little think about it? And what's the one that was here, so we had methodical, can use computers –

Apple: and that one

Interviewer: what have you got [Cleo]?

Cleo: determined

Interviewer: why's that one important?

Cleo: because if something goes wrong, you have to try again. If not, you're basically giving up and not being resilient

Interviewer: okay, what does everybody else think? Do you agree with [Cleo]?

Apple: yeah

Interviewer: it's okay – we can disagree with each other as well, so if somebody says something and you're not quite sure you agree with them, feel free to say – because it's good to talk about. Thank you [Cleo], put that one in the middle. Which one have you got there [Jelly]?

Jelly: comes up with lots of new ideas

Interviewer: ah what do you think about that one?

Jelly: I think you need to come up with lots of new ideas because if you're a scientist and you like archaeology, you could come up with a new place to dig, and if there's nothing there you need to come up with a new idea to go somewhere else.

Interviewer: okay, brilliant – pop that one in the middle. Yeah [Apple]?

Apple: I've got enjoys maths because for the mathematical one, you might need enjoys maths because then you would know what to do

Interviewer: yeah? What does everybody else think about that one?

Jelly: yeah

Interviewer: [Cleo] you agree?

Cleo: yes

Interviewer: okay, pop that one in the middle – [Cleo] have you got one there?

Cleo: I think you have to like visiting other countries, because maybe if you had a conference in a different country you would have to go

Interviewer: yeah? Yep, brilliant

Pepperoni: I've got two of them

Interviewer: you've got two? Choose your favourite one, and we'll talk about that [Pepperoni]

Pepperoni: I picked like to learn new things because if you learn new things, you will get cleverer and cleverer at science and then you'll know nearly everything about science

Interviewer: okay, what does everybody else think?

Jelly: I'm learning about [unclear]

Interviewer: ah is that something you've enjoyed learning about? Brilliant

Apple: I've got this one. I think this is a *bad* thing because if you get all the answers right, it's just going to be really easy

Interviewer: yeah?

Apple: and things that are really easy are a bit boring

Interviewer: okay

Apple: you just know what to do

Interviewer: okay, shall we start a new pile for things that *aren't* important? So this one can be the things that aren't important. You said getting all of the answers right wasn't very important. What does everybody else think about that one?

Jelly: yeah

Pepperoni: yeah

Jelly: I agree with [Apple] – and I've got this that I don't really agree with because being good at science – if you're good at dancing, it doesn't really help you do science

Interviewer: what does everybody else think?

Apple: [agree]

Cleo: maybe not – I disagree because maybe if you're a scientist, maybe you're looking at what happens to your heartbeat or maybe to your oxygen levels when someone's dancing

Interviewer: interesting yeah

Apple: can we put it in the middle?

Interviewer: definitely, do you know what? I've done this activity with other children, they put theirs on a range of answers, so five is not very important, and one is quite important and then they had the other ones in the middle. Shall we do a similar thing here?

Children: yeah

Interviewer: so we've got one, two, three, four. Okay, so I really liked what you said there: the idea that you might like to research what happens in your body while you dance. And where did you want gets all of the answers right to go?

Apple: four?

Interviewer: four? Okay

Apple: It would still help, but it would be boring

Interviewer: yeah? Okay, what do we think about the other ones we chose, are any of those *really really* important? Likes to learn new things on one, you think that's the most important?

Cleo: I think that's three

Pepperoni: I think that's two

Interviewer: okay, so why do you think can use computers is 3 [Cleo]?

Cleo: because maybe, if you could use a computer, it won't help everything but if you worked with computers you would have to know that. So it's kind of in the middle

Interviewer: okay

Apple: I think I disagree because science and stuff, you can use computers for most things

Interviewer: yeah?

Apple: they use it for zooming in on stuff, they use it they can zoom in and then examine it

Interviewer: okay, so you think that computers might be important because you might need to be able to use them to do whatever your job is?

Apple: yeah

Interviewer: okay, shall we leave it in the middle then if everyone has slightly different opinions? Because I'm recording this I'll remember what you both said. Okay, we had lots put on just then, so we had comes up with lots of new ideas on two – so we think it's not the most important thing, but still quite important?

Child: yeah

Interviewer: is everybody happy with that?

Pepperoni: yeah

Interviewer: yeah? And then you put creative on 1 there [Jelly]. What do you think about creative? What makes you think –

Jelly: I think you need to be very creative, to help about science. Because you need to be creative to learn about new things. But sometimes there might be an animal that looks like *this* in the world, and there might not be. So I think you might need to be a bit creative in the world

Interviewer: okay

Jelly: most scientists are creative

Interviewer: okay, does anyone else have any thoughts about creative being

Cleo: I think it should be number two

Interviewer: okay

Cleo: because if you're creative, maybe you have to – you can't be over creative because maybe you have to stick to something and if you're too creative, you might not stick to it.

Interviewer: ah so as well as being creative you have to be able to do the instructions you've been given?

Cleo: yeah

Apple: you have to be able to stick to them

Interviewer: okay

Apple: I've got a good one and a bad one

Interviewer: oh okay shall we – which one do you want to talk about? The good one or the bad one?

Apple: the bad one

Interviewer: okay, so which one do you think is not important?

Apple: I think likes computer games because if you're doing the computer like I said

Interviewer: yeah

Apple: and you play computer games, it might make your eyes bad so you can't see the computer properly

Interviewer: so if you play computer games too much, you won't be able to…

Apple: yep

Interviewer: what does everybody else think about that one?

Pepperoni: yeah

Child: I agree

Interviewer: what do you think about that one [Pepperoni]?

Pepperoni: yeah I agree with that one as well

Interviewer: okay, and [Pepperoni] you just put inventive on number one, can you tell me –

Pepperoni: I didn't put that one, it was [Jelly]

Interviewer: you didn't? Oh it was [Jelly] who put that one? Which one did you just put on number one?

Pepperoni: likes learning languages

Interviewer: okay, can you tell us about that?

Pepperoni: because maybe scientists might have to learn languages because maybe when they scan a bone or something it might – I don't know if this makes sense but – it might be from another country and the computer talks in different languages?

Interviewer: okay, so you think it might be useful to be able to use information from other places that maybe aren't written in English?

Pepperoni: uh huh

Interviewer: okay. Go on [Cleo]

Cleo: I agree with [Pepperoni] because maybe if you're an archaeologist and you've found something – let's say in Latin, you might be able to read it, and you might use a computer but on the other hand you should still be able to know how to try and read it

Interviewer: okay, good ideas. Go on [Jelly]

Jelly: it might be written in very old Latin, like old English. Some people from now can't understand old English, Italian can't understand old Italian

Interviewer: okay, so it might be good to know those languages? Okay so you guys have just put absolutely loads on there. Shall we talk about inventive?

Jelly: I put that one on

Interviewer: okay, what did you think about that one?

Jelly: if you're being an engineer in a university, you might need to be inventive to be able to create new things like [pause] a person needs to be creative to make a chocolate bar

Interviewer: yeah! What does everybody else think about that one?

Pepperoni: I agree

Interviewer: okay, so [to Apple] what was your good one that you had?

Apple: my good one was listens to other people's opinions

Interviewer: okay [Apple], so listens to other people's opinions – how important do you think that it?

Apple: I think it's a two because you can listen to other people's opinions, which is a good thing because it gives you more ideas

Interviewer: yeah

Apple: but sometimes you've got to have your own ideas as well

Interviewer: okay – what does everybody else think?

Children: yeah

Cleo: I've got [unclear]

Interviewer: you've got three? [Cleo] did you just put one on there?

Cleo: yeah, I put curious

Interviewer: okay, and you put curious on number two, what made you put it there?

Cleo: you can't be over curious, because you can't just be nosey looking at what other people are doing

Jelly: yeah, like if you have someone next to you and you're being really nosey

Cleo: and it's like if you were doing a test, you can't really look over and ask people questions

Interviewer: okay

Cleo: so you can't be that curious, but it's still important to learn new things. It helps learning new things

Interviewer: okay, brilliant. Go on [Pepperoni], pick your favourite out of the four you've got there

Pepperoni: I'm going to pick can work independently

Interviewer: okay, and what do you think about that one?

Pepperoni: I think you need, if you're a scientist you need to be independent

Interviewer: uh huh

Pepperoni: because you can't always ask for help, you need to do stuff yourself. Because one day you might have to do a test on your own without anyone else and then you might not learn anything because you've been copying people.

Interviewer: ah okay, so where do you think that should go? Where would you like to put that one?

Pepperoni: I think it should go in the second one

Interviewer: the second one? What does everybody else think about that one?

Cleo: I think it should be in the third one

Interviewer: ooh why do you think it should be in the third one [Cleo]?

Cleo: because you need to work independently, but sometimes you need to actually – you can't always be by yourself, just doing everything by yourself because sometimes you have to work as a team

Interviewer: okay

Cleo: so if you're not good at team work, you're not going to get very far in life

Interviewer: okay, well we've got can work as a team on number one, who put that one on there?

Apple: me

Interviewer: what do you guys think about that one? Are you happy with that one on number one?

Apple: I think that should actually go on number two

Interviewer: why do you think that

Apple: because independence is a good thing

Interviewer: okay

[unclear]

Interviewer: so you think can work in a team and can work independently should go on the *same* one?

Cleo: yeah

Interviewer: they're equally important? Okay, what does everybody else think about that?

Pepperoni: yeah

Apple: okay

Interviewer: fab, okay. Who's turn is it next?

Pepperoni: [Jelly]

Jelly: I think it's mine – I've missed a couple of my turns

Interviewer: okay [Jelly] which one would you like to talk about?

Jelly: I'm going to put on learns from their mistakes

Interviewer: uh huh

Jelly: that's very important because say if you got something wrong in science, you need to learn from that mistake and move on

Interviewer: okay

Jelly: so that you know your mistake, but you can learn from it and learning from your mistakes means that you can learn more things, but if you don't make any mistakes in life you won't be able to learn as much

Interviewer: okay

Jelly: and then you'll be perfect, and you won't need to learn because you'll be perfect

Interviewer: is there anyone who you think is like that? Who doesn't need to learn anything?

Children: no

Pepperoni: not me

Interviewer: I think everybody can learn something can't they? What else did you want to talk about

Jelly: this is something that describes me

Interviewer: Wants to understand how things work? What do you think about that one [Jelly]?

Jelly: I think it's a 2 or a 1 I don't really know

Cleo: I think it's a 2 because it means the same thing as curious

Jelly: yeah but say if you were studying how bodies work, how things work, how your brain works, how your heart works

Child: I think it should go on number one

Jelly: how your body works and all your body functions

Interviewer: okay, so you guys think number one? Why did you think number one?

Pepperoni: because it's really important Because if you don't know how things work, you might not learn, when you grow up, you might not know stuff. You might not know how stuff works and you might make it really wrong. When you do a mistake the first time, you might do it a second time, and you need to understand how to do it right

Interviewer: [Jelly] you've just put one on number five, which one did you put on there?

Jelly: competitive

Pepperoni: I don't actually know what it means

Apple: I think it's number four as well. Because if you get *too* competitive, you can start to be mean, and bring down other people's work

Cleo: but you can't just be lazy

Interviewer: ah okay

Apple: yeah, you can't just be lazy. You do need to be a bit competitive

Jelly: if you get too competitive, you might upset someone and it can bring their emotions down, and you could bring their work levels down as well

Interviewer: ah okay, so you need to be careful when you're being competitive?

Jelly: yeah

Pepperoni: I think it's four

Interviewer: so do we think four?

Apple: yeah

Jelly: Last year on sports day, I got really competitive. I went round a corner really fast and I ended up sliding

Interviewer: oh no

Jelly: and twisting my ankle because I got too competitive

Interviewer: there you go! Yeah, you need to be careful with it. Speaking of being careful, sensible [Pepperoni]? What do you think about sensible?

Pepperoni: Sensible, because if you don't be sensible, you might go too far and it might go all wrong because you didn't be sensible. And if you're sensible, you wouldn't have messed it up

Interviewer: okay, so what does everybody else think about that one?

Cleo: you can't be over sensible, because then it will be boring if you're too sensible, so you need to have at least fun with your job

Apple: yeah you need to have a bit of fun

Interviewer: three okay, is everybody happy with that one?

Children: yeah

Interviewer: okay [Cleo]?

Cleo: I've got logical

Interviewer: logical, what do you think about logical?

Cleo: I think number one because if you're just making stuff up, it's not going to be true, and you're going to be spreading lies around

Interviewer: okay – what does the glossary say that logical means?

Cleo: to be able to think clearly about facts and information

Interviewer: okay, how important do we think that is?

Child: a little, maybe number two

Cleo: I think number one

Interviewer: okay, so you think number one, you think number two. Why do you think number two [Cleo]?

Cleo: because if you don't understand facts and information, you can't really transfer it to anything. If you have a question in school, it might be like a comprehension or something. So you have to read the text and you have to find out the answers and

Apple: wait, what was it again?

Interviewer: logical – so what did logical mean again?

Cleo: is able to think clearly about facts and information

Interviewer: okay, and what did you think [Pepperoni]? why did you think number two?

Pepperoni: I think now it's number one

Interviewer: okay

Pepperoni: because knowing facts and information helps you be a better science person

Interviewer: okay

Apple: yeah but if you understand everything that means you don't have anything else to learn

Interviewer: ah okay

Jelly: [Apple] is right

Interviewer: what do you reckon then?

Apple: number…

Pepperoni: now I'm thinking number two again

Interviewer: that's okay because like I said, because we're recording the conversation I can remember what everybody said about everything

Jelly: if you know everything there's no point of being alive because you need to learn new things to have fun

Interviewer: okay

Jelly: so if you knew all the maths, you wouldn't really be learning anything you'll just be like "errrr"

Interviewer: okay

Cleo: but if you are logical, it means to be able to think clearly about facts and information you're given, not like facts and information [that] you already have

Interviewer: okay, I tell you what guys – this has been very good – there's another little part to this activity which we've got five minutes left for. So I'm going to quickly take a photo of [recording paused]

Interviewer: what do you think of them, practical and likes being outdoors?

Apple: I think practical should go on four, because if you're not practical at all, that means no one's going to like you because you're not funny.

Interviewer: okay

Apple: but if you're a little bit practical, some people are going to like you because you are a little bit funny

Interviewer: ah like a practical joker?

Apple: yeah

Interviewer: and what did you think about likes being outdoors?

Apple: likes being outdoors, I think that would be a one because you could discover new things like go exploring and discovering

Interviewer: brilliant, thank you very much. So we just have a couple of minutes and if there are any words that two of you want to use, that's fine you just need to share them okay?

Apple: okay. Does it matter what number it's on?

Interviewer: no not at all, just choose whichever one you think describes yourself, it can be *any* of the words we've talked about

Jelly: I've picked five

Interviewer: you've picked five? While everyone else is choosing theirs, [Jelly] could you tell me why you've chosen those five words?

Jelly: I've got six!

Interviewer: ah you need to choose five mate

Apple: I've got five!

Interviewer: you've got five? Fab [Apple]

Apple: the third one is the best one to describe me ever

Pepperoni: I've got six!

Interviewer: You've got six?

Cleo: I've got five

Interviewer: You've got five? While you're having a think about which one you're going to put back can [Apple]? Can you tell us which words you've chosen and why you've chosen them please?

Apple: Imaginative

Interviewer: yeah?

Apple: because when I'm at home, I like grabbing my toy sword and shield and pretending I'm in a battle

Interviewer: oh cool, okay

Apple: I also chose – I like visiting other countries

Interviewer: okay

Apple: I've only been to one country and I'm really looking forward to going to Turkey

Interviewer: ooh brilliant, I went to Turkey in the summer – it's very nice, you'll enjoy it

Apple: this one is the best one to describe me ever

Interviewer: yeah?

Apple: likes computer games

Interviewer: okay

Apple: it's just because

Jelly: fortnite?

Apple: you know *boys* – the boys are the ones that like the computer games

Interviewer: okay

Jelly: that word *definitely* doesn't describe me

Interviewer: you don't? So maybe not *all* boys like computer games?

Cleo: I don't

Interviewer: you know what guys? [whisper] I quite like to play computer games as well, so maybe not everybody thinks one way

Jelly: I like reading

Interviewer: I like reading as well – what was your last one?

Apple: my next one is practical

Interviewer: yeah

Apple: because I'm funny a little bit

Interviewer: yeah

Apple: and my last one is likes being outdoors

Interviewer: okay

Apple: because at the moment, I've got a sore throat

Interviewer: uh huh

Apple: so I like being outdoors to get some fresh air every now and then

Interviewer: ah nice, okay

Jelly: I like going outdoors

Interviewer: is there anything else that you wanted to say about those ones?

Apple: no

Interviewer: no? brilliant, [Cleo] could you tell us what your words were? Thank you [Apple]

Cleo: so these words describe me the most: enjoys sport because I do sports every day, and I *love* it

Interviewer: which sports do you do?

Cleo: I do gymnastics three times a week because I do squad training, I do football on Fridays

Interviewer: yep

Cleo: I do swimming on Monday and also on Wednesday s I sometimes go out and play football with my dad

Interviewer: that is *a lot* of sport – brilliant. Okay and what were your other words?

Jelly: I play football with my grandad, but he doesn't play fairly he doesn't play by the rules

Interviewer: we're listening to [Cleo] at the moment, but that sounds very fun playing with your grandad

Cleo: can work independently because I like working independently because I can get more ideas down in time

Interviewer: uh huh

Cleo: because I write very slowly, but neatly

Interviewer: okay, brilliant can you tell us your other words please?

Cleo: I'm sensible

Interviewer: yeah?

Cleo: because I don't usually break rules

Interviewer: okay

Cleo: and I don't like to mess about a lot

Interviewer: okay

Cleo: and I'm competitive because I'm used to winning stuff a lot

Interviewer: okay

Cleo: whenever I do my sports

Interviewer: okay

Cleo: and I'm clever because I work hard

Interviewer: ah okay, thank you. [Pepperoni] can you tell us your words please and why you've chosen them?

Pepperoni: I've got learn from their mistakes because if you don't learn from their mistakes, you won't get any better

Interviewer: okay, you think you *do* learn from your mistakes?

Pepperoni: yeah. I put enjoy maths because if I want to be a scientist, I need to learn maths

Interviewer: okay, and what else did you choose?

Pepperoni: can use computers

Interviewer: fab, okay why did you choose that one?

Pepperoni: because I like researching stuff on computers

Interviewer: okay

Pepperoni: and I done likes learning languages because –

[noise from children entering room]

Interviewer: [Pepperoni] can you finish telling us your words please? Which ones had you told us about before?

Pepperoni: I think this one

Jelly: you told us about four

Pepperoni: I think these two I haven't done

Interviewer: okay, can you please tell us about those two and why you chose them?

Pepperoni: I enjoy science because you can learn a lot from it

Interviewer: uh huh

Pepperoni: I think that's all why I like science

Interviewer: okay, brilliant why did you choose enjoy maths?

Pepperoni: I enjoy maths because as well, you can learn a lot from it and it's lots of fun ways to learn how to do maths

Interviewer: ah okay, so you like all the different things that you can do within it? Thank you is there anything else that you wanted to add to that [Pepperoni]?

Pepperoni: no

Interviewer: no? thank you very much [Pepperoni]. [Jelly] can you tell us about your words please?

Jelly: I put like helping others because I'm a buddy and I normally like helping others

Interviewer: okay

Jelly: I help all in need, I give money to charities, I help homeless people

Interviewer: okay

Jelly: give them money to buy food and all of that

Interviewer: okay

Jelly: and I put can takes risks because I like climbing cliffs

Interviewer: okay

Jelly: and I put like to learn new things because learning new things is fun

Interviewer: okay

Jelly: like I don't know how to do a backflip, and sometimes you need to get hurt to learn new things, and that's why I've picked these as a joint

Interviewer: ah so can take risks comes hand in hand with learning new things sometimes? Okay

Jelly: I put enjoy history because I enjoy history, I like learning about Romans, Celts

Interviewer: yeah?

Jelly: I'm starting to understand Old English

Interviewer: very cool

Jelly: I'm learning German

Interviewer: brilliant, okay. And your last card?

Jelly: is hardworking

Interviewer: yep

Jelly: because I am very hard working. I can write two and a half pages in fifteen minutes

Interviewer: no way

Jelly: yes

Interviewer: okay, thank you very much guys

39 Appendix 27: Pupil task-based interview 2, NB

Title: Pupil interview 2

Date: 15th March 2019

Speakers: Poppy Hodkinson (interviewer), Jelly, Apple, Cleo and Pepperoni

Interview duration: 29 Minutes

Interview location: NB

Interviewer: so, the first thing I thought we could talk about today is some of the people that we know in our lives who work in STEM. So, just to recap: what does STEM stand for again?

Child: I know no one

Cleo: Science, technology, engineering and maths

Jelly: Mathematics

Interviewer: maths *or* mathematics yeah, absolutely. Right, what colour paper do we want? Is blue okay?

[discussion about colour of paper and pens children will use]

Interviewer: so we're going to make a mind map of all the people that *we* know who work in STEM, or are involved in STEM. So what shall we put in the middle of our mind map?

Child: STEM

Jelly: I know literally no one

Interviewer: STEM okay

Jelly: I know no one

Interviewer: [whisper] that's okay

[talk about the pen and how to present the centre of mind map]

Pepperoni: [Jelly] did you just say 'umm'?

Interviewer: are you thinking?

Jelly: yeah

Interviewer: okay, brilliant. Very neat. So can we think of anybody in our lives – so that might be someone in your family

Jelly: you

Interviewer: it might be a friend, it might be someone at school

Pepperoni: wait, does BT sport count as STEM?

Interviewer: yeah, sports?

Pepperoni: My dad works at BT sport

Interviewer: does he? What does he do at BT Sport?

Pepperoni: I don't really – he – I don't really understand but sometimes he goes to London to have meetings, and he goes to different football pitches.

Interviewer: oh wow, that sounds interesting

Pepperoni: basically [unclear]

Jelly: does this count?

Interviewer: oh he works with football does he?

Apple: can we do four lines? One for each of us?

Interviewer: yeah, that's a good idea okay. So do you want to do your line first [Pepperoni]?

Jelly: does a social worker count as something in STEM?

Pepperoni: shall I write my dad or BT Sport?

Interviewer: how about both? So 'dad works for BT Sport'? So a social worker, do they do anything with science, technology, engineering or maths?

Jelly: he goes into London and has meetings, he looks after children

Pepperoni: oh my dad does maths in BT Sport because sometimes he has to maybe – I don't know – count up stuff?

Interviewer: okay, put maths on there

Jelly: my dad has to use his computer or a phone every day

Interviewer: okay, so in his job he uses that? So pop those ones down

Jelly: okay, I'll just write 'social worker'

Interviewer: but then, put the STEM thing that they do as well

Pepperoni: shall I write 'maths' going out?

Interviewer: why don't you put maths off of that one so we know that it's maths that your dad uses

[chat about mind map presentation]

Interviewer: what was it that you said your dad did?

Jelly: social worker

Interviewer: what were the STEM skills that he uses in his job?

Jelly: a computer and his phone

Interviewer: okay, fab so put those ones down. [Cleo] did you have anyone?

Cleo: my mum works as a software engineer in the [University]

Interviewer: ah brilliant okay, so you definitely want to put that one on there. [Apple] did you have anyone that you wanted to put on? Maybe a family friend or an older brother or sister?

Apple: no, but my dad used to work at a motorbike place

Interviewer: oh really? What did he do at the motorbike place?

Apple: He had to do maths because loads of people wanted motorbikes so he had to do lots of maths to work up all the money stuff and bills and things

Interviewer: ah so when he was selling them things?

Apple: like bills and stuff

Interviewer: ah okay

Jelly: someone else that I know that does science – J's dad! He builds, so he's an engineerer

Interviewer: oh is he? Okay

Jelly: a builder.

Pepperoni: He's a scaffolder

Jelly: that counts as engineering!

Pepperoni: yeah, I just wanted to give you the word

Interviewer: ah so he's a scaffolder okay

Jelly: it counts as engineering

Apple: what shall I write?

Interviewer: what was it that you were going to say [Apple]? So your –

Apple: grandad worked at a biker shop

Cleo: wait, shall I write technology?

Interviewer: yeah, good idea. Your dad worked at a bike shop

Pepperoni: my dad used to work at a fire station, does that count as STEM?

Interviewer: does he do things with Science, technology, engineering or maths?

Pepperoni: [thinks] I don't know what firemen do that involves STEM, I don't really know

Interviewer: okay – well I'm not sure exactly what firefighters do either

Cleo: oh my mum used to work at the fire department, and she used to advertise the websites and stuff

Interviewer: oh really? So what would that relate to in STEM?

Apple: shall I just put adding up?

Cleo: technology?

Interviewer: technology, yeah

Jelly: my mum used to work in Asda as a till lady?

Interviewer: in that one the till adds it up for you maybe? But she might have still used other STEM skills? Can anyone think of anyone else?

[pause]

Interviewer: because I've got a couple of my friends as well that I thought we could talk about

Jelly: oh Poppy! I can write Poppy!

Interviewer: ah are you going to put me?

[laughter]

Interviewer: cheers guys! [laugh]

Child: Poppy science!

[chatter about a red nose one of the children has with them]

Interviewer: so as well as all of your family members and family friends who work in STEM, I've brought some of my friends who work in STEM for you guys to have a look at – would you like to look at one each? We can read them out to each other and what it is they do with their jobs

Apple: I've got Scott

Jelly: that looks like my aunty who died last year

Interviewer: oh, well this is somebody else [laugh]. Would you like to start [Apple]?

Jelly: my aunty was called [name]

Interviewer: oh really? Well this person's called Johanna – her name is Swedish so it's pronounced a little bit differently. So [Apple] did you want to read out your description of this person that I'm friends with?

Apple: [description of Scott, comments that he owns a VR headset whilst reading]

Interviewer: awesome, shall we read out another one? In a second we're going to have a think about all of the skills that these people need to use. So thank you for reading that out [Apple]. Who would like to read the next one? Go on [Cleo]

Cleo: [reads Chloe description]

Interviewer: okay, so she uses some STEM skills in her job as well. Who would like to go next? Go on [Pepperoni]

Pepperoni: I don't know how you say it but, it's R-h-o-d-I

Interviewer: Rhodri, so that's a Welsh name

Pepperoni: [Rhodri description]

Interviewer: lovely, thank you [Pepperoni]. So have a think about some of the STEM skills that Rhodri might use. What about Johanna?

Jelly: I can see why she's your friend!

Interviewer: go on?

Jelly: by the text

Interviewer: will it all become clear?

[discussion about how to pronounce Johanna]

Jelly: [description of Johanna]

Interviewer: Brilliant, okay so she also uses STEM skills. And I've got the last one here, shall I read this one out? Can you guys see this person?

Pepperoni: no

Interviewer: Can you see the picture?

Pepperoni: okay, now I can

Interviewer: [Ali description] so now that we've got all of those – do you remember these? [word cards] we had them last time

Pepperoni: oh yeah

Interviewer: do you remember these words?

Children: yeah

Interviewer: can we have a look at these and think about the people in your lives that you know who work in STEM and about the people that we've talked about here – and can we pick out skills that we think would be important for them in their jobs?

Jelly: I already know one for [friend's] dad

Interviewer: go on then

Jelly: he's an engineerer – he owns his own company

Interviewer: yeah?

Jelly: a car company

Interviewer: okay and what does he do with the cars?

Jelly: he sells them

Interviewer: ah

Jelly: builds them

Interviewer: he builds them and sells them? Wow okay what kind of skills –

Jelly: he's hardworking, he's honest

Interviewer: yeah

Jelly: very competitive

Interviewer: okay

Pepperoni: I don't know why I picked 'like playing computer games' I don't know why

Jelly: he does

Interviewer: so why did you choose likes computer games?

Pepperoni: I'm not finished

Interviewer: you're not finished? Okay

Child: how many do we pick?

Interviewer: well just pick out some that you think are important and we can talk about them

Apple: these are ones for my grandad: enjoys maths, can work independently

Interviewer: okay, so could you tell us more about those ones? Why would those be important for your grandad?

Apple: because he enjoys maths because he's really good at adding up bills

Interviewer: okay

Apple: he's clever because he – if I ask him to fix an iPad or something, he'll just do it

Interviewer: okay

Apple: it will take him like five days or something, but he'll do it

Interviewer: oh okay, are there any other things as well? If it takes somebody a long time to do something but they get it done in the end, are there any other words that might describe that person?

Jelly: hardworking

Cleo: patient

Interviewer: patient yeah – is patient on there?

Apple: no

Jelly: likes computer games maybe?

Interviewer: maybe… we'll see, we might come across the word. And the last one?

Apple: can work independently

Interviewer: okay

Apple: because sometimes – for his birthday which was either tomorrow or the day before

Interviewer: yeah

Apple: my cousin got him an amazon Alexa

Interviewer: oh yeah

Apple: and grandad worked it out himself

Interviewer: ah so he worked by himself to understand a new piece of technology?

Apple: yeah

Interviewer: okay, thank you for sharing those with us – does anyone else that they think might be important for the people in their lives or the people that we talked about?

Jelly: me. Me!

Interviewer: go on [Pepperoni], your hand was up first

Pepperoni: I don't know what ones to pick, I've got a lot

Interviewer: oh wow. I should have said as well, I've got the glossary so if there are any that we're not sure what they mean, we've got the definition of them here.

Pepperoni: I don't know what one to pick first

Interviewer: gosh, you've got a lot – right, which one would you like to go for first?

Jelly: first of all, who are you describing?

Pepperoni: my dad

Interviewer: was it anyone in particular? Or did you just think it was useful if you worked in STEM?

Pepperoni: yeah, likes helping others

Interviewer: okay can you tell us more about that one?

Pepperoni: I don't really know, I just picked this because I think it's important

Interviewer: okay, is it important for people who work in STEM in particular?

Pepperoni: yeah, because – I don't know

Interviewer: okay, but you just thought it was important?

Pepperoni: yeah

Interviewer: okay – what about any of the other words?

Pepperoni: oh I've got it now!

Interviewer: go on

Pepperoni: so you need to work together to figure out – if you're a – how do you say it?

Cleo: Archaeologist

Pepperoni: yes! There you go. You have to help each other to figure out what bones it is and like [Apple's] as well, sometimes you have to work independently

Interviewer: okay

Jelly: I have to help my brother learn how to play a videogame called [unclear]

Interviewer: okay that's nice of you, so you like helping him with that? Are there another words that you wanted to talk about that you think are important for people who work in STEM [Pepperoni]?

[pause]

Pepperoni: ah this one!

Interviewer: go on

Pepperoni: listens to other people's opinions – I picked listens to other people's opinions because if you don't listen to other opinions, you won't get any ideas. The person who's saying their own opinion might have a really good – I don't know… or have an opinion [laugh] there you go!

Interviewer: [laugh] okay, thank you. Go on [Cleo] was there one that you wanted to talk about?

[chat about red nose]

Cleo: I think for Chloe – she needs to enjoy building things, because she designs things

Interviewer: yeah?

Cleo: but she has to enjoy building things at the same time

Interviewer: okay, awesome. Were there any other words that you think might be important?

Cleo: and for STEM overall, you need to like being outdoors because sometimes you have to do experiments, if you're a scientist or if you're doing archaeology

Interviewer: yep

Cleo: and you're excavating places, you need to be outside to do it

Interviewer: okay, brilliant – thank you. Was there anything else that you wanted to say about that?

[Cleo indicates no]

Interviewer: fab, okay [Jelly] which words did you think might be important for somebody who works in STEM?

Jelly: I'm doing this for my friend – he's a grown up but I can never remember his name. He's [friend's] dad

Interviewer: okay, what does he do in STEM?

Jelly: he owns his own company, he uses a computer to design a car

Interviewer: okay

Jelly: he's very competitive with other companies, he's very honest

Interviewer: okay

Jelly: because what if you say: "I know this answer in STEM", but you never do?

Interviewer: okay

Jelly: so you need to be honest, and he's very hardworking. Extremely hard working

Interviewer: okay. Fab thank you. Where there any other words on here that we thought might be important? Go on [Pepperoni]?

Pepperoni: I've got four

Interviewer: four? Okay go on tell us about one of them first

Pepperoni: well I've got even more but I had to pick – I had all them, but I had to pick the best four

Interviewer: so you've picked the four that you think are most important?

Pepperoni: yeah. Reliable so if someone – reliable, wait?

Apple: it means you can rely on people

Jelly: you can rely on a person, so I rely on you

Apple: reliable means you trust

Interviewer: so [Pepperoni] will read it out to us – those are good definitions

[Pepperoni reads glossary]

Pepperoni: ah now I know! So you need to be reliable to be an –

Cleo: archaeologist

Pepperoni: there you go – so you need to be reliable if someone needs you – with all the bones and you have to be sensible and reliable with all of them

Interviewer: okay

Pepperoni: then my second one: likes to learn new things because –

Jelly: a word to describe you!

Interviewer: do you think?

Pepperoni: yeah, because you have to learn when you learn new things, you learn from

Jelly: I learn new things every day

Pepperoni: yeah every second I learn new things

Interviewer: okay

[teacher speaks]

Pepperoni: two more

Interviewer: two more? Okay

Pepperoni: enjoy science because if you don't enjoy science and you work for a STEM company, one day you might have to do STEM and you might – well you don't *have* to enjoy science, but it would be better if you enjoy science to do science

Interviewer: yep, fair enough, you might enjoy your job more if you like it

Pepperoni: last one: sensible – I've already explained this

Jelly: you really do need to be sensible

Pepperoni: can I do another one because I've already explained this

Interviewer: oh you did yeah

Jelly: you have to be sensible because you can't just be playing catch with random bones

Interviewer: no, that's very frowned upon

Jelly: oh yeah! come here! Catch that! You can't be throwing *bones* all over the place – what if you hit someone in the head?

Pepperoni: actually no

Interviewer: not resourceful, you're going to do creative instead?

Cleo: [Jelly] don't you mean if you hit someone anywhere?

Pepperoni: so you have to be creative to do something? We're making [an] invention and you have to be creative – you don't have to be, but you can be as creative as you like

Interviewer: okay

Jelly: I've been very creative with my invention. It's basically a really fancy windmill that can stop a tornado

Interviewer: ohh that sounds really useful

Pepperoni: mine is a bin which has electric arms to pick up trash on the floor

Interviewer: oh is this stuff you've been doing in Science Week?

Child: yeah

Interviewer: There's one more quick thing that we need to do guys – sorry to interrupt you [Pepperoni]. Do you remember before we picked out five words that we think describe ourselves and talked about?

Jelly: yes

Interviewer: can you choose five words and remember that if somebody else has chosen that word you can also have the word – so you guys can share the words

[fault on recorder]

Interviewer: okay, so have we all chosen our words?

Apple: yes

Jelly: no! I can't find the word that I need!

Interviewer: while [Jelly] is looking for a word, can one of you who *does* have five words, share them with us please?

Apple: me!

Interviewer: Go on [Apple], you go first. [Jelly] you need to look for your word quietly – in fact if you listen to what everybody says, you might find that they have the word you're after. So [Apple] could you please tell us about the words that you chose?

Apple: I've got: enjoys building things

Interviewer: yeah?

Apple: because I like building Lego

Interviewer: okay

Apple: I put I like helping others because [pause] sometimes in the Golden Mile I run with people

Interviewer: yeah?

Apple: because if they're running on their own, I try and run with them

Interviewer: oh to support them?

Apple: yeah

Interviewer: okay

Apple: imaginative because sometimes I just go wild with imagination

Interviewer: yeah?

Apple: I imagine there's a massive T-rex, pterodactyl, evil thing outside

Interviewer: oh my goodness!

Jelly: I can imagine doughnuts flying into my mouth!

Apple: exactly!

Interviewer: okay, fabulous

Apple: I also put enjoys sports because I *love* football

Interviewer: uh huh – are you listening [Jelly]?

Apple: and likes computer games *obviously*

Jelly: that's the one that *I* was trying to find

Interviewer: okay, well we can pass that one over now. Who would like to talk about their words next?

Child: me me me!

Interviewer: go on [Jelly]

Jelly: yay

Interviewer: sit down and tell us which words you've chosen and why you've chosen them

Jelly: the one word that describes me the most: likes learning languages

Interviewer: okay

Pepperoni: yeah, German

Jelly: I love German, I can already count from 0 to 9,999

Interviewer: really?

Jelly: I can have a full conversation

Pepperoni: I can only count to [unclear]

Interviewer: well maybe don't do it now [laugh]

Pepperoni: I can't count to 1000 in English, barely in German

Interviewer: okay, and what was your next card?

Jelly: enjoys history. Definitely me. I like computer games – every day of my life. I'm hard working and I am reliable

Interviewer: okay, is there anything you wanted to say about being hardworking and reliable?

Jelly: [pause] I rely on [Pepperoni] and [Pepperoni] sort of relies on me?

Pepperoni: because we're girlfriend and boyfriend

Interviewer: ah okay

[chat about red nose and heading back to class]

Interviewer: can you please tell me which words you chose and why you chose them?

Pepperoni: Likes visiting other countries

Interviewer: so you chose likes visiting other countries, why did you choose that one?

Pepperoni: because [pause followed by laugh]

Interviewer: do you want to have a think about that one and talk about it again at the end?

Pepperoni: yeah

Interviewer: okay which other ones do you have?

Pepperoni: enjoys science because I like science because learning new things

Interviewer: which bit do you like best about science?

Pepperoni: experimenting with stuff and problem solving – like bones and stuff

Interviewer: okay cool

Pepperoni: and then I've got can use computers because I like to use computers and you can learn on them

Interviewer: okay, what kind of things do you learn on you computers – do *you* like to learn on computers?

Pepperoni: I research stuff

Interviewer: okay, anything in particular?

Pepperoni: I research [pause] gemstones and stuff

Interviewer: oh very cool okay

Pepperoni: and creative – I put creative because I just like to be creative

Interviewer: okay, what do you like to 'create'?

Pepperoni: something which involves football [Pepperoni is wearing Barcelona kit]

Interviewer: ah okay so you like to be creative with football?

Pepperoni: yeah. And then I put enjoys dancing because I just do like dancing

Interviewer: and then likes visiting other countries – what made you choose that one?

Pepperoni: I made me choose that one because I like learning new things in different countries

Interviewer: ah what kind of countries do you like visiting?

Pepperoni: Spain, Barcelona, Lanzarote

Interviewer: I can see that you like going to Barcelona, have you been to the Nou Camp?

Pepperoni: no, actually, I haven't been to Barcelona but I went to Lanzarote which is in Spain and I came from Kent – that's is two hours away, so it isn't in a different country but it's kind of like… that's all I've got

Interviewer: that's all you've got? Brilliant. Is there anything else you want to add?

Pepperoni: well I can add to 'can use computers' and 'enjoys science' and 'creative'

Interviewer: okay wonderful

Pepperoni: so can use computers: actually no I can't add to that one

Interviewer: okay, that's fine

Pepperoni: enjoys science: because I love finding out new things and I like predicting stuff, because I like working out new things

Interviewer: okay

Pepperoni: and creative: because we're building an invention – and you have to

Interviewer: yeah

Pepperoni: yeah, I said that earlier

Interviewer: wait, let me remember what yours was. Was it a machine to pick up rubbish?

Pepperoni: yes. Wait – did I do? Yes, I have done them all

Interviewer: you've done them all? Brilliant, thank you so much, is there anything else you want to say before I stop the recording?

Pepperoni: yes

Interviewer: yes! Go on then, what would you like to say?

Pepperoni: I've visited different other countries – I've just remembered

Interviewer: uh huh

Pepperoni: I've visited Australia

Interviewer: wow

Pepperoni: France and maybe next time we might go to – what is it called again? Mexico!

Interviewer: wow, okay brilliant

Pepperoni: that's all

Interviewer: that's all? lovely thank you!

Cleo: I chose clever because I just like learning – I like learning and I like doing new things. And I enjoy sport because I just like being active and not always staying inside and not doing much

Interviewer: yeah

Cleo: and most of the time I get all of the answers right

Interviewer: uh huh

Cleo: I enjoy reading because it helps with learning

Interviewer: okay

Cleo: and I am quite competitive sometimes – like with the sports

Interviewer: oh so specifically with your sport

Cleo: yeah

Interviewer: okay is there anything else you wanted to add to that?

Cleo: [indicate no]

Interviewer: brilliant, thank you so much for that

40 Appendix 28: Pupil task-based interview 2, BF

Title: Pupil interview 2

Date: 19th March 2019

Speakers: Poppy Hodkinson (interviewer), Bluebell, Black Cat and Olivia

Interview duration: 62 Minutes

Interview location: BF

Interviewer: so we're going to start by making a mind map of the all the people that we know in our lives who work in STEM. What does STEM stand for again?

Children: science, technology, engineering and mathematics

Interviewer: wonderful, okay. So is there anyone – maybe someone in your family, or a friend that does anything, or has a job in STEM?

Black Cat: what if they look at – my brother he digs for bones

Interviewer: does he?

Black Cat: or something like that

Interviewer: oh cool, do you know exactly what it is that he does?

Olivia: isn't it archaeologist?

Interviewer: yeah, archaeologists dig for bones – but other people might do different types of digging

Black Cat: he found a dinosaur bone

Interviewer: really? Wow, where did he find that?

Black Cat: in our garden

Interviewer: in your garden?? Ah so is he interested in it, in your garden?

[chat about pen colour]

Olivia: I know somebody

Interviewer: you do? Go on [Olivia]

Olivia: you

Interviewer: [laugh] okay! So what needs to go in the middle of our mind map?

Bluebell: people in STEM?

Interviewer: yeah, that's a good thing to go in the middle?

Olivia: can I put STEM in the middle?

[chat about colours, children draw on mind map]

Interviewer: okay so, who were the people that we know in our lives who maybe work in STEM, or maybe they're studying something in it

Black Cat: or maybe they're interested in it

Interviewer: yeah exactly

Olivia: I think my – she's my baby sitter and she teaches me in dance – but I think she's working in science

Interviewer: is she? What is it that she does in science?

Olivia: I'm not quite sure, because she's in university but I don't know exactly

Interviewer: okay, so do you want to put that one down, and you had one as well with your brother's interest?

Olivia: shall I put [babysitter name]?

Black Cat: do we put the name of it?

Interviewer: you don't have to, you could just write 'your brother'

Olivia: how do you do [babysitter name]?

Interviewer: how do you spell it? What letter does it begin with? [spell out babysitter name]

Olivia: I'm sure we mentioned her in the other one – [babysitter name], I think we did

Interviewer: yeah, I remember you mentioning her before. So what is it that [babysitter] does?

Olivia: she's studying…

Interviewer: she's studying science at university, fab – and what is it that [brother] likes to do?

Black Cat: he likes looking at bones

Interviewer: did you know anyone [Bluebell]? maybe someone in your family, or a friend? Doesn't have to be your friend, it could be one of your mum's friends or one of your brother's friends?

[Bluebell speaks unclearly about brother]

Black Cat: [Bluebell] has a brother and three sisters

Interviewer: that's a lot -my brother has three sisters!

Bluebell: I'm not quite sure

Interviewer: you're not quite sure?

Bluebell: I don't know if that's kind [unclear]

Interviewer: well, do you want to put him on anyway? Which bit do you think he looks at? Does he look at science technology engineering or maths? Does he look at any of those?

Black Cat: I've got another one, it's a really good one

Interviewer: [whisper] okay, we're talking about [Bluebell's] one at the moment

Bluebell: he likes maths

Interviewer: does he? Okay, so [Bluebell's] brother likes maths – do you want to pop that on there?

Bluebell: how should I write it? Should I write his name?

Interviewer: yeah you can do

Black Cat: my first cousin

Interviewer: yeah

Black Cat: he is studying wine, and he is basically looking at all the berries and he's doing science on it

Interviewer: oh really? Like distillation and fermentation and all that kind of stuff? Very cool, okay – what was yours [Olivia]?

Olivia: you

Interviewer: me? [laugh] thanks

[chat about Bluebell's spelling]

Olivia: Poppy what do you do? An archaeologist?

Interviewer: yeah

Olivia: how do you spell that?

[spell archaeologist]

Interviewer: so we've talked about some of the people that you guys know in your families and friends, and I've brought

Bluebell: shall I write maths on [brother]?

Interviewer: yeah that would be good – so you'll remember its maths that I likes. I've brought some of my friends for you guys to have a read about. So these are people that I'm friends with who all have a job that's in STEM? So would you like to choose a person? I've written a little bit about what their job is and what they do with it

[children choose]

Interviewer: fab, who'd like to read first?

Olivia: me

Interviewer: go on then [Olivia]

Olivia: [Ali description]

Interviewer: so that's Ali – my friend who's a doctor, she works in Emergency medicine

Bluebell: I'm not a very good reader

Interviewer: okay, shall we read it together? Which would you prefer?

Bluebell: I'll try reading it

Interviewer: brilliant, go on then

Olivia: can I pick another one?

Bluebell: [Rhodri description]

Interviewer: so Rhodri works in IT and if people have problems with their computers or their phones, he helps them work out what's wrong and how to fix it. He also makes sure the security settings on their computer keeps them safe online. Thank you [Bluebell]. [Black Cat] would you like to read your one?

Black Cat: [Scott description. Children are unsure what VR is, interviewer explains]

Interviewer: okay so Scott is a technologist and he does experiments on different electrical products to make sure that they work or to try and improve them. And because he works for a

Japanese company, he gets to go to Japan to visit their main office. Shall I read one out? [Johanna description]. So really old objects need looking after in special ways

Black Cat: like those things from the sea?

Interviewer: exactly – and Johanna has to know exactly what kind of environment those objects like to live in, and how to keep them safe. Go on [Olivia], you do that last one

Olivia: [Chloe description]

Interviewer: okay, so Chloe is a civil engineer – this isn't the only thing that civil engineers do, but she'd worked with people in other countries to make sure that they have access to safe, clean water. She's a problem solver, and she has to understand what the problem is, and what needs to be done or built to overcome those problems

Black Cat: like plastic pollution

Interviewer: absolutely, that's a really big problem that engineers are dealing with – really good example. Do you feel like you understand each of those people? Is there anything you want to talk about with what they do a little bit more before we move onto the next bit?

Olivia: I think I understand them

Interviewer: [Bluebell]?

[Bluebell indicates yes]

Interviewer: fab, so

Olivia: I just want to say one thing to [Black Cat]

Interviewer: go on

[girls speak quietly to each other]

Interviewer: right, do you guys remember these from before?

Children: yeah!

Interviewer: Yeah, you remember the words? Okay, so what we're going to do now, is we're going to have a look at these words and have a think about which words and skills and traits and abilities are important for all of our friends and family here. So all of these guys that I've told you about, all the people in your families as well. And remember we've got the glossary as well, so if there's any words you're not sure about, we've got that there

[cards are spread out]

Olivia: [Bluebell] I've found 'enjoys maths'

Bluebell: where?

Interviewer: enjoys maths, so what was enjoys maths important for?

Olivia: his brother

Interviewer: for your brother, fab okay. Would enjoying maths be important for anyone else who worked in STEM?

Black Cat: maybe Johanna because she might need to count how many she has from that day and then figure out how many need that place

Interviewer: yeah maybe

Olivia: I also think Ali because she needs to count how many

Black Cat: patients?

Olivia: she needs to count how many medicines are left in case there's no more medicine left

Interviewer: great idea, so enjoy maths could be important for lots of people? Anything else on there at all that you think might be important?

Olivia: building things?

Interviewer: yeah?

Olivia: because Chloe – she designs things in our built environment

Interviewer: okay, so what might she build?

Olivia: she might build [pause] she might build a thing to help to stop the environment from flooding, like what happens

Interviewer: yeah maybe, to stop it from flooding

Bluebell: does he [Rhodri] fix things?

Interviewer: yeah,

Bluebell: does he fix or make things?

Interviewer: Rhodri fixes stuff, Scott makes them

Olivia: he could maybe put some walls around places that need them?

Black Cat: Like all around the water or places where lots of water goes there

Interviewer: okay, fab so shall we pop that one on Chloe then? What have you got there [Black Cat]?

Black Cat: enjoys history

Interviewer: okay, who's that important for?

Black Cat: Johanna

Interviewer: okay, why's that important for Johanna?

Black Cat: because she does things with history from the past

Interviewer: cool, okay

Bluebell: likes…

Interviewer: what have you got there [Bluebell]?

Bluebell: likes learning languages

Interviewer: okay, do you think that might be important for someone working in STEM?

Bluebell: maybe

Black Cat: Scott because he might need to learn

Bluebell: he might go to different places and he might want to talk to somebody

Interviewer: fab okay, pop that one on

Olivia: I've got one

Interviewer: go on [Olivia] which one have you got?

Olivia: [attempts to say methodical]

Interviewer: methodical yes, what does methodical mean

Olivia: I don't know

Interviewer: shall we have a look on the glossary, what does methodical mean?

Olivia: works through each stage of a task carefully. I think Ali needs to do that one

Interviewer: yeah?

Olivia: because she needs to think things through before, like which medicine they should take

Interviewer: okay, is there anyone else who needs to be methodical?

Bluebell: maybe him

Interviewer: Rhodri? Why does he need to be methodical?

Bluebell: because he needs to think things through – what he needs to do with that thing.

Interviewer: okay, fab. Any other words?

Bluebell: hardworking

Interviewer: hardworking, why might that be important if you work in STEM?

Bluebell: that's what they all do

Black Cat: because

Interviewer: [Bluebell] did you say for all of them?

Black Cat: it's because then if we only have one person on the task, then it's not

Bluebell: not very good

Black Cat: very quick, and then you want to get most of it done and we're all doing something

Bluebell: [unclear]

Olivia: I've got one

Interviewer: what was it you just said [Bluebell]?

Bluebell: about this?

Interviewer: about hardworking yeah. What was it that you said about hardworking?

Bluebell: probably all of them might need to do hard work

Interviewer: okay, cool

Olivia: I've got one

Interviewer: you've got a word [Olivia] yeah?

Olivia: likes to visit other countries, I think Scott might need it because he visits to Japan

Interviewer: yeah, okay. Who would like to talk about their word next?

Black Cat: inventive

Interviewer: inventive, what does inventive mean?

Black Cat: when you make things, like buildings – invent new

Interviewer: yeah, who might be inventive that we know?

Black Cat: Chloe

Bluebell: wait, what was that one?

Interviewer: this one's inventive, so can we read out the definition of inventive?

Children: inventive: comes up with new ideas to solve puzzles or design new things

Black Cat: but Chloe designs new things

Interviewer: yep, is there anyone else who designs new things?

Bluebell: [indicates Scott]

Interviewer: Scott, very good [Bluebell]

Olivia: I think enjoys dancing

Interviewer: enjoys dancing, is that important for any of the people that we know who work in STEM?

Olivia: I know she [pause]

Interviewer: ah you *know* [babysitter] does – so she's someone who's interested in science at university and she also enjoys dancing? Excellent, pop that one on her

Black Cat: enjoys science

Interviewer: yes [Black Cat] – who enjoys science?

Black Cat: think it's all of them,

Olivia: because they work for science

Black Cat: they all want these jobs and work in the science, and science is in STEM

Interviewer: okay so enjoying science is important if you work in STEM? Why is it important?

Black Cat: because [pause] you find out new things all the time

Interviewer: okay

Black Cat: and it's really useful because if somebody else comes across that same thing, and they need a little bit of help with it, then you can help them

Interviewer: okay brilliant. Shall we put that one in the middle, so we know that's for everyone?

Olivia: I've got one

Interviewer: Have you got one [Bluebell]? Shall we talk about one of your ones?

Bluebell: no, not really

Interviewer: no? okay, we'll talk about [Olivia's] one

Olivia: determined

Interviewer: determined, what does determined mean?

Olivia: it means 'doesn't give up, even if things become difficult'

Interviewer: okay, and why might it be important to be determined in STEM?

Olivia: so you can get past your task

Interviewer: okay

Olivia: and I think [babysitter's] quite determined to get past her exams

Interviewer: ah okay. So is that her science exams?

Olivia: [indicates yes]

Interviewer: does anyone else need to be determined? Is that important for anybody else?

Black Cat: maybe Chloe?

Interviewer: yeah?

Black Cat: because she want to be determined to build this thing? Maybe if it's not the right time to, she doesn't have many of the right things,

Olivia: like materials

Black Cat: but then she got them and then she can build it

Interviewer: ah so if she waits until she *does* have the right things she'll be able to do it? [Bluebell] what have you got there?

Bluebell: competitive

Interviewer: competitive – what does competitive mean [Bluebell]?

Bluebell: always tries their best to win

Interviewer: okay, so someone who always wants to win. Do you think that might be important if you work in STEM?

Bluebell: maybe [pause]

Interviewer: why do you think it might be important?

Bluebell: [pause] just so you get it right and maybe [pause]

Olivia: what was it?

Interviewer: competitive, so you said that it might be important so you get something right – does anyone else want to add anything to that? Do you think competitive is important if you work in STEM?

Child: yeah

Interviewer: yeah

Black Cat: but a bit because if somebody else from another place came over, and then they said “I can do this and you can’t” you might want to say something that they wouldn’t be able to do

Interviewer: okay

Olivia: so it’s a bit like [Black Cat’s]? So say if somebody said “I can do this and you can’t” then you would say to get them impressed “actually yes I can”, but you might not be able to yet

Interviewer: okay

Olivia: ooh I found something [indictates a poster in the room]

Interviewer: oh yeah it says science on [that poster]?

[chat about poster]

Interviewer: So have we got any other things that we think are important for somebody working in STEM? What have you got [Black Cat]?

Black Cat: curious

Interviewer: curious, okay. So why is being curious important?

Black Cat: because you might want to find out more things, not just stay to the ones which you already know, because you need to have a growth mind set if you want to be curious

Interviewer: awesome, so which people do you think need to be curious? Is there anyone in particular?

Olivia: I think maybe

Black Cat: I think maybe Johanna because she – well she's curious about history and she wants to learn more about it

Interviewer: okay, so Johanna's curious about history yep. Go on [Olivia]?

Olivia: organised

Interviewer: organised, why might it be important?

Olivia: I think Ali might be organised, because she might need to get the medicine out before the patient comes to pick it up

Interviewer: okay

Olivia: and she might need to make sure she knows it before – it might be really important

Interviewer: yeah? If it's very busy in her hospital yeah

Bluebell: does she do a hospital?

Interviewer: yeah, she works in a hospital

Black Cat: she's a doctor

Interviewer: so why might you need to be organised if you're a doctor in a hospital?

Black Cat: because if you can't remember where a medicine is, and your patient is coming, then you need to be organised where your medicines are

Interviewer: okay, cool thank you [Black Cat. Yeah - go on [Olivia]?

Olivia: I think – my dad needs to go to hospital because he's somehow pulled a muscle and it's really painful

Interviewer: oh no!

Olivia: so he had to go to the doctors – I forgot what the test is called in your leg

Interviewer: okay

Olivia: but the doctor was not organised because he didn't write down all the notes

Interviewer: ah so you need to be organised to write everything as well? And your dad had a doctor who *wasn't* organised?

Olivia: yeah

Interviewer: do you think being organised could have improved your dad's care?

[Olivia's response unclear]

Interviewer: okay.

Black Cat: logical

Interviewer: logical? Why might logical be important if you work in STEM?

Black Cat: because then you can think clearly what you're going to do in the future and what you've already done

Interviewer: ah so you can think clearly about what you're going to do and also think about what you've already done? Why might it be important to think about what you've already done?

Black Cat: because then that could help with something that is happening, or is going to happen in the future

Interviewer: okay, fab. Is there anyone in particular that you think needs to be logical here?

[pause]

Interviewer: there might not be?

[chat about cushions]

Black Cat: maybe Scott

Interviewer: you think Scott might need to be logical? Why might Scott need to be logical?

Black Cat: because he needs to – if he's going to Japan, he needs to think "what's the quickest way to get there?" because if there's something which has gone wrong with the technology then he has to get there because it could cause [unclear]

Interviewer: okay, [Bluebell] what have got there?

Bluebell: likes helping others

Interviewer: likes helping others

[Bluebell indicates Ali]

Interviewer: Ali?

Bluebell: because she's a doctor

Interviewer: yeah? So why is it that she needs to like helping others?

Bluebell: so she needs to give them medicine and stuff so she must like helping others

Interviewer: brilliant – is there anyone else who likes helping others as well? So Ali helps other people: she helps poorly people.

[Bluebell indicates Rhodri]

Interviewer: Rhodri, yeah? Who does Rhodri help?

Bluebell: I think he helps other people because he fixes stuff for them?

Interviewer: yeah so he helps people who've got something that's a bit broken? Pop that one down

Olivia: I've got another one

Interviewer: go on [Olivia]

Olivia: maybe Scott? Because he helps people to get their internet

Interviewer: ah okay, so you might want to help people get access to the internet?

Black Cat: I've got…

Interviewer: go on, what's your word?

Black Cat: sensible

Interviewer: sensible? Okay – why might being sensible be important?

Black Cat: because if you mess around with something and it was really expensive, and it was from a different country, then it's going to be really hard to get it back.

Interviewer: okay, what kind of things might these people use that are expensive?

Black Cat: maybe medicine – can sometimes be quite expensive

Interviewer: yeah

Bluebell: maybe, what's it called?

Olivia: I've got one

Black Cat: things that are expensive

Olivia: the equipment

Black Cat: materials, for building stuff – that can sometimes be – like metal can be very expensive

Interviewer: yeah okay, so the equipment. So we need to be sensible with that?

Bluebell: if he was fixing something

Interviewer: yeah

Bluebell: if he might have dropped it and broken it even more and he couldn't fix that then it's going to [unclear]

Interviewer: so Rhodri needs to be sensible with the equipment that he uses?

Black Cat: I think my cousin is sensible because he sometimes get tempted to squeeze out the berry and get some wine, but he doesn't

Interviewer: oh, so he has to be sensible not to drink the wine while he's making it? That's a good one yeah. Go on [Olivia]

Olivia: I've got another explanation for

Interviewer: sensible?

Olivia: If you're doing something that someone has asked you a question, you need to say it and you don't mess around. So in this book I've got at home

Interviewer: yeah

Olivia: it's a David Walliams book

Interviewer: oh yeah?

Olivia: this girl called Miranda, she's not very sensible

Interviewer: okay

Olivia: because the teacher asked "what ended in 1945?" and she said "1944", so you need to make sensible answers instead of just messing around

Interviewer: ah okay yeah?

Olivia: like saying the wrong thing to make you sound funny

Interviewer: ah so you're being sensible at school? So you need to be sensible, so you're concentrating?

Black Cat: yeah because also it might have been something super serious and you just messed around

Interviewer: okay

Olivia: I've got one

Interviewer: you've got a word yeah? Which word have you got there?

Olivia: creativity

Interviewer: creativity. Why might it be important to have creativity? Ali might need creativity? Go on?

Olivia: because she might need to maybe mix some medicines

Black Cat: or maybe – that's also like taking risks. Because it could be wrong

Interviewer: oh okay

Black Cat: or something

Interviewer: so sometimes being creative means…

Black Cat: taking a risk

Interviewer: taking a risk? Okay

Black Cat: because in medicine, if you try it and it goes wrong, something could happen to you and then they won't know what medicine to use to help you get better

Interviewer: okay

Olivia: shall I put taking risks with Ali?

Interviewer: you could put it with creative, yeah? Is there anyone else who needs to be creative do you think?

Black Cat: I think [Rhodri]

Interviewer: Rhodri? Why do you think Rhodri?

Black Cat: I think he needs to maybe make something for the equipment

Bluebell: he might need to – if he's making something, he might not have a piece that he needs for the thing, so he doesn't have enough money to make it

Black Cat: so he tries to make it

Bluebell: he can't buy it so he has to make it! [laugh]

Interviewer: ah so he has to come up with a creative solution? I like that, very good. What word have you got there [Bluebell]?

Black Cat: I've got another one

Interviewer: for creative or for another word?

Black Cat: creative

Interviewer: okay, let's finish with creative – what were you going to say about creative?

Black Cat: Chloe might need it because if she needs to build something, she might need to use her imagination, so that also goes with imagination

Interviewer: ah, so imaginative as well? So, imaginative and creative – shall we put that there? Chloe might need to be creative *and* imaginative

Black Cat: could we put it in the middle?

Interviewer: good idea, yep

Olivia: I've got one

Interviewer: you've got one? Well we were going to talk about [Bluebell's] next – what was your one there [Bluebell]?

Bluebell: can work in a team?

Interviewer: ooh who's that important for?

Bluebell: I think [indicates Chloe]

Interviewer: for Chloe?

Bluebell: she might need a team to build this big thing

Black Cat: to build something

Interviewer: yeah

Black Cat: because if she hasn't got it, somebody else has who's a friend, she'll get that friend and…

Interviewer: okay, yeah?

[unclear chat]

Interviewer: [Black Cat] what word did you have there?

Black Cat: clever

Interviewer: clever, okay so why might it be important to be clever?

Black Cat: because if you did something wrong, and you'd learnt it already – you need to also memorise it, so if it was two weeks ago that you learnt it and you forgot about it, you need to be clever to remember it

Interviewer: ah right okay, what was the definition of clever on here?

Children: quick to understand new information

Interviewer: okay, do you still think what you said?

Black Cat: yeah I think that still

Interviewer: okay, is there anyone in particular you think needs to be clever?

Olivia: I think maybe you..

Interviewer: I do? [laugh] sometimes being clever can be very helpful if you can understand new things very quickly – so maybe if you need to learn something new very quickly?

Bluebell: maybe you could put it in the middle?

Interviewer: you could put it in the middle? Sure? So it could be important for everyone to learn new things quickly?

Bluebell: you need to be clever to make…

Interviewer: you need to be clever to make?

Bluebell: to fix

Interviewer: Oh Rhodri needs to be clever to fix stuff?

Olivia: I've got one

Interviewer: you've got one? Go on [Olivia]

Olivia: get all the answers right

Interviewer: get all the answers right? Who needs to get all the answers right? Or why might it be important?

Black Cat: you don't need to actually

Olivia: you might actually need to – like if you're studying it [pause] you might need to because if you get it wrong, you might not be able to do the job that you want to do

Interviewer: ah so who might need to get things right when they're studying?

[Olivia indicates babysitter]

Interviewer: [babysitter] yeah okay

Olivia: because she's studying

Interviewer: [Black Cat] you had an interesting thing to go with that, what were you going to say about getting all the answers right?

Black Cat: you don't also need to, because if you've made the mistake – like at school, then that's good because then you learn from that

Interviewer: yeah? You pointed to Ali, what were you going to say about Ali?

Black Cat: it's because if she made a medicine,

Interviewer: yeah

Black Cat: she needs to try to get it right

Interviewer: ah okay

Black Cat: so she doesn't [unclear]

[children playing with cushions]

Interviewer: okay, what word have you got there [Bluebell]?

Bluebell: this one – we've done this one, but I didn't know where to put it

Interviewer: competitive, what did you decide for competitive in the end?

[children playing with cushions]

Interviewer: I can't remember where we put competitive, did we put it with Rhodri?

Black Cat: I don't know who – I think we put it with all of them

Interviewer: with everyone, shall we put it in the middle then?

Black Cat: that one's important

Interviewer: so hard working's important for everyone? And what have you got in your hand there [Bluebell]?

Bluebell: honest

Interviewer: honest, okay

Bluebell: so he might need to be honest, to say to somebody that he cannot actually fix it

Interviewer: oh so he needs to be honest if he doesn't know something?

Bluebell: yeah

Interviewer: okay, that's a good idea. Is there anyone else who needs to be honest? Might it be important for anybody else?

[child indicates Ali]

Interviewer: for Ali? Why might it be important for Ali?

Bluebell: she might not have the right medicine, for the patients?

Interviewer: yeah? So she needs to be honest with her patients. Very good. Do you want to pop that one down? Where would you like to put it?

Black Cat: I think we should put it there because most of them need to

Interviewer: ah so you think everyone needs to be honest? Why do you think everyone needs to be honest [Black Cat]?

Black Cat: because if they were doing something with somebody – like Chloe, she was building something with somebody and she told them that she has the material

Interviewer: yep?

Black Cat: but she doesn't, then she needs to be honest about it

Interviewer: ah okay

Black Cat: because then the other person who's planning it will go ahead and it's too late because the material could be in a different country

Interviewer: ah okay – what have you got in your hand there then [Black Cat]?

Black Cat: can use computers

Interviewer: okay, who needs to be able to use computers?

Bluebell: maybe [indicates Rhodri card]

Black Cat: I think

Interviewer: Rhodri yeah?

Black Cat: he needs to use equipment on technology?

Interviewer: yeah, so he uses technology equipment. And what equipment might he use if he works in IT?

Black Cat: computers

Bluebell: didn't it say on here – the security?

Interviewer: yeah

Bluebell: it says he fixes everything on laptops

Interviewer: yeah, so if he's fixing laptops what does he need to be able to do?

Bluebell: to know how to…

Black Cat: he needs to know the right wires, which hole to go in, how to connect them, how to charge them? What's the right size socket

Interviewer: cool, okay so Rhodri needs to be able to use computers fab. Go on [Olivia], what have you got?

Olivia: can work independently

Interviewer: can work independently? Why might that be important?

Olivia: because when people – so say there was [pause] ten of you, and then nine of them leave, you might need to work independently

Interviewer: okay, do you think that applies for anyone in particular?

Olivia: I think that might go for Ali

Interviewer: for Ali? Okay

Black Cat: or it could go for Chloe

Interviewer: or for Chloe?

Bluebell: did we do likes helping?

Interviewer: yeah we did didn't we? That went with Rhodri didn't it? So he needed to like helping others because he helps them to fix their computers, and we also thought Ali would need that as well

[unclear]

Interviewer: we'll do [Bluebell's] one and then we'll do [Black Cat's] one

Bluebell: we just did that one did we?

Interviewer: reliable?

Black Cat: no we haven't

Interviewer: we haven't done reliable – what does reliable mean?

[discuss spelling of reliable]

Children: always does what they have promised and can be trusted

Interviewer: okay, so always does what they have promised and can be trusted

Black Cat: so like somebody is relying on somebody to if the phone rings, they get the phone. Or rely on them to fix the computer or something else?

Interviewer: yeah so [Bluebell] you said Rhodri as well, so rely on them to fix a computer

Bluebell: he could say "I promise to fix the computer"

Interviewer: yep?

Black Cat: or maybe Ali – this person relies on her to give her the right medicine and get them back to how they're meant to be

Interviewer: okay

Bluebell: somebody might make a medicine for her, and she might trust that it's the right medicine for them

Interviewer: ah so as well as *being* reliable, she needs to be able to rely on other people to give her

Child: because they're trusting

Interviewer: yeah. Okay, awesome ideas guys. What have you got there [Black Cat]?

Black Cat: I've got likes being outdoors

Interviewer: okay, why might being outdoors be important?

Black Cat: because if you're digging up bones or something, then basically, you like being outdoors to find things?

Interviewer: okay yeah? Does anyone else need to like being outdoors? There's quite a few pictures [on the profiles] that are outdoors aren't they?

Olivia: I've got something to add

Interviewer: you've got something to add yeah? What would you like to add?

Olivia: if you like to be outside, so say that I was digging up bones

Interviewer: yeah

Olivia: I would basically need to go *into* the ground to get the bones

Interviewer: uh huh

Bluebell: on the dig site

Interviewer: on the dig site, yeah

Olivia: so I would need to get the bones, so I would need to like the outdoors

Interviewer: ah so you need to be outdoors to do archaeology?

Black Cat: or maybe if you're right there and you're outdoors, if the bone is really far down, and you hit it, but it's really big, then you could also try to get help – if they're inside doing something else. Like my brother

Bluebell: are we doing [Black Cat's]?

Black Cat: then maybe – because my brother he also sometimes doesn't want to be outside, he wants to play the PS4

Interviewer: ah okay

Black Cat: and I'm outside, so I get him out because I need a bit of help getting this thing out of the ground

Interviewer: ah right okay

Bluebell: and he

Black Cat: getting somebody out of their place where they're on the computer or something like that – because being outside is good

Interviewer: okay, yeah – what were you going to say [Bluebell]?

Bluebell: I think he's [indicate Scott]

Interviewer: Scott yeah?

Bluebell: outdoors because he might go to a place, and he might need to be outdoors for it?

Interviewer: okay?

Bluebell: so a job that he might need to do that's outdoors

Olivia: I think you need to be outdoors

Interviewer: you think *I* need to be outdoors? So Scott might need to be outdoors, *I* might need to be outdoors, okay. Yes [Olivia]?

Olivia: artistic

Interviewer: artistic, okay. Why is being artistic important?

Olivia: because you might need to draw the bones to sketch all the little details. Maybe you could draw it and then you could put it back and then you could research it?

Interviewer: yep?

Olivia: and see if that's the bone and then you could find out all about it?

Black Cat: or could you scan the bone to find out which it is?

Bluebell: and when/ where it's from

Black Cat: and then you could draw it, and then you can label it. And if somebody else needs that – if they have found that same bone, then you can tell them what it is to help them

Interviewer: okay

Black Cat: if they're really stuck on it

Interviewer: okay, so. Out of the ones that are left, choose one that you think is really really important

Olivia: I've got one

Black Cat: I've got one

Interviewer: you've got one? Okay, so we'll talk about those two. [Bluebell] would you like to choose a last one that you think is really important? There might not be anything, you don't *have* to have one, but if you think -

Olivia: [Bluebell] there's some over here

Interviewer: yeah there's those two as well. So out of the ones that are left, is there anything that you think we need to talk about still?

Black Cat: I've got another one

Olivia: I just want to see what this one means

Interviewer: okay, [Bluebell] is there anything that you think you need to talk about?

Black Cat: I've got another one: listens to other people's opinion

Olivia: I've got another one which I think is important

Interviewer: okay, so listens to other people's opinions? Okay, so let's talk about our last words, and then we're going to choose the words about ourselves again? Do you remember we did that last time?

Olivia: I've got two

Interviewer: you've got two? Can you choose which one you think is most important? So you've got wants to understand how things work and practical. Which of those do you think is important? Okay, so we'll talk about [Black Cat] resourceful you've got there. What does resourceful mean?

Children: finds quick clever ways to get things done or make things easier

Interviewer: okay, so why might that be important?

Black Cat: I think if you get – I think Ali needs it

Interviewer: okay

Black Cat: because if the patient has chosen a time when to be there, and come back then she needs to get a quick and easy way how to get it done so that they can be back home

Interviewer: okay, so she needs to be resourceful when she works out what their treatment's going to be?

[Black Cat indicates yes]

Interviewer: awesome. [Bluebell] shall we talk about your word?

Bluebell: listens to other people's opinion

Interviewer: brilliant, and why might that be important?

[pause]

Bluebell: so [pause] maybe him because

Interviewer: Rhodri yeah? Why might it be important for Rhodri?

Bluebell: maybe because he might say “it’s broken”, but some other person might say “it’s not broken”?

Interviewer: oh so he might need to listen to their opinion?

Bluebell: maybe he’ll check because they might be right or they might be wrong

Interviewer: oh so he needs to listen to people’s opinion and double check before carrying on? Awesome, what did you want to say about that [Olivia]? Did you have something to say about listening to opinions?

[Olivia indicates no]

Interviewer: okay, it’s just your word. What was your word [Olivia]?

Olivia: wants to understand how things work

Interviewer: okay

Olivia: so basically, if somebody was – you might want to know what that thing is and what that can do

Interviewer: okay, and who might need to be able to do that?

Olivia: maybe you and [babysitter]?

Interviewer: me and [babysitter], yeah? Okay

Olivia: shall I put it there

Interviewer: sure. So wants to understand how things work: Is that important for anybody else?

Black Cat: maybe Ali – she might want to know how that medicine works and what it can do

Olivia: or maybe him

Interviewer: Scott [?] yeah

Olivia: because he might

Child: [whisper] design technology

Olivia: he might want to learn a bit more about technology, so if he doesn’t know how big –

Bluebell: the problem was

Olivia: the person wants it

Interviewer: yeah

Olivia: and then he needs to find out the size and do that

Interviewer: okay, fab. Thank you for that guys [takes photo of card layout]. Right okay. Shall we put all the words back together, and can you guys choose five words that you think describe yourself

Olivia: oh I'm definitely artistic

Interviewer: and remember, you can share words. So if one person has a word that you think describes you as well, you can share that word.

Child: I can definitely do that

Olivia: has anybody got… oh there! I need one more

Black Cat: [Olivia] I like being artistic too. I'm artistic too

Olivia: can I see your words as well?

Interviewer: is there anything else on there that you think describes you [Bluebell]?

Olivia: I'm actually quite creative as well, so can we put those two in the middle? Me and [Black Cat] have got all our words

[Olivia and Black Cat speaking about 'princess and pea' as they are sat on many cushions]

Interviewer: [to Bluebell] so that says likes learning languages

Bluebell: maybe not

Interviewer: maybe not, okay

Olivia: I think [Bluebell] is quite clever

Bluebell: no

Interviewer: [laugh] [Bluebell] doesn't agree?

Black Cat: [Bluebell] definitely enjoys maths

Interviewer: okay

Olivia: [Bluebell] do you like any of these: determined, curious, like being outdoors, creative?

Interviewer: that's alright guys, we'll just let [Bluebell] choose the words he wants to choose

Black Cat: I think I know which ones

Bluebell: one more

Interviewer: okay, well no pressure [Bluebell]. You choose which ever one you want to

Black Cat: I think he likes that one

Olivia: yeah

Black Cat: likes computer games

Olivia: yeah I think that's definitely true

Interviewer: don't feel like you have to choose the ones that we're saying, you say whichever ones you want. Lovely, okay. So, we've all got five words that describe ourselves

Olivia: have you got five words?

Interviewer: if we've got time, I will do five words, but I'm more interested in what you guys think. So we'll do your five words first. Can you tell us what your words are and why you chose them please – [Bluebell]!?

Bluebell: huh?

Interviewer: so which words did you choose and why do you think they describe yourself?

Bluebell: shall I say the words? Enjoy maths, can work independently, can try risks, enjoys building things, likes to learn new things

Interviewer: awesome, okay. So why did you choose enjoys maths?

Bluebell: well [pause]

Interviewer: what do you enjoy about maths?

Bluebell: I just – it's just fun

Interviewer: yeah? What do you find fun about it?

Bluebell: it's kind of easy?

Interviewer: oh you find it easy do you?

Bluebell: because [pause] yeah I do [pause]

Interviewer: okay, what made you pick can work independently?

Bluebell: because at home, if I have something I have to do, and everybody else is busy normally, I've got to do it by myself, so I'm kind of used to it.

Interviewer: oh okay, so you've got a lot of practice at working independently? Yep okay. And can take risks: can you tell us about that one?

Bluebell: not quite sure about that one

Interviewer: okay

Black Cat: I think I know why he takes risks

Interviewer: we'll ask [Bluebell] first

Bluebell: [pause]

Interviewer: would you like to come back to that word? Which one would you like to talk about next?

Bluebell: enjoys building things?

Interviewer: why did you choose enjoys building things?

Bluebell: well at my house, I normally build loads of things

Interviewer: ah cool, like what?

Bluebell: well we're building some wood fence for some reason – oh deers are getting in our garden

Interviewer: ah no, you don't want deer in your garden do you?

Olivia: that actually might be really cute

Bluebell: or foxes

Interviewer: it could be cute…or foxes, yeah. So you're building a wall to keep deer and foxes out?

Bluebell: and so I just like doing it

Interviewer: are you having fun with it?

[Bluebell indicates yes]

Interviewer: brilliant okay. And likes to learn new things – why did you choose that one?

Bluebell: like learning things I don't really know much about

Interviewer: okay

Bluebell: yeah

Interviewer: is there anything in particular that you like learning about?

Bluebell: well maths

Interviewer: yeah? Okay

Bluebell: building new things, and [pause] yeah

Interviewer: awesome, okay. So can take risks – do you want to keep that card, or is there another word that you think would be better?

Bluebell: another word that might be better

Interviewer: okay, so while you're choosing your other word, [Black Cat] could you tell us your words and why you've chosen them please?

Black Cat: determined, curious, likes being outdoors, creative, artistic

Interviewer: okay, and why did you choose those words?

Black Cat: I like being outdoors because I usually find these things which I haven't found before in the woods

Interviewer: cool, like what?

Black Cat: we once found this cow shoulder bone

Interviewer: ahh

Black Cat: then we told our mum, and she told us what it was

Interviewer: ah very cool

Bluebell: so you didn't know what it was at first, but then you did know?

Interviewer: yeah, so you didn't know what it was at first but then you found out the answer?

Black Cat: I like being determined because I want to find out more about this thing, then I'll move onto the next thing

Interviewer: okay, so you're determined when you're learning? Okay

Black Cat: I think I'm artistic because I like doing art, and I'm really good at doing art. Because right now we're doing 'Our Rivers' and I like my drawing of my river

Interviewer: ah cool, can you show that to me afterwards?

Black Cat: I think I'm creative because, sometimes at home with my brother – I made this wood shelf

Interviewer: a shelf?

Black Cat: yeah and we also – with my brother – we were drawing this scarlet macaw and it's in the classroom

Interviewer: ah really? Cool okay

Black Cat: I think I'm curious because I sometimes want to get another bone, but if we don't have it, I go somewhere else. Because we have loads of fields at our house, so I go into one of the fields

Interviewer: ah so you're curious as to what's in the field, to try and find things?

Bluebell: we've obviously got a field next to us because deers get in

Interviewer: yeah the deer are coming into yours from the field. That doesn't happen in my back garden, I live in a city so there are *no* deer in my back garden

Black Cat: I live in the countryside

Interviewer: yeah – I guess you all do? Because you live round here. Is that everything you wanted to say about your words [Black Cat]? Thank you very much. [Olivia] what are your words and why did you choose them?

Olivia: my words are: hardworking, can work in a team, enjoys dancing, creativity and artistic

Interviewer: awesome, okay. Can you tell us about those any why you chose them?

Olivia: I enjoy dancing – well enjoy dancing and working in a team are kind of [unclear] all the teams in my dancing studio

Interviewer: ah okay

Olivia: and I really enjoy it, so that's why sometimes – that's why I dance at school because we do a talent show

Interviewer: ah talent show? Cool okay. What was your next word?

Olivia: can work in a team because I'm really good at working in a team because I make sure everyone's opinion is said

Interviewer: ah really – what kind of teams to you work in?

Olivia: I work in dancing teams

Interviewer: yeah

Olivia: I work in school teams, and I work in teams like this team. Me and [Black Cat] are in a team with people

Interviewer: ah okay so you work in a team with your friends?

Olivia: no, it's like a school duty thing

Interviewer: oh I see! So you have responsibilities in school?

Olivia: we're the learning council

Black Cat: so we have to take on other learning council's opinions

Interviewer: ah okay so you have to work in a team with them – that's lots of different contexts that you work in a team. Very good. What was your other word?

Olivia: hardworking

Interviewer: yep

Olivia: because sometimes at dancing, people will work really hard because in my ballroom dancing – we do disco as well, and I'm in the highest disco

Interviewer: ah and you have to work hard to develop that skill did you?

Olivia: yeah. And then I think I'm quite artistic

Interviewer: yeah?

Olivia: because every time I'm at home, I keep on trying different ways of drawing art and I love my art

Interviewer: what do you like drawing?

Olivia: I like to make up my own art

Bluebell: so do I

Interviewer: you do that as well [Bluebell]?

Olivia: and creative because I make different colours – so I get two different colours, like really opposite colours, like maybe orange and blue

Interviewer: yeah?

Olivia: and I try mixing them together to see what colour it will make

Interviewer: what colour does it make?

Olivia: I'm not quite sure what it's called

Black Cat: I think – we did this art lesson with the colour wheel and were mixing different colours like

Olivia: purple

Black Cat: yellow and red to make orange

Interviewer: ah okay. And you mixed blue and orange? Did you *like* the colour that it made?

Black Cat: not really

Olivia: it was quite dark

Black Cat: and it wasn't very nice

Interviewer: but it was something you were creative with?

Olivia: I just like to draw stuff

Interviewer: awesome. Is there anything else that you'd like to say about your words?

Olivia: no

Interviewer: in which case, can we hear your last word please [Bluebell]?

Bluebell: organised?

Interviewer: organised, tell us more about that one

Bluebell: because [pause] I like to be organised, but then not really organised

[children laugh]

Interviewer: so you *like* to be organised, but not everything is organised

Olivia: that doesn't make any sense

Black Cat: well he does organise his work

Interviewer: that makes sense, if you *try* to be organised, we can't always

Black Cat: *be* organised

Interviewer: yeah

Bluebell: because every time I do be organised, [brother] just messes it up like this, because normally at home…

Interviewer: oh really? So you try to be organised but your brother messes it up?

Bluebell: yeah and

Black Cat: I think it's also because he organises his work very neatly

Interviewer: do you? Do you agree with that, that you organise your work in your book neatly?

Bluebell: yeah

Olivia: I've got something to add

Interviewer: go on [Olivia]

Olivia: he definitely organises his games

Interviewer: do you?

Bluebell: yeah

Interviewer: what kind of games do you organise?

Olivia: he organises fighting games and chasing the girls

Bluebell: no I don't! You just made that up!

Interviewer: ah I see you organise games on the play ground

Bluebell: that was [Olivia]!

Olivia: that's actually me and [Bumble] because we fight the most

Black Cat: I fight with my brother

Interviewer: well we don't want to be doing any fighting on the playground. Is there anything else you'd like to say before we go back to class?

Children: no [laughing]

41 Appendix 29: Pupil task-based interview 2, YP

Title: Pupil interview 2

Date: 27^{th} March 2019

Speakers: Poppy Hodkinson (interviewer), Barry and Stanley

Interview duration: 47 Minutes

Interview location: YP

Interviewer: so the first thing that we're going to do is we're going to have a think about all the different people that might be in our lives, so maybe someone in our family – which colour would you like to use?

[chat about colours]

Interviewer: so we're going to make a mind map of people, so maybe someone in our family or a friend who works in STEM – so which people

Barry: my mum, my mum! My mum is a science teacher

Stanley: my dad is a

Interviewer: yep

Barry: she was, but then I think at the end of the year [unclear] she cooks as well

Stanley: yeah, she's really good

Interviewer: oh does she?

Barry: because we have this thing – she's like a science one

Interviewer: so your mum's a science teacher yeah? Shall we put that on? What shall we put in the middle of our mind map?

Barry & Stanley: science

Interviewer: is it just science we're talking about?

Barry: put STEM

Stanley: STEM. Put STEM and then a bubble

[child draws on mind map]

Interviewer: do you remember what those different bits stand for again?

Barry: science, technology

Stanley: so we could put science

Barry: science technology

Interviewer: do you remember what the E stands for?

Stanley: engineering – my dad's an engineer

Barry: and maths

Interviewer: okay

Stanley: my dad's an engineer

Interviewer: what does your dad engineer?

Stanley: aeroplanes. He designs the aeroplane wings

Barry: that's cool

Interviewer: that *is* cool – okay, we'll pop both of those on there shall we?

[chat about mind map]

Interviewer: so who's the first person that you want to put on there?

Barry: my mum

Stanley: my dad

Interviewer: your mum and your dad

[chat about adding them to mind map]

Interviewer: and what is it that your mum does? And what is it that your dad does? Shall we write those down?

Barry: science

Stanley: my mum's an actor

Interviewer: is she?

Barry: yeah she is, I watch her

Stanley: a welsh actor

Barry: and my dad is –

Stanley: a head teacher

Barry: you know Estyn?

Interviewer: at school?

Barry: no it's not a school

Interviewer: oh I do know Estyn – yeah?

Barry: our head teacher went there, and my dad works there

Stanley: yeah

Interviewer: oh I do remember, yeah

Stanley: the head teachers, they have their job and then they turn –

Barry: to Estyn. And my dad was a head teacher

Stanley: they stay there for a year

Interviewer: uh huh

Barry: my dad doesn't do that

Stanley: you can stay there for more

Barry: yeah, my dad does that

Stanley: but they usually stay there for a year

Interviewer: okay

Barry: [Teacher] comes back when we are in Year 5

Interviewer: ah okay

Stanley: Year five in a couple of weeks

Interviewer: okay, so we've got two people on here – do we know anyone else? Is there anyone else in your life, or that you know who works with STEM?

Stanley: my nan and grandad, they used to be nurses. Grandad was a doctor and my nan was a nurse

Interviewer: okay, put those on. So your grandad was a doctor and your nan was a nurse?

Barry: my

Interviewer: do you want to put what they do as well?

Barry: so like science?

Interviewer: yeah

[pause]

Barry: science… and my brother dad is a head teacher

Interviewer: okay

Stanley: can I put my mum on there?

Interviewer: is it a STEM thing?

Stanley: no

Interviewer: we're just thinking about the STEM things

Stanley: is it nurse?

Interviewer: n-u-r-s-e. Can you think of anyone else that you know who works with or is interested in STEM [Barry]?

Barry: ah yeah, my mum's brother

[Interviewer spelling out engineer for Stanley]

Interviewer: your mum's brother?

Barry: is working with technology in his house

Interviewer: oh really? What does he do with technology in his house?

Barry: I think he fixes [pause] things you can type on?

Interviewer: keyboards?

Barry: yeah, keyboards

Interviewer: put that on yeah

Barry: so like brother's mum?

Interviewer: your mum's brother, is that your uncle?

Barry: no

Stanley: my mum's brother makes honey and he makes wine

Interviewer: is he a beekeeper?

Stanley: yeah he has about 50 hives

Interviewer: really? Wow, okay, so what part of STEM might that use?

Stanley: oh pollen!

Interviewer: yeah, absolutely you'll need to know all about pollination, things like that yeah

Stanley: mum's brother

Interviewer: yeah?

Stanley: can I just say his name?

Interviewer: yeah you can do that if you want to

Barry: my dad works at Estyn and somebody else I know works at Estyn

Stanley: bee keeper?

Interviewer: okay

Barry: I think I don't know anyone else

Interviewer: okay, well I've got a couple of people here that I know, I thought you guys might be interested in finding out some of the people that I know

Stanley: oh

Interviewer: oh go on

Stanley: my grandad's a farmer, he helps with the bees

Barry: oh yeah! [Stanley] reminded me of my dad's uncle he was a farmer. He owned a whole farm

Interviewer: okay

Barry: and because Africa didn't have lots of water and plants. So then he was checking everyone's doing their work so that they could go to Africa and plant some trees and get some water to them

Interviewer: oh okay

Stanley: There's loads of trees there

Barry: oh not in Africa, in…I don't know

Interviewer: was it a different place?

Barry: yeah

Interviewer: that's really interesting

Stanley: there's loads of plants in Africa, but there's not much water

Barry: yeah water and plants like wheat

Interviewer: I've got someone here who does something with water as well, would you guys like to read about some of the people that I know?

Stanley: my nan

Interviewer: Have you got one last one?

Stanley: yeah it's not something really to do with STEM – she didn't have the *best* job, she learnt people how to knit

Interviewer: oh really? My Nana does that as well

Stanley: and she had a job of making food in schools

Interviewer: okay, that's a really important job isn't it? If no one makes food in schools, you guys would be hungry wouldn't you?

Barry: yeah

Interviewer: so that's a really important job. So you can see here, I've got some pictures of people

Stanley: oh that looks…

Interviewer: and I've got a little description of what they do for their job – so would you like to choose any of those people and read out for all of us?

Stanley: I'm going to read this

Interviewer: you're going to read that one? Okay, who would like to go first?

Barry: I don't mind – I'll go first

Interviewer: okay [Stanley]

Barry: [Rhodri description]

Interviewer: okay that's my friend Rhodri who works in IT – would you like to read about that person [Stanley]?

Stanley: [Scott description]

Interviewer: very good, okay. So Scott's a technologist, he works to test products to make sure they perform better. Shall I read one now?

Barry & Stanley: yeah

Interviewer: you want to read about that one?

Barry: I don't mind

Interviewer: so I'll read about this one: [Chloe description]

Stanley: I've been to Peru

Interviewer: you've been to Peru as well?

Stanley: my mum's been to Peru

Interviewer: very cool – whereabouts is Peru?

Stanley: it's right… somewhere

Barry: south Africa?

Interviewer: Peru is in South America [cont. Chloe description]

Stanley: [Johanna description]

Interviewer: okay, so Johanna looks after really *old* objects making sure they survive

Barry: oh what, like?

Stanley: oh the thing in New York? The big tower?

Interviewer: yeah, she might look after an old building, she might look after –

[teacher speaking]

Interviewer: brilliant, okay so you were about to read that last one [Barry]?

Barry: [Ali description]

Interviewer: brilliant okay

Stanley: I remember this

Interviewer: so Ali is a doctor and she has to understand how our bodies work and how to treat people who are poorly.

Barry: oh I remember now

Interviewer: So what we're going to do now is a little bit different to before – we've got these words again

Barry: this is like the last time

Interviewer: yeah, it's a little bit like it. We've got the words and we've got the glossary as well remember? So if there are any you're not sure about

Barry: oh yeah

Interviewer: and what we're going to do now is we're going to pick out the words that we think are important for the people in our families, so someone like your mum who does science, your mum's brother is it who does, your dad who's an engineer, or your nan who's a nurse – or even say Rhodri who looks after IT, or Chloe or Johanna. So we're going to look at which of these words we think are important for these people. And we'll talk about why we think they're important for them as well

Barry: I think Ali should not take risks

Interviewer: Ali *shouldn't* take risks – why do you think that?

Stanley: because she has to do it quickly

Barry: yeah

Stanley: treat them quickly

Barry: so if she does a risk, there's more chance the patient's going to die

Interviewer: okay

Stanley: there's more chance of her really struggling. Because if you usually finish it in time

Interviewer: uh huh

Stanley: you would usually go for one which you're "oh okay, go" instead of going like "oh okay"

Barry: "I can't do this, I'm just going to…" don't just do that

Stanley: then you do it and then you're like "ah…"

Barry: "I've failed"

Interviewer: oh okay

Stanley: she's like with one minute left and she's like still doing something

Interviewer: okay

Barry: So I would say, don't take risks

Stanley: if you're doing it to somebody's parent – if you kill them, if they die – you won't feel good for the people

Interviewer: okay, yeah

Barry: you'll be like [deep sigh]

Interviewer: if you're a doctor and people might die – it's not okay to take risks?

Stanley: yeah

Interviewer: is there anyone else that we know that it *is* okay for them to take risks?

Barry: my mum

Interviewer: yeah?

Barry: because if –

Stanley: science?

Barry: yeah, science – she can take risks, but sometimes

Stanley: not with like really –

Barry: no, not with like dangerous

Stanley: medicines

Barry: but with – if you do an explosion, you can take a risk

Interviewer: okay? Sometimes taking a risk might be a good thing?

Barry: yeah

Interviewer: why might it be a good thing?

Barry: in a careful thing – you've got more chance of doing it right

Stanley: sometimes you might say – to make an explosion you need a bottle of coke

Barry: a mento

Stanley: one mento, and it says to you to put one mento in and instead you might put ten mentos in!

Barry: yeah!

Stanley: then it will go up

Interviewer: okay

Barry: that's fine – I would say that's fine

Interviewer: that's an okay risk?

Barry: for that

Stanley: but if you did it with a volcano, an actual volcano, but it was full of coke

Interviewer: [laugh] yeah?

Stanley: you might have the world's biggest

Barry: yeah imagine you put one mento in and then it does an explosion

Stanley: and you put a whole massive mento

Interviewer: yeah?

Stanley: it says *just* to drop one in

Interviewer: yeah?

Barry: and you drop ten

Stanley: and you drop ten, that's a risk

Interviewer: okay

Stanley: but you know that it will be safe

Interviewer: okay

Stanley: because everybody won't die because it's not lava

Interviewer: okay, so it's okay to take risks

Stanley: can take risks

Interviewer: maybe when you're in

Stanley & Barry: sometimes

Interviewer: sometimes?

Stanley & Barry: yes

Barry: in school

Interviewer: in school it's okay?

Stanley: my nan can't take a risk

Barry: no she's a nurse

Interviewer: okay

Stanley: my dad can't because he's an engineer does the wings – he designs them

Barry: and if he does something wrong

Stanley: if he puts too much weight up on one and one's up here

Barry: so he can't take risks

Stanley: my mum she's not nothing about STEM, but she has to follow the –

Barry: instructions

Stanley: - the script

Interviewer: yeah

Stanley: so my mum maybe, she *could*

Interviewer: okay, so there are certain situations where you *can* take risks and some where you can't. Are there any other words on here that we think are really important?

Barry: I think Ali could be clever

Interviewer: go on

Barry: clever what to do because if it's a baby born – she can be clever what to do with the – you know you need to clean the baby?

Interviewer: uh huh

Barry: she could be clever what step to do after the other

Interviewer: okay

Barry: she could be clever at that?

Interviewer: so knowing all the steps you need to take?

Barry: yeah

Interviewer: Okay. Go on [Stanley] what have you got there?

Stanley: science

Barry: enjoy maths

Stanley: – you can use maths

Interviewer: yeah

Stanley: [Barry's] mum and my dad

Interviewer: uh huh

Stanley: they could enjoy maths

Interviewer: yep

Stanley: and they could use maths – and my nan

Interviewer: yeah?

Stanley: because you have to count their heartbeat

Barry: their heart pressure

Interviewer: yeah

Barry: if the electronic thing doesn't work

Stanley: I think this is pretty –

Barry: big

Stanley: maths is a big thing

Barry: to everyone

Interviewer: to everyone? Shall we put it in the middle then?

Stanley: all the sums on paper for about three of these

Interviewer: do you reckon? So pop that one in the middle then, so everybody can enjoy maths?

Stanley: yeah lots of people can

Interviewer: okay

Stanley: likes to learn new things

Interviewer: okay

Stanley: my dad could learn new things?

Interviewer: yep

Barry: yeah

Stanley: how to learn [to] make very slow wings, smooth wings

Barry: fast wings. And my mum

Interviewer: yeah?

Stanley: you could use the wings that are straight, and they could open up

Interviewer: yeah

Barry: it can open like this

Stanley: yeah, so if it's like that

Interviewer: yep

Stanley: then it opens up like a mouth

Interviewer: ah okay

Stanley: then it flies. So say it's flat – this is

Barry: that's the top of the plane

Stanley: this is the actual plane

Interviewer: yeah?

Stanley: where the people are sitting

Barry: yeah

Stanley: this is the plane – the plane's wings are here and it flies instead – my dad could try new things – could put two: one up and one flat

Interviewer: ah okay – is there anyone else who would like to learn new things? So that's your dad – anyone else?

Barry: my mum because she learned something new in science – you know when you're in a restaurant? When you're waiting? You can have a piping thing, no it's not piping – like a stick – you know with chicken – you can put chicken or marshmallows – either on the stick?

Interviewer: yeah?

Barry: one of those, get a spoon and then a fork. Stick them together, put the thing in, get a cup and try and balance it on

Interviewer: ah okay, so your mum learns new things as well – like that experiment that you just described? Shall we put that one in the middle? Are there any other words that might be important?

Stanley: I think I might have another one

Barry: I have one

Stanley: enjoys history because if *you* – you have to know how old the bone is

Barry: and

Stanley: that's a big part of STEM?

Interviewer: okay

Barry: that's a humungous part – if you don't know that.. well

Stanley: history's a very clever thing because you can learn about your ancestors, what they did

Interviewer: okay

Stanley: usually you will think back and say, "what did I do?" then you could look at your family tree and see what they –

Barry: have done

Stanley: yeah

Interviewer: okay, so I enjoy history so that's something that I would need to do. Go on [Barry]

Barry: clever

Interviewer: you talked about that one just did you?

Barry: yeah

Interviewer: did you want to add it onto another one as well?

Barry: yeah I think science, you can be clever because if you get two bones and try to stick them together, and it needs to go somewhere important, you can be clever – you try and stick it together and "oh, that doesn't go there – I'm clever so I can do the other way"

Interviewer: okay

Barry: instead of trying and breaking it – and then you break it

Interviewer: okay is there another word for if you're trying something lots of times? You keep working at something to try and - ?

Barry: that is 'not giving up' – something like that

Interviewer: what's this one here?

Barry: determined

Interviewer: what does determined mean?

Barry: never give up

Interviewer: yeah!

Barry: doesn't give up when things become difficult

Interviewer: yeah, so being determined – is that important for anyone who works in STEM do you think?

Barry: a lot of people

Interviewer: anyone in particular?

[pause]

Interviewer: Why might it be important if you work in STEM?

Stanley: because you're not supposed to give up because –

Barry: if you give up, it won't work

Stanley: lots of stuff you do can be mistakes, but can be really something good

Barry: yeah like the coke

Stanley: we learnt that diet coke

Barry: no coke! Was supposed to be a medicine

Interviewer: really?

Stanley: yeah, so this doctor was trying to make medicine, and after he made it

Barry: it was black and he just called it coca cola

Stanley: then he drunk it and he was like "oh that's very sweet"

Barry: and then

Stanley: he told somebody to come in to there and drink it

Interviewer: yeah?

Stanley: and the person was like “oh” and he invited everybody on the street inside

Interviewer: yeah

Stanley: and it got bigger

Barry: bigger bigger bigger and now it’s all over the world. And there’s only two people knows the recipes

Interviewer: oh really?

Barry: and they’re not allowed to go on the same plane because if they go on the same plane, if it crashes – nobody can make coca cola

Interviewer: okay, so what was the word that we thought was important for that? So when they were making coca cola? Determined? Okay. So what was it about determined that was important?

Barry: never give up

Interviewer: so the fact that they didn’t give up

Stanley: and crisps was a mistake

Barry: and post it notes

Interviewer: oh so it’s about using mistakes to make something good?

Barry: yeah

Interviewer: ah okay

[talk about stickers on backs of cards]

Stanley: so I have competitive – you always have to be competitive in life

Interviewer: you *do* have to be competitive? What’s important about being competitive?

Stanley: because you can get far. If you’re not competitive you’re like “ah I’m not going to win”

Barry: like Ronaldo

Stanley: “I don’t really care about this, I’m just going to have a go”

Barry: and see what happens

Stanley: and see what happens then when you've finished everybody thinks that you're good – you don't recognise how good you are

Interviewer: so why is being competitive being important in STEM?

Barry: so you can show you're good

Stanley: so you can show that you're competitive

Barry: and trusted

Stanley: you *want* to do it

Barry: so you're competitive

Stanley: then you're being competitive and somebody realises

Barry: so then they can take you somewhere – where you can do something

Stanley: then you could have a whole new life

Interviewer: right okay – so have you got anyone in particular who needs to be competitive on here?

Stanley: sport

Interviewer: if you work in sport you might need to be competitive?

Barry: like Ronaldo

Interviewer: like Ronaldo okay

Stanley: I have a [unclear]

Interviewer: okay

Stanley: enjoys science

Interviewer: enjoys science, okay why is that important if you do STEM?

Barry: so then you can be a scientist

Interviewer: okay

Barry: if you enjoy it

Stanley: be a scientist you *can* use science in engineering

Interviewer: yep?

Stanley: when you [unclear – draw?] a big plane: that's science

Interviewer: yeah?

Stanley: and then, with the actual plane – that's science

Interviewer: okay, fab – any other words? Did you have any [Barry]?

Barry: wants to understand how things work

Stanley: How a beekeeper keeps all the bees in the hives? How the bees make it work, how they turn the –

Interviewer: nectar?

Stanley: the nectar into honey

Interviewer: ah okay

Stanley: how do the people get the bees to them and in the hives to make honey for the people?

Interviewer: okay, so a beekeeper might want to understand how the bees make honey?

Stanley: yeah

Barry: likes computer games

Interviewer: go on – is that important for someone working in STEM?

Barry: no… it could be

Interviewer: it could be? Why do you think that?

Stanley: this is -

Barry: can use computers – like you – you can scan how long it is – the bone?

Interviewer: is there anyone on here that needs to be able to use computers?

Barry: Ali?

Interviewer: Ali yeah?

Barry: because she has to scan

Stanley: they scan the broken bone, they want to know so she scans it then she looks at them

Barry: she can scan how many degrees it twisted

Interviewer: okay – and what was that one? Likes computer games – do you think that would be important for somebody who works in STEM?

Barry: no

Stanley: I don't really think, because games are not the *best* thing, but some games like monopoly, you could learn –

Barry: you can learn to bank

Stanley: yeah you could learn how to use the bank

Interviewer: okay

Stanley: you could put – say if there was such thing as a hundred pound note

Interviewer: yeah?

Stanley: put £100 note in and you don't have much £50 notes, so you put £100 note in and you have two £50 back

Interviewer: ah so it might help you learn about different currency? Okay

Stanley: it makes you understand, because if you give 500 and the house that you wanted to rent –

Barry: was 600, you'd have to [have] another 100

Stanley: no, and the house to rent was 350

Interviewer: yeah

Stanley: you have to know how much change you get from that

Interviewer: okay, so computer games can help us learn maths skills?

Barry: yeah

Interviewer: okay

Stanley: board games are a lot better

Interviewer: okay you think board games are better?

Stanley: chess, you have to have the mind to check mate

Interviewer: yeah? What was that one?

Stanley: listen to other people's opinions

Barry: yeah that was what we did!

Stanley: like a doctor you

Barry: listen what they're going to do

Stanley: listen to what the person thinks and what he really wants you to do well with him

Interviewer: so this person here, she's a doctor isn't she? Who does she need to listen to?

Stanley: she needs to listen to other doctor's opinions

Barry: yeah

Interviewer: yeah?

Stanley: because then she

Barry: can make something bigger

Stanley: she and him, or another she can work together

Barry: or him and her, or him and him?

Interviewer: okay

Interviewer: what other words have we got then?

Barry: enjoys sport

Stanley: you might have really hurt yourself by doing sports

Barry: and you're a doctor

Stanley: and go to a nurse or a doctor

Interviewer: yeah

Stanley: then your nan or your

Barry: grandpa

Stanley: if the nurse could help you then she says "you can do a *little* bit of sport"

Barry: but not too much

Stanley: but not too much

Interviewer: ah okay

Barry: like go to training

Stanley: when you finish it, you could be all back all on sport

Barry: yeah you can [unclear]

Interviewer: so a doctor or a nurse might need to know a little bit about sport so they know what they can tell their patients about what they can do?

Barry: yeah

Interviewer: okay – what word do you have there [Barry]? Do you want to talk about it?

Barry: artistic

Interviewer: artistic – do you think that might be important for someone working in STEM? Or for any of these people?

Barry: you could be artistic

Interviewer: how could you be artistic?

Stanley: you could draw paintings or copy the Mona – you could be there all night doing it

Barry: I don't think somebody would do that

Interviewer: why do you think they –

Stanley: they might get ideas from the Mona Lisa or other paintings like Picasso or Leonardo Da Vinci

Interviewer: why might someone in STEM need to be artistic? Do they need to be artistic?

Barry: they don't have to, they could just

Stanley: it's a good thing to do

Barry: yeah

Stanley: how to draw really neatly – you could learn lots of shapes

Interviewer: okay

Stanley: then you learn how to do something with a [ruler] than without

Interviewer: okay

Stanley: so tell if you forgot one and

Barry: you're like "I can't do it"

Stanley: [your lines] were all squiggly

Interviewer: yeah

Stanley: instead if what you learned over and over and over again you could go like [straight line]

Interviewer: okay

Barry: or if you're sure you can't do it – because my [friend] does this – just do it with a pen he doesn't always do it with a [ruler]

Interviewer: okay

Barry: he doesn't always do it, just sometimes

Interviewer: okay. Are there any other words that we think are important?

Stanley: I have a good one, hardworking

Interviewer: let's talk about hardworking

Stanley: so you always need to put lots of effort into something

Barry: yeah

Interviewer: uh huh

Stanley: say if you're engineering a plane, you won't be like "okay another plane to work on okay I'll do exactly the same" - but it might a different plane

Interviewer: okay

Stanley: so you need to think hard, put all of it

Barry: okay, so I make the same size but then I'll put different things on it

Interviewer: okay, and you need to work hard to do that?

Stanley: if you always work for one company, well you *might* but you will usually work just for one company and you have to try your *best* for that company

Interviewer: okay

Stanley: so say if you work for two plane companies, you're like "okay, I won't work for this one"

Interviewer: okay

Stanley: "I'm working for this one"

Barry: instead

Stanley: "it's boring, but I'll just do the wing and he designs is and it all goes wrong when the plane takes off"

Interviewer: ah right so you need to be hardworking to make sure it works properly?

Barry: yeah

Stanley: but in the other one he might be "okay let's go!"

Interviewer: okay

Stanley: so he'll put all of his efforts in both of them

Interviewer: okay so it's important to be hardworking?

Barry: and then he could be fired

Interviewer: oh well you don't want to get fired do you?

Barry: so he *has* to do it

Stanley: before he goes on holiday, he designs the wing of the plane that he's going on

Interviewer: yeah

Stanley: on holiday and then the plane might go all wrong

Barry: and he will kill lots of people

Interviewer: well you don't want to be killing lots of people do you? So are there any other words, just before we move onto the last stage of what we're doing, are there any words on here that you think are *really* important if you work in STEM?

Stanley: this is not the best – but get all the answers right. You can do a couple of mistakes and then go back at it and do it better

Barry: and rethink what you did

Interviewer: ah okay so you don't always have to get the answers right?

Barry: no, like in a maths test –

Stanley: but you have to try

Barry: if you want to get an A you can have like £10 – if you get the A it's like "okay I want £10 to get my new iPhone, I need to put a lot of thinking in my last test, because I got a B instead"

Interviewer: okay

Barry: so I learn from that to this one

Interviewer: okay so do you think that it's more important to learn from your mistakes than it is to get all the answers right the first time?

Barry: yeah

Interviewer: okay, that's a good one. Did you have anything else that you think's really really important?

Stanley: I have methological

Interviewer: methodical

Stanley: methodical: works through each stage carefully

Barry: that would go in everyone

Interviewer: yeah?

Stanley: instead of rushing it and going like this [scribble] "finished"

Interviewer: yeah

Stanley: might have all of the answers wrong

Barry: so you work through

Stanley: you *always* work

Barry: and you have loads of time – you have two hours and it only takes an hour and a half and you have two hours you just go slowly

Interviewer: and make sure you do each stage?

Barry: yeah

Interviewer: okay

Stanley: because you do it and then go over it and go "done it!"

Barry: F!

Stanley: then you say to your teacher "finished" and she says "look over it" you just go like that: "finished" and your teacher looks at it and she's like "F"

Interviewer: okay

Barry: so you don't want [that]

Interviewer: is that important for people who work in STEM as well as when you're doing a test?

Stanley: yeah

Interviewer: how is it important for people in STEM?

Stanley: because you have to learn the bones

Interviewer: yeah?

Barry: you have to learn how long without one of these [ruler]

Stanley: if you find one you'll be like "oh… I forgot to check which one it was" and then your office is about two hours away

Interviewer: mm

Stanley: so then you have to go all the way with that bone to go instead of knowing it and staying there with the rest of the bones

Barry: and you can check how long it is without one of these

Interviewer: okay so without a ruler year? Okay, so. Now if we've chosen everything that we think is important, and we've talked about it. Do you remember before we chose five words that you think describe yourself and we talked about why you chose those words?

Barry: yeah

Interviewer: would you guys be okay doing that again?

Barry: I don't remember it

Interviewer: you don't have to remember the words you chose

Stanley: I love visiting

Interviewer: you like visiting other countries?

Stanley: yeah

Interviewer: they don't have to be the same words, just choose five words that *today* you feel describe yourself

Barry: you did?

Interviewer: you don't have to have *done* it today, but what do you think describes yourself?

Stanley: I think you have to respect other countries

Barry: yeah you have to – like America, they don't respect Mexico – they built a wall

Interviewer: so it's important to be respectful of other people

Barry: and other countries

Stanley: because Mexico, they deliver a lot of food to America

Barry: no, they put drugs to America – that's why

Interviewer: well America *thinks* that they do

Barry: yeah but probably not

Interviewer: we don't know do we?

Barry: if we were Mexican we might know

Interviewer: okay so are you guys ready to choose five words that you think describe yourself, please? You can share words so you don't have to choose one or the other

Barry: I like helping others, I have three

Stanley: I have four

Barry: creative, I am so creative – enjoy reading

Interviewer: have you got five?

[chat about having five or six]

Stanley: can I have six because I'm very competitive

Interviewer: we need to choose five, so are you more competitive than you are something else?

Barry: I enjoy reading, I am *so* creative – I am yeah

Interviewer: happy? You're going to swap one, so you're swapping enjoys history for?

Stanley: actually I do not

Interviewer: you're going to keep that one? [Barry] can you please tell us which words you chose and why you chose them?

Barry: enjoy reading because I like when you read you get more clever and clever and clever– so that's why I've chose

Stanley: and you learn new things

Barry: yeah that's why

Interviewer: okay

Barry: creative because I am so creative about the future, I always think, when I'm bored, I always think what the future's going to be

Stanley: this goes with this: creative, enjoys building things

Interviewer: you think they go together?

Stanley: yeah

Barry: yeah

Stanley: if you create something, you've built something

Interviewer: true yeah

Barry: likes helping others because I don't like people to fail, so I really want to help them

Interviewer: okay, which kind of people do you help?

Barry: my whole class and sometimes my family

Interviewer: okay, fab

Barry: and I enjoy maths, so I can be something close to maths if I need to. And clever – that's like enjoy reading – that makes me more clever

Interviewer: you enjoy reading because you think it makes you more clever – what is it that you enjoy about maths?

Barry: about the sums I do, plus take away and with maths, I can do reading then clever and I can enjoy maths and it goes like that

Interviewer: ah so you think enjoys reading makes you clever, which makes you enjoy maths?

Barry: yeah

Interviewer: okay, is there anything else you wanted to tell us?

Barry: no

Interviewer: okay, [Stanley] can you please tell us about yours?

Stanley: I *love* visiting other countries, because then I learn about them. That's why I love my history as well

Interviewer: yeah

Stanley: I think learning history's a good thing because then you improve – you learn a lot about history

Interviewer: okay

Stanley: I love my science

Barry: yeah you do!

Interviewer: what is it that you like about science?

Stanley: so the way I started loving science was because of [Barry's] mum

Barry: some people say in other classes that my mum's the best teacher

Interviewer: oh really?

Stanley: I think she's the only one

Interviewer: okay

Stanley: she's the best

Interviewer: okay and what were your other words?

Stanley: I absolutely love sport

Interviewer: yeah okay

Stanley: I will never ever stop playing it

Barry: yeah and me

Interviewer: okay

Stanley: I love building stuff – I like my hand

Interviewer: what have you built recently?

Barry: I was going to go with that, but then I didn't [choose] it

Stanley: we have actually built lots of stuff

Interviewer: go on

Stanley: I've built racing stuff. A hot glue gun house – it was about that tall [measures with hands]

Interviewer: okay

Stanley: I built it, like shaped up, shaped down

Interviewer: yeah?

Stanley: In the middle of it, I did something very stupid – I had a glue gun fight

Interviewer: oh dear, that's not sensible is it?

Stanley: no, my brother started it – he took out a glue gun and went like this and put it right on my hand

Interviewer: yeah

Barry: and you were like "how dare you?"

Stanley: I was like [scream]

Interviewer: oh no

Stanley: and I tried to peel it off

Interviewer: oh that's a bad idea

Barry: yeah it was

Stanley: instead I got a sharp knife and cut it

[lunch time: interview is stopped]

42 Appendix 30: Pupil task-based interview 2, SP

Title: Pupil interview 2

Date: 29th March 2019

Speakers: Poppy Hodkinson (interviewer), NJ, Skull Trooper, Cupcake and Blossom

Interview duration: 32 Minutes

Interview location: SP

Interviewer: okay, the first thing that we're going to do is we're going to make a mind map of all the people in your life that either work in STEM, or have an interest in STEM. That can be your family member, or a friend or anyone like that. Okay? Would you like to choose a pen each?

[chat about pen colours and children say names in order to discern between voices when transcribing]

Interviewer: okay, so what do we need to put in the middle of our mind map?

NJ: STEM

Interviewer: Good idea [NJ] – do you want to put that one?

Skull Trooper: wait, why don't we do it in rainbow colours because there's four of us?

[child draws on mind map]

Interviewer: lovely, okay. Does someone want to put a little bubble around it? Go on [Skull Trooper]

[child draws on mind map]

Interviewer: right, so who can think of someone that is either in their family, or is a friend, or that they know, who works in STEM?

NJ: can it just be one of them or does it have to be all of them?

Interviewer: it can be just one of them yeah

NJ: my dad

Interviewer: your dad? Okay yeah, what does your dad do?

NJ: he works at Barclays in technology

Interviewer: ah so your dad works with technology? Fab, stick that on

Skull Trooper: I've got my neighbour [who] works actually as an archaeologist as well

Interviewer: really? Very cool!

NJ: do I just do dad

Interviewer: maybe put technology as well so I remember what it is. So you can put your neighbour who's an archaeologist – very cool. [to Cupcake and Blossom] have you guys got anybody?

[pause]

Interviewer: anyone that you know maybe? It's okay if you don't

Blossom: my dad works somewhere to help the planet

Interviewer: oh very cool

NJ: technology…engineer… science it could be – planet science?

Interviewer: what is it with the planets?

Blossom: well he tries to look after the world so there's no plastic

Interviewer: oh that's very interesting. That definitely sounds something to do with STEM. Would you like to put that on there? [to Skull Trooper] was this one archaeology?

Skull Trooper: yeah, that's why I put STEM

Interviewer: Have you got any ideas? [pause] I wasn't sure how many people you guys would know, so I brought along some of the people that I know. And I've got a little profile here, for each of my friends. So I've got five friends who work in STEM, and there's a little picture of them, and a little bit of information about them. And I thought we could think about the jobs that they do. So would anyone like to read any of these out?

[child indicates yes]

Interviewer: yeah? Do you want to grab one? Do you want to read one out? No, okay well I'll read these two. Who'd like to start?

Skull Trooper: I will

Interviewer: okay, [Skull Trooper] will start

Skull Trooper: [Rhodri description]

Interviewer: okay, so that's Rhodri – he works in IT helping people fix their computers. Are you going to read next?

Skull Trooper: I can fix computers really well

Interviewer: can you?

Skull Trooper: all my class – say if we're doing computer work –

Interviewer: yeah

Skull Trooper: they just all ask me to do it – they're just all around me

Interviewer: ah are you the go to guy for IT?

Skull Trooper: kind of

Interviewer: ah I see

NJ: I can program

Interviewer: You can program? I remember you said that before yeah! Are you ready to read one?

Cupcake: [Ali description]

Interviewer: okay, do you want to go next [NJ]? Sorry – I'll summarise that one: Ali is a doctor and works in medicine, so she has to make sure that she gives her patients the right treatment to make sure that they get better

Skull Trooper: my grandad works in the hospital

Interviewer: what does your grandad do in the hospital?

Skull Trooper: well he tests out the ambulance and sometimes he's a receptionist

Interviewer: ah okay

Cupcake: oh my nan works in the hospital

Interviewer: does she?

NJ: my pop does and he got a medal from the Queen for doing it

Interviewer: really wow, so we've got a lot of medical people in our family. Because medicine is part of STEM isn't it? Okay, have you got Scott there?

NJ: [Scott description]

Interviewer: so Scott works with technology, he designs different products and tests them to make sure that they work properly or to try and make them work better. [To Blossom] did you want to read one? No? okay. I'll read about Chloe

[Chloe description]

Interviewer: and I've got one more person, does anyone want to read this one out? Or shall I read this one as well?

[Skull Trooper and NJ discuss who will read it out]

Interviewer: go on then [NJ]. so Johanna

NJ: [Johanna description]

Interviewer: okay, so Johanna works with really *old* objects making sure that they can survive over time. So she has to make sure she understands whether they shouldn't be exposed to lots of sunshine or how warm they need it to be or cold. So that's really important

Skull Trooper: so like plants – like you were talking about with my class just then?

Interviewer: yeah exactly! Like plants! They like to live in certain types of environment – different objects do as well yeah. Exactly. Do you remember before we had all of these cards, and we picked out things that we thought might be important for people that work in STEM. Can we do a similar thing now? But we're going to be looking for things that we think are important for everyone that we know – your dad and your neighbour and you mum who works in the hospital?

Cupcake: my grandad

Interviewer: your grandad sorry – as well as the people we've talked about here. As well as my friends. So can we look for cards that you think might be important for them? Can you see from there [Skull Trooper]?

Skull Trooper: yeah

Interviewer: okay

Skull Trooper: my mum can use computers – can you do it about yourself as well?

Interviewer: yeah, well we're going to pick out ones for ourselves at the end. So these are just ones that are important – if you had a STEM job – if you were an engineer or a technologist or you worked in IT, which of these would it be important for you to have or be able to do?

Skull Trooper: [NJ] I've just got likes computer games right now [laugh]

Interviewer: which one have you got there [Blossom]?

Blossom: listens to other people's opinions

Interviewer: and why might that be important for somebody working in STEM?

[pause]

Interviewer: anyone else? Do you think that listening to opinions might be important? [Cupcake]?

Cupcake: you can learn other people's ideas and what they decided to do

Interviewer: yeah, is there anyone here that we think that might be important for? To listen to other people's ideas?

[NJ indicates Scott]

Interviewer: you think Scott [NJ]? What were you going to say [Skull Trooper]?

Skull Trooper: I think Rhodri

Interviewer: why do you think Rhodri?

Skull Trooper: because he helps other people for nothing – they don't do anything for him and he just does it for them without them doing anything for him.

Interviewer: Okay, so shall we put this one over here with these guys. And why does Scott need to listen to other people's opinion as well?

NJ: so he can hear people's ideas to improve the technology to work with everyone

Interviewer: okay, awesome. Have we got any other ones that we wanted to share? Have you got one there [Cupcake]?

Cupcake: Likes to learn new things

Interviewer: okay, why might that be important if you work in STEM?

Cupcake: so you want to find out different things, like about how things work and…

Interviewer: yeah?

[pause]

Interviewer: did anyone else have any thoughts about that one? Wanting to learn new things, is that important for someone working in STEM?

Skull Trooper: yes, because if they want to improve stuff, they can listen to other people's opinions and add their opinions onto them there?

Interviewer: ah okay. And that can help them learn new things? Cool okay. What were you going to say [NJ]? What have you got?

NJ: inventive and likes visiting other countries

Interviewer: okay, shall we talk about inventive? Why is being inventive important if you work in STEM?

NJ: because if you have a job like Scott, you need to be able to invent and fix and make things better

Interviewer: okay, cool – does anyone else think anything about that one?

[pause]

Interviewer: nope? Okay – what was the other one?

NJ: likes visiting other countries: he has to visit Japan

Interviewer: yeah, Scott visits Japan yeah

NJ: and you might have to visit other countries to see different old buildings

Interviewer: yeah? So Johanna might want to go to a different place to visit old buildings, cool. So we had inventive here and likes visiting other countries. Go on [Skull Trooper]

Skull Trooper: I've got can use computers

Interviewer: okay, who needs to be able to use computers?

Skull Trooper: scientists

Interviewer: yeah?

Skull Trooper: and they need to use computers because if they've made something new, they might want to show it to the world, so they need computers to tell other people about it?

Interviewer: interesting, okay yeah? Is there any other reason why using computers might be important?

Skull Trooper: because you might want to search up some stuff?

Interviewer: yeah?

Skull Trooper: if you don't know what something is

Interviewer: if you want to research things yeah

Skull Trooper: archaeologists might want to search up some bones, if they don't know what bones there is

Interviewer: yep, awesome – go on?

Cupcake: maybe they could use it to scan, to look closer at things

Interviewer: yeah maybe

Skull Trooper: and you could search up the DNA

Interviewer: ah okay

Skull Trooper: of the animals if you get them off the bone

Interviewer: okay. Cool okay, what other words did we have?

Skull Trooper: I've got clever

Interviewer: why might being clever be important if you work in STEM?

Skull Trooper: because you have to be clever to help people if they want any help

Interviewer: okay

Skull Trooper: like Rhodri, he helps other people with computers so he has to be clever

Interviewer: okay

Skull Trooper: to fix them

Interviewer: okay, what were you going to say [NJ]?

NJ: I was going to – what was it again?

Skull Trooper: clever

NJ: you need to be clever to be able to do things

Interviewer: be able to do *everything?*

NJ: be able to do lots of things

Interviewer: ah right okay

Skull Trooper: you need to be clever

Interviewer: what kind of things do you need to be clever to do?

Skull Trooper: you need to be clever to use a computer

Interviewer: okay

NJ: to be able to fix things and to be able to tell what temperature different objects need to be in

Interviewer: oh right okay. What have you got there?

Skull Trooper: honest

Interviewer: why is being honest important?

Skull Trooper: because if you're not honest about what you've found – it's not going to be real. Like what [teacher] said with the daily mile – if you don't record a correct time and you cheat

Interviewer: yeah

Skull Trooper: you're not proving, and you're not helping yourself by doing it

Interviewer: okay, which of these people might need to be honest then, do you think? Working in STEM? Johanna needs to be honest? Ali? Why does Ali need to be honest?

Cupcake: because if she's not honest with what she's saying to a patient, a patient could get really ill

Interviewer: okay

Skull Trooper: Rhodri could be honest because if he's not honest and it broke again, if the computer's not fixed

Interviewer: yep

Skull Trooper: he could have damaged it even more

Interviewer: ah okay, that's a good one then – shall we put that on? That's kind of on everyone again, shall we put that in the middle of the STEM bit?

Cupcake: that goes on everyone I guess

Interviewer: ah you think everyone who works in STEM – it's important for everyone?

Cupcake: yeah

Interviewer: what other words have we got – can you see any that you think might be really important

NJ: nope

Interviewer: can you see any that might *not* be important? Is there any that you think actually *isn't* important?

Skull Trooper: like computer games [laugh]

Interviewer: like computer games? Do you think that's important or not important?

Skull Trooper: it might be a little bit for those two – but especially him

Interviewer: so a little bit important for Rhodri and Scott? Why do you think it might be a bit important for them?

NJ: because they both use – Rhodri fixes computers

Interviewer: yeah

NJ: so he might need to know how to

Skull Trooper: an Xbox?

NJ: make a computer game – like computer games, maybe it's got a virus on it and then it gives the whole thing a virus, he needs to be able to get the virus off that disk to then carry on using it

Interviewer: okay

NJ: then Scott needs to be able to make a device that if when he plays a game, to stop anyone hacking it or something?

Interviewer: okay, so enjoying computers and liking playing computer games might help you do some STEM things? Interesting

Skull Trooper: enjoy dancing doesn't

Interviewer: you don't think enjoys dancing is important?

Skull Trooper: no

NJ: it might be, if you find something important you might want to have a little boogie

Interviewer: [laugh] if you're excited about your research you might have a little dance?

Skull Trooper: but it wouldn't be like a really good dance, it would just be like [dance]

Interviewer: [laugh]

Cupcake: well you could enjoy dancing, because you wouldn't use it in your work, but you could still enjoy it

Interviewer: yeah okay? So just because you work in STEM doesn't mean you can't enjoy dancing? Absolutely. What card have you got there?

Cupcake: competitive – I don't think you really need to be competitive with your work – you just try to find out as much as you can

Interviewer: okay [to Blossom] what do you think about competitive? You're not sure? So what do you guys think about competitive?

NJ: no, not at all

Skull Trooper: no because if you're competitive then – say if there's a manager

Interviewer: yeah?

Skull Trooper: and then two people who work, one competitive person and one just positive

Interviewer: yeah?

Skull Trooper: and then the competitive person is just being mean to the positive

Interviewer: okay

Skull Trooper: It's a new business so they don't have much people and it's only them two

Interviewer: yeah?

Skull Trooper: then the competitive is really competitive, then the positive one might leave the job

Interviewer: okay so being competitive doesn't always help you work with the people around you? So it's important to be nice to people, as well as being driven?

Cupcake: if you're competitive, you may want to do more than the other person, so you may rush what you're doing – and you're meant to take your time and try and do it slowly so you're not rushing down all the research and you do it all wrong

Interviewer: ah okay, cool. Have we got any other words that we want to talk about? Any other cards that we think are really important?

[pause]

Interviewer: are you holding onto those for later or did you want to talk about them now? Oh, we've already talked about those ones haven't we?

Skull Trooper: yeah

Interviewer: you're just holding onto them, okay

NJ: hardworking

Interviewer: yeah, can you tell us about hardworking [NJ]? What do you think about that?

NJ: you need to be able to be hardworking to just do your job and just keep on trying

Interviewer: yeah, okay. So that's for everyone? What does everyone else think about hardworking?

Skull Trooper: I think it's good, because if Rhodri does some bad – not good work on the computer, it might still work a little and then it might be even worse?

Interviewer: okay? Are there any words on here that you've seen and you're not quite sure what they mean? Because I've got a glossary here and we could have a look at those and see what we thought about them – are there any that you aren't sure what the word meant?

Skull Trooper: can work in a team is quite important

Interviewer: can work in a team yeah? You wanted logical [NJ]? Can work in a team, tell us about that one and then we'll do your one as well?

Skull Trooper: if you work in a team then you can improve stuff better?

Interviewer: okay – what do you guys think about working in a team?

NJ: yeah

Cupcake: I think that's good

Blossom: because then you can help everyone else out

Interviewer: yeah

Blossom: and people can help you and you'll learn new things

Interviewer: okay – so can work in a team is helpful because you can work with other people, you can help other people, and they can help you as well can't? What have you got there [Cupcake]?

Cupcake: I don't know what it means

Interviewer: what's that word there? What do we think guys?

NJ: reliable

Interviewer: reliable yeah – what does reliable mean?

Skull Trooper: you can rely

Cupcake: trust

Skull Trooper: you can rely and trust people

Interviewer: absolutely, so you can rely on someone to do something if they said they'd do it. It's just there:

Blossom: oh yeah: always does what they have promised and can be trusted

Interviewer: okay, what do you think about reliable [Cupcake]? or [Blossom]?

Cupcake: I think it should go maybe in the middle because with reliable, you can rely on somebody – maybe in your team, who you're helping, they want to rely on you to help them

Interviewer: okay

Cupcake: with their research

Interviewer: cool. So before we go onto the next activity, is there any words that you think you'd really like to talk about because you think they're really important?

Skull Trooper: okay, I think can take risks is really important

Interviewer: okay, so can take risks – what is important about that? Why is that important?

Skull Trooper: because, if you take a risk

Interviewer: yep

Skull Trooper: it could be a risk that leads to you in a lot of pain

Interviewer: oh okay

Skull Trooper: and if you don't take the risk, it's better. And you'll help other people if you don't take serious risks

Interviewer: okay so you don't think that you should take serious risks. What kind of risks are okay to take? Are there any risks that are okay to take?

Skull Trooper: Trying out new things?

Interviewer: yeah?

Skull Trooper: if it's electrical, and it's a really powerful electrical

Interviewer: yeah

Skull Trooper: you should have some rubber gloves on

Interviewer: oh okay

Skull Trooper: oh and if it lights the rubber gloves, you should have some water

Interviewer: oh okay, so if you get electrocuted?

Skull Trooper: yeah because rubber gloves don't get electrocuted because rubber stops it

Interviewer: it does yeah, rubber doesn't conduct electricity. What was your word there?

Cupcake: [unsure of pronunciation] methodical

Interviewer: methodical – do we know what methodical means?

NJ: I have a method, you have a method

Interviewer: exactly, so you have a method. Methodical

Cupcake: kind of like 'method' ical

Interviewer: yeah exactly, so it says here: you work through each stage of a task carefully, so you have your method and you follow it carefully. What do you think about that one [Cupcake]?

Cupcake: maybe that's in the middle because when you're doing your research and you're helping somebody maybe you have to do it carefully and in steps

Interviewer: okay

Cupcake: so you don't go all rush into it and you forget to do something. Otherwise you wouldn't have done it

Interviewer: okay, brilliant. Thank you. So are we all ready? Are we happy that we've talked about all the words that are important?

Children: yes

Interviewer: We haven't missed anything off?

Skull Trooper: enjoy maths

Interviewer: oh go on – enjoy maths

Skull Trooper: if it's 8000 BC and all the other stuff that you're talking [about] in the class, you could add up the years?

Interviewer: yeah

Skull Trooper: so if you're not good at maths, and you don't enjoy it

Interviewer: yeah

Skull Trooper: there's kind of no point if you're an archaeologist – of being an archaeologist if you don't enjoy maths

Interviewer: okay so if there are parts of your job that need maths, it would be good to enjoy it?

Skull Trooper: yeah

Interviewer: okay so – it's lunchtime in a second

Skull Trooper: I've just seen the dinner ladies

Interviewer: okay in which case, shall we choose five cards that you think represent you? And you can share them – so if someone's already chosen one, you can both use that card, so you don't have to lose out. So five things that you think represent you – are there any down here for you guys as well?

NJ & Skull Trooper: use computers!

Skull Trooper: me and [NJ] are just getting the same stuff

Interviewer: are you?

NJ: I want that dancing one

Cupcake: I want the dancing one

Skull Trooper: honest

Skull Trooper: the dancing one is over there, but you can remember that you want that one

Cupcake: I need one more

Blossom: I need a few more [laugh]

Cupcake: I need one more because I'm going to do dance

Interviewer: okay

NJ: me and [Skull Trooper] play Fortnite together

Cupcake: my sister plays Fortnite

Child: your sister?

Skull Trooper: are you absolutely – what?

Interviewer: okay, so has everyone got their cards?

Skull Trooper: me and [NJ] are sharing all of them so far

Interviewer: are you going to choose some cards [Blossom]? It's okay if you don't want to

Skull Trooper: me and [NJ] are all sharing the same cards

Interviewer: okay

Skull Trooper: we all like the same stuff

Interviewer: okay, well [Skull Trooper] can you please tell me which ones you chose and why you chose them, and then [NJ] can tell us his ones

Skull Trooper: well I like helping others because if you do, you can feel good in yourself

Interviewer: yeah?

Skull Trooper: I like to be honest because then it will come to good consequences, not bad

Interviewer: yeah

Skull Trooper: can use computers because you might want to search up some stuff and get even smarter if you want to

Interviewer: okay

Skull Trooper: and use computers for questionnaires with maths

Interviewer: yeah?

Blossom: [whisper] I'm not very artistic

Cupcake: [whisper] you are!

Skull Trooper: I enjoy maths because it's a fun subject

Interviewer: okay, what do you think is fun about it?

Skull Trooper: I don't really know, I just like maths in my work

Cupcake: [whisper] you're an incredible drawer. You *are*

Interviewer: okay

Skull Trooper: I like computer games because they're fun to play with your friends

Interviewer: uh huh

Skull Trooper: and I can help – I can play with my friends and then they can play with me and we can all have fun together

Interviewer: awesome

Skull Trooper: even when we're not together

Interviewer: ah so you like being able to play games even when you're not at each other's houses?

NJ: yeah that's what we do

Interviewer: do you play over the internet?

Skull Trooper: yeah and I speak to [NJ]

NJ: on the mikes

Interviewer: okay, thank you [Skull Trooper]. [NJ], can you tell us why you chose your words please?

NJ: I like helping others because it makes you feel proud of yourself and… yeah

Interviewer: okay

NJ: I like being honest because it's never good to tell lies

Interviewer: okay

NJ: I can use computers because I code and I'm making an app

Interviewer: what app are you making?

NJ: I'm making one that's meant to be like a game

Interviewer: okay

NJ: sort of thing, similar to Fortnite

Interviewer: ah very cool

NJ: like a gun game. I really enjoy maths, it's the funnest subject I think – it's not P.E. and anything, well exercise

Skull Trooper: yeah [NJ] loves exercise

Interviewer: ah so maths is your favourite outside of P.E?

NJ: P.E would be my favourite out of all [unclear]

Interviewer: okay

NJ: I *love* computer games

Interviewer: yeah? Which computer games do you like?

NJ: Fortnite, Apex Legends, Forza seven

Skull Trooper: I'm downloading Apex Legends because I like to play with [NJ] a lot

Interviewer: okay

Skull Trooper: I wanted to play on different games, not just one

Interviewer: okay, so you like to have the same games as each other?

NJ: I play FIFA, I play rocket league, what's the game called where you have…? Roblox. I have an Xbox, he has the Nintendo switch

Interviewer: cool

Skull Trooper: I've got a Nintendo 3DS

Interviewer: okay guys, thank you. Was there anything else you wanted to say about your words at all?

Skull Trooper & NJ: no

Interviewer: no, brilliant. Thank you ever so much. Shall we hear from this end of the table? Which words have you chosen and why have you chosen them?

Cupcake: So me and [Blossom] both chose dance

Interviewer: okay, hang on one second girls [boys are invited to go to lunch]

Cupcake: me and [Blossom] both like dancing

Interviewer: okay

Cupcake: [Blossom] used to go to dance, I still go to dance. We used to go to the same one, but we didn't used to go at the same time, then [Blossom] quitted

Interviewer: okay

Cupcake: and I do street dance and jazz

Blossom: I used to do tap dancing

Interviewer: tap dancing? Okay

Cupcake: I do street and jazz

Interviewer: okay, and what do you enjoy about dancing [Blossom]?

Blossom: it's just really fun – it entertains you a lot!

Interviewer: okay. What was your next word?

Cupcake: I've got clever

Interviewer: okay

Cupcake: my teacher said at parents evening that I'm clever

Interviewer: okay cool

Cupcake: hardworking: I always like to – not get things right – but I like to

Blossom: help other people

Cupcake: try and do as best as I can

Interviewer: okay

Cupcake: so I always work hard

Interviewer: you always work hard

Cupcake: I'm always sensible

Interviewer: okay

Cupcake: not like some people [Blossom] – not you, but you know who!

Interviewer: okay, so you're sensible. What do you feel about being sensible?

Cupcake: [Teacher] can trust me because, when me and [Blossom] sometimes come up to ask for help in the class, he always says: oh yes, we have something for you to do, just go over there and tidy up the book corner or something like that

Blossom: [laugh]

Interviewer: oh so there's always extra work for you to do is there?

Blossom: yep

Cupcake: and then my last one is creative

Interviewer: okay, can you tell us about creative?

Cupcake: well, I like drawing and I like being creative because I like cooking!

Interviewer: okay, brilliant. And your words [Blossom]?

Blossom: she told me to pick these two

Cupcake: no I did not!

Blossom: yes you did too

Cupcake: Well you're good at them, so I thought you would

Interviewer: ah right okay

Blossom: okay! The first is artistical

Cupcake: [whisper] artistical

Interviewer: artistic, what do you think about that – do you think that you're artistic?

Blossom: she told me yes

Interviewer: you don't think you are but you [Cupcake] think she is?

Cupcake: yes, lots!

Interviewer: okay, what about imaginative?

Blossom: she says I overthink a little bit

Cupcake: no I didn't

Blossom: yes you did

Cupcake: you are *so* imaginative [Blossom]! Your drawings are perfect!

Interviewer: ah so your imagination is what helps you to be so artistic?

Blossom: yeah

Interviewer: and you do lots of drawings okay – last one?

Blossom: can work as a team

Interviewer: did you choose that one?

Blossom: yep

Interviewer: okay, can you tell us about that one?

Blossom: so basically, I like helping other people

Interviewer: uh huh

Blossom: [pause] that's all I can think [of]

Interviewer: that's all? Okay thanks very much guys!

43 Appendix 31: Pupil task-based interview 2, BG

Title: Pupil interview 2

Date: 4th April 2019

Speakers: Poppy Hodkinson (interviewer), Buster, Pasta and Videogame Guy

Interview duration: 50 Minutes

Interview location: BG

Interviewer: the first thing that I thought we could do is try and make a little mind map of all the people that you know in your life, so maybe a family member or a friend, or a friend of your family who works in STEM

Pasta: no, I don't think anyone does

Interviewer: no? is there not anyone? Okay, well if you can't think of anyone that you know, then I've got some people that I know – I made some little [information cards] about. So these are my friends who work in STEM, I've got a picture of them so you can see them. And I've got a description of their jobs that they do. So would you like to read about any of those?

Pasta: yeah?

Interviewer: yeah? Shall you read one out and then I'll read one out?

[Pasta indicates yes]

Interviewer: which one would you like to start with?

Pasta: this one

Interviewer: yeah, cool. There you go

Pasta: shall I start?

Interviewer: yeah

Pasta: [Ali description]

Interviewer: okay, so Ali's a doctor, so she has to know all about the science of the body, and medicines, and how to treat people's illnesses. Okay, I'll read this one out: [Johanna description]. So she works with historical things, maybe old furniture or clothing or something like that. She has to understand how to keep them safe. Which one would you like to read now?

[Pasta indicates Scott card]

Interviewer: cool

Pasta: [Scott description]

[people enter room, recording is paused]

Interviewer: so which bit were you reading there?

Pasta: this one

Interviewer: okay, so we're talking about Scott – and what is it that his job is?

Pasta: technologist

Interviewer: yeah, so what does he do with his job?

Pasta: he does experiments on electrical products

[other participants arrive]

Interviewer: okay, so we've been thinking about people in our lives that work in STEM. So do you two have anyone – maybe someone in your family or a friend or a friend of one of your parents or a neighbour who works in STEM?

Children: no

Interviewer: no? okay so I've brought some of my friends for you guys to look at, and we've looked at three of them already. In fact, would you be able to summarise do you think what we learned about each of these people? We haven't look at those two yet have we? Can you remember what Scott does?

Pasta: technologist, and does experiments on electronic products

Interviewer: yeah, so this is Scott and he's a technologist [summarise Scott description]. So that's Scott, who else have we got here?

Pasta: Ali

Interviewer: Ali, what do you remember about Ali?

Pasta: is a doctor and understands how our bodies work and how illness or diseases can affect them

Interviewer: yeah, absolutely, [summary Ali description]. And the last one, do you remember this one?

Pasta: no

Interviewer: shall I say this one? So this is Johanna [description]. We've got two more people, would you guys like to read these last ones out?

Videogame Guy: okay

Interviewer: who wants to go first?

Videogame Guy: I'll go first

Interviewer: which one would you like to read out [Videogame Guy]?

Videogame Guy: [Rhodri description]

Interviewer: okay, so Rhodri works for an IT company and he fixes people IT equipment, but he also makes sure that the people's computers are safe online – making sure they've got all their security settings up to scratch. Who have you got there [Buster]?

Buster: [Chloe description]

Interviewer: okay so Chloe is a problem solver basically, so people have a problem: maybe they don't have enough clean water, and she would work out a way of solving that. And she might build something to help them fix it. Do you remember last time we looked at all these cards

Child: yeah

Interviewer: and they have all these hobbies and interests and traits? And we talked about which ones might be important if you worked in STEM? Do you remember that?

Videogame Guy: yeah

[one child indicates no]

Interviewer: that's okay, because I'm going to remind you now: so we've got the words again today. Some of them are the same as before, and there a couple that we haven't got this time. We're going to be thinking about which skills we think are important for somebody working in STEM, and we can use the people that we've learned about today. So Scott and Ali and Johanna and Chloe and Rhodri, and we can think about which of these skills we think might be important for them. Okay? Can everyone see that cards okay? You can move around if you need to and you can move the cards around as well. So have we got anything on here that we think might be important for someone working in STEM? **Videogame Guy:** can work independently

Interviewer: yeah? Where is that? Why do you think can work independently might be important?

Videogame Guy: because it's [pause]

Interviewer: are there any of these people in particular that you think might need to work independently? Are there any that's coming to mind when you think about that?

Videogame Guy: no

Interviewer: no, okay. Does anyone else think anything about can work independently? Do you guys think that might be important?

Buster: I think it might be important because if you weren't in a group, or there's not much people that work in a certain part, and you want to work on your own, then you have to be good at working on your own

Interviewer: okay, and do you think any of these people or anyone else working in STEM might need to do that in particular?

Buster: [pause] I'm not sure

Interviewer: you're not sure, so we'll put that one to one side. So we think can work independently is important. Is there anything else that you think might be important for somebody working in STEM or doing any of these jobs, or any other jobs in STEM?

Videogame Guy: maybe that one because STEM is science, technology, engineering, mathematics.

Interviewer: yeah

Videogame Guy: For the technology thing – technology is computers

Interviewer: okay, so you think it will be important to be able use computers? Is there anyone in particular that you think really needs to be able to use computers here?

Videogame Guy: him

Interviewer: Scott? Why might Scott need to be able to use computers?

Videogame Guy: because he's a technologist

Interviewer: okay

Buster: I think maybe Rhodri as well

Interviewer: why do you think Rhodri as well?

Buster: because it says IT equipment

Interviewer: yeah, he works with IT equipment. Okay. Is there anything else that you wanted to say about using computers? Is there anyone else that might need to use computers?

Pasta: yes, that one

Interviewer: Ali? Why might Ali need to be able to use computers

Pasta: she needs to know the bodies

Interviewer: yeah?

Pasta: and she needs to see the illness, and that's why she [uses] computers

Interviewer: oh okay so would she'd use computers…?

Pasta: she uses on the computer so she can see all what's happening with the body

Interviewer: ah right okay, so she uses computers to help her work out what an illness might be? Okay. Are there any other words on here that you think are important for somebody working in STEM?

Buster: Inventive

Interviewer: inventive? Do you remember from before, we had this glossary? I've got this here as well, sorry I should have mentioned it already. So why might it be important for somebody working in STEM to be inventive?

Buster: maybe because [pause] I'm not sure

Interviewer: you're not sure? Shall we read out what inventive means? Shall we read the definition?

Videogame Guy: I've already read that

Interviewer: can you read it for us all to hear please?

Videogame Guy: inventive: comes up with new ideas to solve puzzles or design new things

Interviewer: okay, so do we think that being inventive might be important if you work in STEM?

Pasta: yes

Interviewer: why do you think that?

Pasta: what did he say again?

Interviewer: so inventive: comes up with new ideas to solve puzzles or design new things

Videogame Guy: I think I know why as well

Interviewer: yeah

Videogame Guy: because the mathematics part

Interviewer: yeah

Videogame Guy: it says comes up with new ideas to solve puzzles

Interviewer: yeah?

Videogame Guy: you might need to do that

Interviewer: so you might need to solve puzzles in mathematics?

Buster: I think inventive goes with Chloe because she's an engineer

Interviewer: ah okay, so what kind of things is she inventing?

Buster: she's seeing the hygiene of the water in Peru and Uganda

Interviewer: okay, and how is she being inventive? What's she doing to be inventive?

Buster: she is [pause] making new designs and building [pause] things in the environment

Interviewer: okay, thank you. Does anyone else think anything about inventive? Being inventive might be important if you work in STEM? Have you got any other thoughts about that?

[pause]

Interviewer: no? that's okay, so are there any other words? You were pointing at one, which one did you want to talk about?

[child indicates clever]

Interviewer: clever, what did you want to say about clever?

Pasta: it's quick to understand new information

Interviewer: okay

[pause]

Interviewer: do you think it might be important for someone working in STEM?

Pasta: no

Interviewer: no? can you tell us more about that?

Pasta: I'm not sure

Interviewer: you're not sure? Does anyone else think anything about clever?

Buster: you don't *need* to be clever if you're working in STEM because you can do what you can do, and you don't need to be clever because… you *can* be clever but you don't need to be to be in STEM

Interviewer: okay. What did you want to say?

Videogame Guy: although clever you don't *need* it

Interviewer: yeah?

Videogame Guy: it would be good to have it. It would be good to be clever

Interviewer: so some of us think it isn't important because you can… what would you be instead if you weren't clever? What do you think you might be instead?

Buster: you could be – I'm not sure

Interviewer: You're not sure? Okay, some of us think being clever might be important – were you saying that if worked hard [pause] that would be good?

Buster: yeah

Interviewer: are there any other words that you think might be important for somebody working in STEM?

Buster: reliable

Interviewer: reliable? What made you choose that one?

Buster: because if you're on your own and someone leaves you to go and do something else

Interviewer: uh huh

Buster: you have to be – you can't make it all messy when they're gone

Interviewer: okay – are there any people in particular who need to be reliable here? Is there anyone out of these guys?

[pause]

Interviewer: any thoughts about reliable?

Buster: maybe Johanna?

Interviewer: Johanna? Why does Johanna need to be reliable?

Buster: because [pause] she has to [pause] I'm not sure but I just think it would be – she has to be reliable

Interviewer: okay? Do you want to put that one down on there? Are there any other words?

Videogame Guy: I think you might have this one

Interviewer: yeah, can work in a team – what do you think about that one?

Videogame Guy: I don't know, I just think they might need to work as a team to answer a question, or do a task that they need to do

Interviewer: okay, is there anyone in particular that you think needs to do that?

Videogame Guy: no

Interviewer: just everyone should be able to work in a team?

[Videogame Guy indicates yes]

Interviewer: okay, what did you think about that [Pasta]?

[Pasta pause]

Interviewer: did you have any thoughts about it?

Pasta: no

Interviewer: no? okay. Are there any other words that we think might be really helpful or important?

Buster: honest

Interviewer: honest yeah? What do you think about that one?

Buster: I think you have to be honest because if you're in a group – if you're in a group and someone leaves you, and you do something wrong and then the person comes back, and you blame it on someone else, then that person will get in trouble

Interviewer: okay

Buster: and then it will make it even worse

Interviewer: ah okay, so it's important to be honest?

Buster: yeah

Interviewer: is there anyone in particular you think should be honest here?

Buster: I think all of them

Interviewer: you think all of them? Shall I put it [in the middle]?

Buster: yeah

Interviewer: okay. Are there any words on here that you can see that you think *aren't* important? Is there anything that you think isn't important at all?

Videogame Guy: I know one

Interviewer: if you work in STEM. You know one?

Videogame Guy: definitely not this one – you definitely don't need to do that

Interviewer: likes computer games – what did you think about that one?

Videogame Guy: you definitely don't need to

Interviewer: uh huh

Videogame Guy: because it's not relevant at all – well it's an intsy wintsy bit relevant for the technology bit but…

Interviewer: okay – why might it be a little bit relevant for the technology bit?

Videogame Guy: because computer games are technology

Interviewer: yeah?

Videogame Guy: but you don't *need* to like them

Interviewer: okay – does anyone else have any thoughts about likes computer games?

[pause]

Interviewer: did you want to say anything about that?

Child: no

Interviewer: okay, shall we put that – did we think it might be a *little* bit relevant?

Videogame Guy: intsy wintsy

Interviewer: and insty wintsy bit? Okay, so we'll put it here?

Buster: enjoys dancing isn't relevant

Interviewer: okay – can you tell us more about that?

Buster: because in science technology engineering and mathematics, you don't do any dancing in that

Interviewer: no? okay – did you think anything about the dancing?

Pasta: no

Interviewer: did you have any thoughts about the dancing?

Videogame Guy: well, it is fun, but you don't *need* to

Interviewer: do you agree?

Buster: yeah

Interviewer: so shall we put it with this one as well? Which one did you just have there [Pasta]?

Pasta: I had maths – but it's mathematic

Interviewer: well maths is mathematics, so what did you think about enjoys maths?

Pasta: well it's not really maths, but I just heard it was

Interviewer: okay, so do you think it might be important to enjoy maths if you work in STEM?

[Pasta indicates yes]

Interviewer: yeah? Why do you think that?

Pasta: because it's says mathematics in the – that's because it's what it says

Interviewer: okay, does anyone have anything to add to that?

Videogame Guy: I totally agree

Interviewer: you totally agree? Why do you agree?

Videogame Guy: because, to enjoy STEM you need to enjoy maths

Interviewer: how come?

Videogame Guy: because maths is a part of STEM, so to enjoy it all then you need to enjoy maths because that's a part of it

Interviewer: okay, fab. Is there anyone in particular you think that applies to?

Videogame Guy: [pause]

Interviewer: no? shall it put it on this one for everyone? What do you think [Pasta]? Cool are there any other that might be important if you work in STEM? Go on [Buster]?

Buster: I think sensible because you can't – if you're working in a lab, then if you're making explosions when you're not supposed to, that's not being sensible

Interviewer: okay – so it's important to be sensible if you work with things that are maybe a little bit dangerous?

Buster: yep

Interviewer: okay

Videogame Guy: you don't want the lab to explode! [laugh]

Interviewer: you do *not* want the lab to explode no! Okay, so where would you like to put that card?

Buster: [pause] I think all of them need to be sensible

Interviewer: okay. Right are there any other words on here that you think are important?

[pause]

Interviewer: so you've picked up likes helping others – can you tell us more about that one [Videogame Guy]?

Videogame Guy: I don't know why – I just think so. Say you're working together

Interviewer: yeah

Videogame Guy: then say the other person couldn't do something, but you needed to do it. Then you could help them and then you would end up doing it

Interviewer: okay, so what other person might need your help?

Videogame Guy: I don't know

Interviewer: okay

Videogame Guy: everyone

Interviewer: everyone? Okay where would you like to put that card

Videogame Guy: there

Interviewer: for everyone okay. What have you got there [Buster]?

Buster: likes visiting other countries

Interviewer: ah okay, what do you think about that?

Buster: I think it's important because if you go to a different country and you're uncomfortable being there

Interviewer: yeah?

Buster: then you wouldn't be [pause] and then you go to a country that you've been [to] before and you're [un?]comfortable being there then that's good

Interviewer: okay

Buster: I think this one should go on Chloe

Interviewer: yeah, why do you think that one should go with Chloe?

Buster: it says that she's been to Peru and Uganda

Interviewer: absolutely, was there anyone else on here that travels to other countries?

Pasta: no – I did once, America

Interviewer: oh did you? Nice. Whereabouts in America?

Pasta: Florida

Interviewer: lovely!

Buster: this one

Interviewer: which one sorry?

Buster: this one

Interviewer: so Rhodri needs to like visiting other countries as well?

Buster: [pause] not that one, this one

Interviewer: ah Scott okay

Buster: yeah

Interviewer: why does Scott need to enjoy visiting other countries?

Buster: because he goes to Japan

Interviewer: yeah okay? So he visits other countries as part of his job as well. So shall we move Chloe [move around cards etc.] have we got anything else that we think is important if you work in STEM?

Videogame Guy: enjoys science

Interviewer: can you tell us more about that one?

Videogame Guy: well, this one's quite like the maths one because science is a part of STEM

Interviewer: yeah

Videogame Guy: and to enjoy STEM fully, you also need to enjoy science

Interviewer: okay so where would you like to put that card?

Videogame Guy: here

Interviewer: so you think everybody should enjoy science? Okay. Which one did you just pick up there [Pasta]?

Pasta: resourceful

Interviewer: resourceful, okay can you tell us what resourceful means?

Pasta: finds quick clever ways to get things done or to make things easier

Interviewer: okay, so what do you think about resourceful?

Pasta: [pause] it's a – oh no

Interviewer: you're not sure? Okay shall we all talk about resourceful? Do we think being resourceful might be important for someone who works in STEM? So being able to find quick clever ways to get things done or make things easier. Do we think somebody in STEM might need that?

Buster: yeah

Interviewer: yeah? Why do you think that?

Buster: because [pause] you have to – Ali works as a doctor and she has to think quickly because then she has to work out what the cure could be

Interviewer: Okay, so shall I put resourceful on for Ali?

Buster: yep

Interviewer: yeah? Do you think it should go on for anybody else at all?

Buster: I'm not sure

Interviewer: you're not sure, okay. What card have you got there then [Buster]?

Buster: hardworking

Interviewer: what do we think about hardworking?

Buster: I think hardworking because if you're in STEM then you have to be able to do things that sometimes you can't do

Interviewer: okay

Buster: and if you can't do it yet, then you have to try again

Interviewer: okay, so you have to work hard to try again?

Buster: yeah

Interviewer: where would you like that card to go?

Buster: I think they all need to be hardworking

Interviewer: okay, so you think that's important for everyone? Okay. Have we got any others that we'd like to talk about? You're picking up determined [Videogame Guy]. what do you think about determined?

Videogame Guy: I just think they need to be ready. Say they were going to do something

Interviewer: yeah

Videogame Guy: and they knew they were going to do it, they would –

[teacher enters]

Interviewer: what were you saying about that one [Videogame Guy]?

Videogame Guy: say they were going to do a task

Interviewer: yeah

Videogame Guy: which was kind of hard

Interviewer: yeah

Videogame Guy: they would need to be ready to do that task

Interviewer: okay

Videogame Guy: especially if it was hard

Interviewer: okay, does anyone else have anything to say about determined?

[pause]

Interviewer: okay, where would you like to put determined? With everyone? Okay. And what have you got there [Buster]?

Buster: I've got one that isn't important

Interviewer: okay, so what do you think *isn't* important?

Buster: getting all the answers right

Interviewer: oh okay, what do we think about that one?

Buster: I think if you're in STEM, then you don't need to get all the answers right. If you do get some answers wrong, then you can try the test again or do what you're doing again

Interviewer: okay, what do you think about that one [Videogame Guy]? You look like you have a thought about that one!

Videogame Guy: if at first you don't succeed: try try again!

Interviewer: okay, so you think that if at first you don't get all the answers right, you can keep trying?

Videogame Guy: yeah

Interviewer: okay, so we thought these ones might be a little bit important did we? You thought liking computer games might be a little bit important? Did we think being clever might be a little bit important?

Pasta: a little bit

Interviewer: what about enjoys dancing?

Buster: not important at all

Interviewer: not important okay. So shall we put those ones together? Are there any other words that you'd like to talk about here guys?

[Buster indicates card]

Interviewer: what would you like to say about organised?

Buster: you have to be organised because if you have two bones that look exactly the same

Interviewer: yeah

Buster: if they mix together, you can't really put them back into the other groups

Interviewer: so you need to make sure you've organised...?

Buster: you have to make sure you've organised which things are which

Interviewer: ah right, so where would you like organised to go?

Buster: on all of them

Interviewer: on all of them, okay. Do either of you guys think anything about organised?

Videogame Guy: about what she said about the bones being the same – to organise them you could write down the names of the people who were using it on them

Interviewer: ah okay

Videogame Guy: so they don't get mixed up

Interviewer: ah so that would be a technique for being organised?

Videogame Guy: yeah

Interviewer: okay, cool. Have we got anything else to talk about that you want to talk about? Is there anything that you think we've missed out?

Videogame Guy: this one

Interviewer: okay, what's that one?

Videogame Guy: wants to understand how things work

Interviewer: okay

Videogame Guy: I think the technologists would need to do that because

[loud noise, pause recording]

Videogame Guy: I think the technologists would need to do that because – [they] would want to understand how the technology works, like how when you press a key on a computer, something happens

Interviewer: yeah?

Videogame Guy: or how when you press something on an iPad, something happens

Interviewer: okay – is there anything else about wanting to understand how things work?

Children: no

Interviewer: okay so where would you like to put that one? With the technologists? Okay – logical? Tell us about logical

Buster: I think you need to be logical if you're in STEM because you have to be able to know about the facts and know about the information and if you have historical artefacts then you have to be able to know things about what – what kind of things they're from and what year they're from

Interviewer: okay, so you need to be able to already have facts and information?

Buster: yeah

Interviewer: what if you're presented with new information? That you've not seen before, how might being logical be helpful?

Buster: I think someone that already knows about the things, then you can ask them and they'll teach you about it

Interviewer: okay, so where would you like to put that card?

Buster: on all of them

Interviewer: on all of them? Okay. So we've got another activity that I thought we could do, but is there anything here that you think we've missed off before we do the other activity? Are there any cards that you think we've missed?

[pause]

Interviewer: curious, what do you think about curious?

Buster: I think you need to be curious because you need to – if you don't know lots and if you have new things and you don't want to learn about them then you're not curious. But if you did want to learn about them, then you'll know about more things

Interviewer: okay, fab. Does anyone else have anything they want to say about curious? Do you think anything else about curious? So you think it's important to want to learn about new things?

Buster: yep

Interviewer: do you guys think anything about that? [pause] Okay, where would you like to put that card [Buster]?

Buster: in the middle

Interviewer: with everyone? Okay go on [Videogame Guy]. listens to other people's opinion – what do you think about that one?

Videogame Guy: well I think that if can work in a team would go on there, this one should go in there

Interviewer: okay

Videogame Guy: because it kind of links to working as a team

Interviewer: okay, how does it link to working as a team?

Videogame Guy: because listening to other people's opinions – that could help you, so they would be helping you and technically that's working as a team

Interviewer: okay – does anyone else think anything about that? Do you want to put those two next to each other then?

Buster: I think it's important to learn new languages because if you're going to a foreign country, then you have to know the language, and if you don't know the language, then they might not be able to speak English and don't know what you're saying

Interviewer: ah okay, so who might like to learn languages then?

Buster: Chloe and Scott

Interviewer: so when they're visiting those other countries

Buster: yeah

Interviewer: they need to be able to communicate with people while they're there?

Buster: yeah

Interviewer: okay. So is that everything? Have you got something you want to talk about there?

Pasta: no

Interviewer: is that everything you wanted to say about those?

Videogame Guy: I think enjoys sport would go in the middle

Interviewer: yeah

Videogame Guy: because you might need to be fit, but you don't need to enjoy doing that

Interviewer: okay

Videogame Guy: so I think it should go in the middle [medium important]

Interviewer: why might you need to be fit if you work in STEM?

Videogame Guy: maybe you would be [pause] looking for something, maybe and you'll be outside. Or doing a task outside

Interviewer: yeah

Videogame Guy: and then you might be running around to see if you could find it. And to be able to run good you need to be fit

Interviewer: ah okay – so being fit might generally help you if you're doing something that needs a lot of energy?

Videogame Guy: yeah

Interviewer: okay. Go on, which one did you pick up [Buster]?

Buster: reflective

Interviewer: what do you think about reflective?

Buster: I think it's important to be reflective because if you got something wrong, in the past and you want to try again on it, then you have to be reflective

Interviewer: ah yeah. Did you think anything about reflective?

Videogame Guy: we do it in class

Interviewer: oh do you?

Videogame Guy: after our work because we do the 'what went well?' and 'even better if'

Interviewer: do you do that in your class as well?

Buster: yeah

Interviewer: do you do that one in yours?

Pasta: yes

Interviewer: okay, do you think anything about being reflective? No? okay. So where would you like reflective to go [Buster]?

Buster: on all of them

Interviewer: okay so is there anything else that you'd like to talk about before we do our next activity?

[pause]

Buster: no

[pause]

Videogame Guy: no. Wait! Maybe this because you might read to get information?

Interviewer: okay?

Videogame Guy: to help you with things, but you don't necessarily need to enjoy it

Interviewer: okay

Videogame Guy: I think it should go in the middle because of that. Reading could give you information, but you don't need to *enjoy* it

Interviewer: okay

Videogame Guy: so it should go in the middle [medium important]

Interviewer: what does everyone else think about that?

[pause]

Interviewer: agree, disagree?

Buster: agree

Interviewer: okay and go on what was your one [Buster]?

Buster: I've got enjoys history

Interviewer: uh huh

Buster: it's good to enjoy history because if you're working with historical artefacts then you have to be able to know what year and what time it's from

Interviewer: ah okay, so who in particular do you think that applies to?

Buster: [pause] not sure

Interviewer: you're not sure, okay. Where would you like to put that card then?

[Buster pause]

Interviewer: you mentioned someone working with old things didn't you? Working with things in history. Have we got anyone here who works with history?

[teacher enter]

Buster: I'm not sure which one it should go on

Interviewer: okay

Videogame Guy: I think it should go in the middle [medium] because you do need history, but you don't need to enjoy it

Interviewer: okay

Videogame Guy: just like all the other enjoy ones

Interviewer: okay

Videogame Guy: well, most of them

Interviewer: what does everybody else think? Any thoughts?

Child: no

Interviewer: So shall we put it in the middle?

[interviewer takes photo of card placement]

Interviewer: for our last activity, do you remember before when we chose five words that we think describe ourselves?

Children: yeah

Interviewer: and we talked about why we'd chosen them?

Videogame Guy: yeah

Interviewer: do you think you'd be happy to do that again?

Videogame Guy: okay

Buster: yeah

Interviewer: you don't have to if you don't want to. But if you'd like to: remember if someone else has chosen the same word as, you that's fine you can both share a word. So pull out five things you think describe yourself?

[children choose cards]

Buster: I've got all mine

Interviewer: you've got all yours? Okay, lovely

[choosing cards]

Interviewer: are you happy with your ones Pasta? okay? Lovely. Are we happy with all the words we've chosen?

Children: yeah

Interviewer: fab, so who would like to go first? Can you tell me the words you chose and why you chose them? Go on Pasta

Pasta: clever because it's quick to understand new information, and you – instead of not putting your hand up – you put your hand up all the time

Interviewer: okay, is that something that you do?

[Pasta nods]

Interviewer: okay

Pasta: sensible: makes good judgements based on reason and experience. Can work independently is [pause]

Interviewer: so why did you choose sensible for yourself?

Pasta: because it makes good judgements

Interviewer: is that something that you think you do?

[Pasta nods]

Interviewer: and why did you choose can work independently?

Pasta: because in class I do work independently

Interviewer: okay

Pasta: and enjoys sport because I like sports

Interviewer: which sports do you like?

Pasta: football and rugby

Interviewer: oh yeah okay

Pasta: enjoys science because my sister does science at school and we've done one before we came into Year 4

Interviewer: okay, and what did you do then?

Pasta: we did potions I think

Interviewer: potions? What did you like about that?

Pasta: that we did different colours going into it and it was changing colour

Interviewer: cool okay. Would you like to say anything else about those words?

Pasta: no

Interviewer: no? thank you for sharing with us. Who'd like to go next?

Videogame Guy: okay I'll go

Interviewer: okay [Videogame Guy]. which words did you choose and why?

Videogame Guy: likes computer games because I really like them

Interviewer: okay

Videogame Guy: enjoys maths because in my opinion maths is quite fun

Interviewer: what do you find fun about maths?

Videogame Guy: I don't know I think problem solving maybe?

Interviewer: okay

Videogame Guy: can use computers, I know I can because one time I played Mathletics on the computer

Interviewer: okay

Videogame Guy: can work in a team because in class a lot of the time I work in a team, like what we did in the workshop today. Enjoys dancing because I like it

Interviewer: what kind of dancing do you like?

Videogame Guy: rock dancing and break dancing?

Interviewer: do you do those after school?

Videogame Guy: no, but I do like it

Interviewer: okay, awesome. Is there anything else you'd like to say about those words?

Videogame Guy: no

Interviewer: thank you very much [Videogame Guy]. for sharing. [Buster] what have you chosen?

Buster: I'm imaginative because I think of lots of different things to draw

Interviewer: what kind of things do you like to draw?

Buster: animals and sometimes I go on the internet and see things to draw

Interviewer: okay

Buster: artistic because I have lots of art things at home and after school I go to art club

Interviewer: okay

Buster: enjoys reading because I have lots of books at home. Creative because I make lots of good paintings and drawings

Interviewer: yeah

Buster: and likes being outdoors because I have a dog and I bring him for walks lots of the time

Interviewer: oh cool, is there anything else that you'd like to add to that?

Buster: no

Interviewer: does anyone else have anything that they'd like to say?

[children indicate no]

Interviewer: well thank you so much for helping me today guys

44 Appendix 32: Pupil task-based interview 3, BG

Title: Pupil interview 3

Date: 13th June 2019

Speakers: Poppy Hodkinson (interviewer), Buster, Blackjack and Videogame Guy

Interview duration: 51 Minutes (30 minute break) 57 minutes

Interview location: BG

Interviewer: so shall we, before we do anything else just remind ourselves what does STEM stand for?

Blackjack: science, tech – oh! [laughs]

Interviewer: science

Videogame Guy: technology

Buster: engineering

Blackjack: mathematics

Interviewer: brilliant, thank you – so do you remember these words from before? So we're thinking about the skills and the parts of people's personalities – so maybe their interests or their hobbies, that might be *useful* or important to them if they have a STEM job. So if they're a scientist, or a technologist – and do you remember we spoke before about the people that we knew in our families and our friends who worked in STEM? I don't think you were there for that one T, but we talked about the people that we knew in our lives who work in STEM. Or have an interest in it. Is there anyone that you know?

Blackjack: no

Interviewer: a member of your family or maybe a friend of your family?

Buster: I've got a question

Interviewer: go on

Buster: does the NHS work in STEM?

Interviewer: absolutely – so medicine is a really important part of STEM

[teacher enters room]

Interviewer: medicine is definitely part of STEM. And sometimes when people spell STEM, they put an extra ‘m’ on the end for ‘medicine’

Buster: my mum works as a nurse

Interviewer: does she?

Buster: at the hospital

Interviewer: so yeah, your mum works in STEM

Buster: she works with a machine

Interviewer: what kind of machine?

Buster: it’s like a – there’s different coloured ones. There’s a blue one, but I’m not sure what the other ones are

Interviewer: uh huh

Buster: my mum doesn’t work on the blue one, but she works on the different coloured ones

Interviewer: ah okay, do you know what the machine does?

Buster: no

Interviewer: no okay, well that sounds interesting. So your mum works in STEM. And we talked about some of my friends that work in STEM, so I’ve got a friend who’s an engineer, her name’s Chloe, and a friend who works in technology helping to design phone screens. And I’ve also got another friend who – like your mum – works in medicine. So those were the sorts of things that we talked about before. And then we looked at these words didn’t we? And we thought about which of these might be really important for someone who worked in STEM. And today, I’m going to ask you guys to choose the five that you think are the *most* important – you might think they’re all really useful, but which are the five *most* important ones? And then we’re going to pick the five *least* important – so the five that you just think are totally unnecessary

Blackjack: okay

Interviewer: okay?

Buster: likes getting all the answers right

Interviewer: okay, which one is that?

Buster: unnecessary

Interviewer: okay, and why do you think it's unnecessary or not important?

Buster: because if you get an answer right then it doesn't matter, you can learn from your mistakes

Interviewer: okay, does anyone else have anything to say about that one? Do agree with [Buster]?

Blackjack: yeah

Interviewer: why do you agree?

Blackjack: because you don't need to get every answer right

Interviewer: okay

Blackjack: and yeah, what [Buster] said – you learn from your mistakes

Videogame Guy: you just need to get some right – not necessarily first time, but *some*

Interviewer: I suppose that's like what we were doing yesterday – did all of the aqueducts work right the first time?

Buster: no

Blackjack: no

Interviewer: no they didn't did they?

Buster: and also [class teacher] says "if at first you don't succeed, try and try again"

Interviewer: that's good advice – okay so we'll pop that one on the 'not important' pile. Start that pile wherever you want to

[places card]

Interviewer: okay, what have you got there [Videogame Guy]?

Videogame Guy: wants to understand how things work

Interviewer: okay, and what do you think of that one?

Videogame Guy: technology – it's very complicated to know how it works. So if you want to understand how it works, that would be good

Interviewer: okay, so technology's quite complicated: someone who worked with technology might want to understand how it works. Is there anyone else working in STEM who might want to – or might benefit from wanting to understand how things work?

Blackjack: I'm not sure

Interviewer: you're not sure? Okay that's fine. Do we think that *is* important or *isn't* important?

Videogame Guy: is

Interviewer: what do you two reckon?

Blackjack: yeah

Buster: yeah

Interviewer: yeah, is there anything else that you'd like to say about that one?

Buster: no

Interviewer: so shall we start an 'is important' pile – where do you want to put that one?

Videogame Guy: there

Interviewer: perfect, and what have you got there [Blackjack]?

Blackjack: enjoys maths because maths is an important thing of your job – of STEM

Interviewer: okay

Blackjack: and [pause] just yeah, it's part of STEM, so you need to know about it

Interviewer: okay. What else do we think? Did you guys think anything about that one?

Child: no

Interviewer: enjoy maths

Videogame Guy: no

Buster: maths – you don't have to enjoy maths, but you can like maths because you don't have to work in a job that is in STEM, but that doesn't really have that much about maths. But it does in STEM – the M stands for mathematics

Interviewer: okay, so do we want to put that one on the important pile?

Children: yeah

Interviewer: stick that one on there then [Blackjack]. What have you got there [Buster]?

Buster: reliable

Interviewer: reliable, what do we think about reliable?

Buster: I think that you have to be reliable, because if you were left on your own to do a job then you have to [pause] be sensible and not mess things up.

Interviewer: okay

Buster: But if you do mess something up, but by accident, then you can say what happened

Interviewer: okay so being reliable is to do with your behaviour?

Buster: yeah

Interviewer: did you two think anything about being reliable? Do you think it's important at all? Do you think anything about that?

Videogame Guy: no

Blackjack: kinda yeah

Interviewer: you kind of agree, or you kind of have some thoughts?

Blackjack: kind of agree

Videogame Guy: I don't have any thoughts about it, but I agree

Interviewer: okay, so you kind of agree – you agree, but you don't have any extra thoughts about it. So do we think it's one of the five most important things?

Blackjack: yeah

Interviewer: yeah, shall we put it on for now and then have another look at the end? At the end, if we want to, we can move some of them around a little bit

Blackjack: what are these?

[chat about coloured tape on back of cards]

Interviewer: who would like to go next? Whose turn is it? Is it [Videogame Guy's] turn?

Videogame Guy: I've got can use computers and enjoys science

Interviewer: okay

Videogame Guy: it would be good to be able to use computers, because computers are technology and you'd need to know how to use them

Interviewer: okay, does *everyone* in STEM need to know how to use them?

Videogame Guy: no, not everyone

Interviewer: are there any examples of people you think might use it?

Videogame Guy: no

Interviewer: what about you guys, is there anyone who uses computers in STEM?

Buster: maybe people who fix computers?

Interviewer: yeah, definitely. Is there anyone else who might use computers at all?

Blackjack: maybe someone who studies bones to see what type it is?

Interviewer: yeah, I use the computer to tell the difference between bones – I've got a file that tells me – yep. Okay, are we putting that one on a pile? Which pile? You've put it on already have you?

Videogame Guy: yeah

Interviewer: fab, is it [Blackjack's] turn now?

Blackjack: [laughing]

Interviewer: enjoys dancing – what do you think about enjoys dancing?

Blackjack: you don't need to enjoy dancing for your job

Interviewer: okay

Blackjack: because you don't do any dancing in STEM

Interviewer: maybe not

Videogame Guy: the only way it would be good to enjoy dancing in *any* type of job is if you were a dancer

Interviewer: it would be *most* useful for that wouldn't it? Do you think if you worked in STEM, does that mean you *can't* like dancing?

Children: no!

Buster: you can still like dancing just –

Videogame Guy: you just don't need to

Buster: - not in your job

Interviewer: ah okay

Videogame Guy: well you can, but you don't need to because it wouldn't make any difference

Interviewer: okay, so where do we all think that card needs to go then?

Blackjack: [laughing]

Interviewer: yeah? On the not important pile? Okay – thank you [Blackjack]. Go on [Buster].

Buster: it's likes learning languages

Interviewer: okay, what do you think about that card?

Buster: if you're going to a different country, and the people who you're visiting have no idea what you're saying if you're speaking in English

Interviewer: uh huh

Buster: then you would have to learn that language to be able to communicate with that person

Interviewer: okay, and why would that be important if you worked in STEM?

Buster: because you have to be able to communicate with other people if they don't know what you're saying

Interviewer: okay – does anyone else think anything about that card?

Children: no

Interviewer: okay, and where would you like to put that card [Buster]?

Buster: there's five on there

Interviewer: well we can still have a look and see if there are any others that we think are important

Videogame Guy: I've got one that I think might be important for that one

Interviewer: okay, which one's that [Videogame Guy]?

Videogame Guy: enjoys science

Interviewer: ah okay, so what do you think about that card?

Videogame Guy: I think it would be good – the S is for science

Interviewer: yeah

Videogame Guy: so it would probably be good to enjoy science

Interviewer: okay, what do we think about enjoys science guys?

[pause]

Buster: I'm not really sure

Interviewer: you're not really sure, so [Videogame Guy] said that it would be important because it's the S of STEM. Did you have any thoughts about that at all?

Blackjack: no

Buster: no

Interviewer: no, and so do you want to put it on the important pile?

Videogame Guy: yes

Interviewer: okay, so do we need to rearrange the important pile? Is there something that could be taken off, or switched for enjoy science?

Blackjack: what does this mean? Reliable

Buster: always does what they have promised and can be trusted

Interviewer: what do we think, is that more or less important than enjoying science if you work in a STEM job?

[pause]

Interviewer: what do we think?

Videogame Guy: I don't really know

Interviewer: okay

Blackjack: I don't know why, I don't have any thoughts – I just think it should go onto the other pile

Interviewer: oh you think reliable should go where sorry?

Blackjack: on the other pile – I don't know why

Interviewer: you just don't think it's important at all?

[pause]

Interviewer: so this word here, is this the one you're talking about?

Blackjack: yeah

Interviewer: you think it should go on the other pile?

Blackjack: I don't know why

Interviewer: okay, so shall we put it in the middle for now – we can have a think about it. And you would like to put enjoys science over there. Do we have any others? What have you got there [Buster]?

Buster: artistic

Interviewer: artistic, and what did you think about artistic?

Buster: I think it's important, and also not important

Interviewer: okay

Buster: because it says on here – artistic: good at making beautiful items, drawings, paintings and sculptures

Interviewer: uh huh

Buster: you might need to make sculptures of dinosaurs and bones

Interviewer: ah okay

Buster: so then if you're sending something to a museum to display it, you might need to make a sculpture of it so then you can remember what it looks like

Interviewer: ah okay, so there's a visual aspect as well? Who is it who's using that sculpture of the dinosaur then?

Buster: the people who work in the museum

Interviewer: okay

Buster: and for displaying, so then the people who go there can see what the dinosaurs used to look like

Interviewer: ah okay, so the sculptures are for the people who work in the museum? Are they for anyone else?

[pause]

Interviewer: who else gets to see them?

Buster: the visitors

Interviewer: okay, so being artistic would be helpful in your job if you worked in the museum, but it might also be helpful for the people who visit the museum if someone there is artistic?

Buster: yeah

Interviewer: okay, So you want it to go on this pile here is it?

Buster: in between

Interviewer: ah so it would be useful, but it's not the most important. Okay, what's the next word that we'd like to talk about?

Videogame Guy: Enjoys reading

Interviewer: okay

Videogame Guy: I think it should go in the middle because it isn't *not* important, but it isn't *very* important because – well – reading *could* help you to do the job, but you don't need to *enjoy* doing that do you?

Interviewer: okay. [pause] Does anyone else think anything about that one?

Children: no

Interviewer: how might reading be helpful for your job?

Videogame Guy: well, say you needed some – if you were in science then you might need some information in order to do what you want to do

Interviewer: okay

Videogame Guy: and you could find it in a book

Interviewer: okay, cool. Where do we think that that one needs to go then?

Children: middle

Interviewer: okay, so we've got at the moment: five that we think are very important, maybe even *the most* important, we've got three that we're not sure of, and then two that we think *aren't* important. Are there any more that we just think aren't important at all?

Blackjack: [laughs]

Interviewer: what have you got there [Blackjack]?

Blackjack: likes computer games

Interviewer: what do you think about likes computer games?

Blackjack: well you might go on the computer, but I don't think you'll play games

Interviewer: okay

Blackjack: yeah, you don't *need* to like computer games

Interviewer: okay, what do you guys think?

Buster: you don't have to like computer games, you can but it's not very important for your job?

Interviewer: ah okay

Videogame Guy: so it's *okay* to do it, but you don't have to

Interviewer: okay, so where would you like to put that one then? Have we got anything else that we think isn't important at all? Which one shall we talk about first? Who's turn is it?

Child: [Buster's]

Interviewer: [Buster's] turn, go on [Buster] which one have you got there?

Buster: likes visiting other countries

Interviewer: okay, so what do you think about that one?

Buster: if you live in a really sunny place

Interviewer: uh huh

Buster: and you're going to a tropical or rainy kind of place, you have to be used to going to that place, or if you're living in a place that it rains a lot, then you have to be used to going to a place that is sunny

Interviewer: okay, and why might someone who works in STEM be going to a different place?

Buster: to find other dinosaur bones, or different kind of bones that are from animals or information from other people

Interviewer: okay – what did you think about that one?

Blackjack: I was going to do what she was going to say

Videogame Guy: I think it would be *good* about that, but you don't *need* to

Interviewer: oh okay, so where do we think that card needs to go then? Do we think it's the most important thing?

Buster: in the middle

Interviewer: okay, thank you [Buster]

[chat about names]

Interviewer: what's enjoys sport – what do you think about that one?

Videogame Guy: I think it isn't important because, well sports isn't anything to do with science, nothing to do with technology, nothing to do with engineering or mathematics

Interviewer: okay

Videogame Guy: so I just think it isn't important at all

Interviewer: okay, what do you the rest of us think? Any other thoughts?

Buster: no

Videogame Guy: I've got something about that

Interviewer: go on

Videogame Guy: it would be okay if you do, but it doesn't matter if you do or you don't

Interviewer: okay, is it similar to dancing, in that you can like sport, you can like dancing

Videogame Guy: yes

Interviewer: so if you work in STEM, you can still like sport?

Videogame Guy: yes

Interviewer: okay, so where would you like to put that one?

Videogame Guy: but,

Interviewer: go on

Videogame Guy: that just means that you can't necessarily do that as a job

Interviewer: uh huh

Videogame Guy: because if you're working in STEM, then you can't work as a footballer because you've already got a job, unless you quit STEM

Interviewer: ah okay

Videogame Guy: that would be the only way so…

Interviewer: go on [Buster]

Buster: for enjoys sport

Interviewer: yeah

Buster: maybe if you found animal bones and you found the animal that is the exact to that animal. Then you – and it was running away from you

Interviewer: okay

Buster: you would be have to be able to chase it – not kill it, but dart it to see what kind of fur or something it has. But [pause] I'm not really sure

Interviewer: okay, so is it the idea that you would have to do some running?

Buster: yeah

Interviewer: that you would have to be fast to do that? Okay, so are there skills that you might use in sport, that could also be useful if you worked in STEM?

Buster: [pause] no

Interviewer: no? Okay. Thank you. So we've got four there – what have you got there?

Buster: competitive

Interviewer: okay, what do you think about that one?

Buster: it's definitely not important because if you were competitive then, you would be starting arguments, and it wouldn't be listening to other people's options

Videogame Guy: opinion

Interviewer: so if you're competitive, it could be a negative thing?

Videogame Guy: yeah, I agree with that

Interviewer: what do you think [Blackjack]?

Blackjack: yeah

Interviewer: so do you have anything else that you want to say about that?

Videogame Guy: if you were competitive, then you would like getting to lots of competitions and that would just be a waste of time. Unless it was a competition for something to do with STEM

Interviewer: uh huh

Videogame Guy: anything else that would be a competition would be bad

Interviewer: okay, what kind of competitions would be bad?

Videogame Guy: a race, a running race would be bad, but a race to 'who can fix the most computers in two hours' would be an okay competition

Interviewer: ah okay, so are there times when being competitive is okay?

Videogame Guy: yeah

Interviewer: what do you two think about that?

Blackjack: I agree

Interviewer: you agree? So where do we want to put that one?

Buster: not important

Interviewer: not important, okay. So we've got five on each side now haven't we? So we've got five for not important, and five for very important – is there anything over here that we haven't got that you think "actually, we really need to reassess and we need to swap something out"? is there anything that *has* to go up there that isn't already?

Videogame Guy: maybe, this because well [pause] engineering

Interviewer: uh huh

Videogame Guy: that's like building

Interviewer: okay, so enjoys building things – you think might be important if you're an engineer?

Videogame Guy: yeah, even if it's – it could be a house that could be good

Interviewer: okay

Videogame Guy: it could be a Lego house that would still be good. Because it's practice

Interviewer: okay, what do you guys think about enjoys building things?

Blackjack: yeah

Interviewer: do you think we need to swap it for any of those five? Is there that you think [enjoys building things] is more important than?

Blackjack: you don't need to learn a different language

Interviewer: okay

Videogame Guy: I think we should move that to there

Interviewer: okay, so likes learning languages is one of the ones that –

Videogame Guy: it's even better now because now we've got five here, five there and five there

Interviewer: ah okay – what do you think about that [Buster]?

Buster: you don't have to enjoy building things, because if you were working in medicine or maths, then you wouldn't be building things – but engineering *would* be

Interviewer: ah okay, so are there different parts of STEM and different jobs that you do in STEM that need different skills?

Buster: yes

Interviewer: okay – what have you got there [Blackjack]?

Blackjack: can work in a team

Interviewer: can work in a team, what do you think about that one?

Blackjack: because you might need to work in a team to find out something

Videogame Guy: that would be good

Interviewer: okay

Blackjack: like what type of bones and what animal

Interviewer: yeah

Blackjack: yeah

Interviewer: and where do you think that one should go?

Blackjack: it should go by there

Interviewer: you think it's most important – what did you think about that [Buster]?

Buster: I think it should be in the most important, because you have to – if you're not very good at working with other people

Interviewer: yeah

Buster: well then [you] wouldn't be doing your job

Interviewer: okay, so would you like to put that one on most important?

Videogame Guy: you might need to work in a team – say you were making a computer for technology

Interviewer: yeah

Videogame Guy: you probably wouldn't be able to do it on your own

Interviewer: okay

Videogame Guy: so you would work as a team because you'd need some help

Interviewer: okay, so where would we like to put that one then? [child indicates a pile] on that pile, do we want to swap anything out? Do we think working in a team is more important than any of those things?

[pause]

Buster: I don't know

Blackjack: we don't really need this one maybe

Interviewer: so wants to understand how things work could be swapped for can work in a team?

Videogame Guy: yeah because you don't physically need to want to understand how things work to do that

Interviewer: okay

Blackjack: you don't need to know how every single thing works because then your job would be a bit boring and it would be a bit confusing, knowing how every single thing works

Interviewer: okay

Videogame Guy: If that isn't – you don't need to do that, then technically that means that you don't *need* anything that's on here

Interviewer: you don't need *anything*?

Videogame Guy: well, no

[laughs]

Interviewer: could you tell us a bit more about that?

Videogame Guy: some of them are good – some are really good, you will most need it, but none of them you physically needed. You could not be any of those, or any of those or any of those. But if you were you still could work in STEM

Interviewer: okay

Videogame Guy: but it would be good if you *were* those

Interviewer: right, okay so do we want to put this one onto that pile then?

Videogame Guy: yes

Interviewer: thank you guys, is there anything else that you wanted to say about any of these?

Children: no

[Poppy takes photo]

Interviewer: okay, so like we did before, now can we pull out the five words that you think best describe yourself.

Blackjack: perfect!

Interviewer: So we're not thinking about other people now, we're thinking about you guys

Blackjack: I'm creative

Videogame Guy: I like maths

[unclear chat]

Interviewer: shall we move some of these a bit closer for you guys?

[pause]

Interviewer: if there's any words that someone else has chosen, you guys can share that word. So if you think "oh I wish I had 'can take risks' " but someone else has it, then you can share

Blackjack: I'm gonna swap one here

Interviewer: so you're swapping likes to learn new things for enjoys dancing, okay

[unclear chat]

Interviewer: and now you're swapping enjoys dancing for can use computers. Okay

Videogame Guy: that's a lot of swapping

Interviewer: that's okay, sometimes you don't always know exactly what you think the first time, you need a bit of time to think about it

Buster: [unclear]

Interviewer: okay, so you'd like to share one with [Blackjack]?

Buster: yeah

Interviewer: which one would you like to share with [Blackjack]?

Buster: likes being outdoors

Interviewer: okay, shall we move all of these – are you happy you've got your five?

Children: yeah

Interviewer: so can you tell us which word you've chosen and why you've chosen them please? Who would like to start?

Buster: I will

Interviewer: go on [Buster]

Buster: I enjoy sports because I go to a club, swimming club

Interviewer: what kind of club sorry?

Buster: I go to different clubs and also [pause], I'm not really sure, but sometimes I play football with my brother, and also I do a gymnastics club. And I want to join a trampolining club as well [chat about break time]

Interviewer: so were telling us that you enjoy sport and you go to lots of clubs including gymnastics and trampolining

Buster: I want to join trampolining

Interviewer: okay

Buster: I like to be outdoors because I have a dog and he's very athletic, and he's also a gun dog, which are a type of dog that needs lots of exercise so we have to walk him whatever the weather

Interviewer: ah okay

Buster: and I have to like outdoors, and before I had the dog I still liked outdoors

Interviewer: okay

Buster: I'm artistic because on Thursdays there's art club, but it's not doing it right now, but I'm going to join it next year as well

Interviewer: okay

Buster: and I do lots of art at home

Interviewer: okay, what kind of art do you do?

Buster: lots of different types. I finished doing a painting on a canvas which is a sunset

Interviewer: that sounds nice doesn't it – have you guys seen this?

Buster: no, I haven't brought it in –

Videogame Guy: I would say that I do like drawing especially things that I'm going do, like plans, but I wouldn't call that one of the most important ones

Interviewer: okay

Buster: I'm hardworking because when I'm set a task I do it and even if I find it hard, then I would keep on trying

Interviewer: okay

Buster: and if we're doing work at school, if I'm not sure on something, then I'll keep on trying

Blackjack: that's good

Buster: I enjoy reading because I have lots of books at home and my favourite author is David Walliams

Blackjack: [laugh] me too!

Interviewer: okay, what kind of books do you like reading as well as David Walliams?

Buster: [pause] I'm starting to like reading Jeremy Strong books, because there was a fair at school and I bought a Jeremy Strong book and it's really good so far

Interviewer: okay, brilliant – is there anything else that you wanted to say about any of the cards you've chosen?

Buster: no

Interviewer: thank you very much for sharing that with us, who would like to tell us about their cards next? Go on [Blackjack]

Blackjack: so firstly, can use computers

Interviewer: okay

Blackjack: because I just love going on computers, and I almost know everything about it

Interviewer: oh really? What do you like doing on the computer?

Blackjack: I just like playing games

Videogame Guy: we should have shared this one

Blackjack: oh yeah

Interviewer: do you like thinks computer games would have been a better one?

Blackjack: yeah

Interviewer: so if you chose again, which one would you choose?

Blackjack: that one

Interviewer: likes computer games? Okay

Blackjack: and then honest because I don't really lie that much

Videogame Guy: me neither

Blackjack: imaginative because I think about different colours – like if I draw something, I might do another colour

Interviewer: oh okay? What do you mean by another colour?

Blackjack: if it's supposed to be an egg

Interviewer: yeah

Blackjack: because I'm imaginative I'd do a different colour

Interviewer: what would be a colour that you'd do the egg?

Blackjack: pink! [laughs]

Videogame Guy: what about the a rainbow egg?

Interviewer: that sounds lovely, what did you want to say [Buster]?

Buster: If I chose again, then I would choose imaginative because I think I have a very active imagination

Interviewer: do you? What kind of things do you imagine?

Buster: just random things really

Interviewer: like pink eggs?

[laughs]

Interviewer: okay and what was your other word?

Blackjack: creative

Interviewer: uh huh

Blackjack: because like [Buster] I like making things, and art, and just yeah I like art

Interviewer: what kind of things do you like to make?

Blackjack: I like making fans, I like painting drawing

Interviewer: okay

Blackjack: and then I like being outdoors because I like playing with my cat outside and I like jumping on my trampoline

Interviewer: ah okay, maybe you could join trampolining club too?

Blackjack: [laugh] yeah

Videogame Guy: sometimes when I'm outside I go on my trampoline and I have a ginormous golden retriever

Interviewer: yeah

Videogame Guy: and sometimes he comes onto the trampoline and he makes it quite hard for us to jump like it's a normal trampoline

Interviewer: yeah I bet if there's a massive dog on there as well. Is that everything you wanted to tell us about those words [Blackjack]?

Blackjack: yes

Interviewer: okay, lovely. Thank you! [Videogame Guy] can you tell us about your words please?

Videogame Guy: enjoys maths because in school maths is my favourite subject

Interviewer: okay

Videogame Guy: I enjoy it – I don't know if it's because it's easy to me, or for another reason

Interviewer: okay. [pause] What do you like about maths? Are there any bits in particular you enjoy?

Videogame Guy: my favourite part yesterday reminded me of, because yesterday in maths

Interviewer: uh huh

Videogame Guy: I was doing fractions and I got to use a calculator to find the fractions of the number

Interviewer: yeah?

Videogame Guy: and that was fun

Interviewer: okay, so you find parts of maths fun?

Videogame Guy: yeah

Interviewer: okay, fab

Videogame Guy: sensible because well I just am

Interviewer: [laugh] okay – what do you do that's sensible?

Videogame Guy: just get on with stuff

Interviewer: yeah?

Videogame Guy: when I'm supposed to

Interviewer: okay

Videogame Guy: especially in school

Interviewer: are you sensible at home as well?

Videogame Guy: I am but not as much as I am in school

Interviewer: okay, why do you think that you're more sensible in school?

Videogame Guy: at home sometimes when things don't go my way I moan a little bit, but in school… no

Interviewer: okay

Videogame Guy: probably because the teacher will tell me off if I do that in school

Interviewer: okay, so you need to be sensible because the teachers expect you to behave that way?

Videogame Guy: and if I did it a lot, then the teacher would tell my parents, and I won't want that to happen

Interviewer: ah okay [pause] fair enough

Videogame Guy: determined, well it's a little bit like enjoys maths because when I'm doing it, I know that I can do it. So I'm determined to do it

Interviewer: uh huh – what about when there are things that you can't do? Or if there is something that you're finding difficult?

Videogame Guy: [pause] well if I'm going swimming, I'm not determined to float without a life jacket

Interviewer: okay

Videogame Guy: so not on things like that, but things like school work I'm determined

Interviewer: yeah?

Videogame Guy: I'm determined. Likes visiting other countries, you would probably think this the same way as me, because well I like going on holiday

Interviewer: yeah?

Videogame Guy: because it's just really fun – I enjoy it

Interviewer: which countries do you like to go to?

Videogame Guy: well there's only one country that I've ever gone to other than Wales and place around it is Majorca, but this year because my mum is having a baby then we're going to Scotland

Interviewer: oh lovely, okay.

[Buster puts hand up]

Videogame Guy: it's fun

Interviewer: is it okay if we ask [Buster] what she was going to say?

Videogame Guy: yes

Buster: if I did it again then I would like to do likes visiting other countries

Interviewer: ah so you like doing that as well?

Buster: because I just like visiting other countries and also my family live in England so we get to visit them

Interviewer: okay

Buster: and abroad it would be Greece

Interviewer: okay

Buster: because we mostly only go to Greece and I've only been to Spain once

Interviewer: okay

Buster: and next year, we might be able to go to Italy

Interviewer: oh lovely! Okay so you like visiting other countries too. What was your final card?

Videogame Guy: likes computer games [laugh]

Interviewer: okay, tell us more about that

Videogame Guy: mostly, because I have a limit on how much computer games I'm allowed to play

Interviewer: okay

Videogame Guy: on the weekdays, so there's four days that I'm not allowed to play computer games, and there's one day where I'm allowed to do it as much as I like

Interviewer: ah okay

Videogame Guy: and I really like playing Roblox and Minecraft

Blackjack: [whisper] me too!

Videogame Guy: and when I said about drawing plans

Interviewer: yeah?

Videogame Guy: I was talking about plans for things I was going to build in Minecraft

Interviewer: ah okay

Videogame Guy: so I just really like it

Interviewer: okay, so you like to draw out plans before you build it on the computer?

Videogame Guy: yes

Interviewer: ah interesting

Videogame Guy: but there are some times where I just draw a plan, but I don't actually make it

Interviewer: okay

Videogame Guy: except the one I'm doing right now I *have* to make

Interviewer: okay, why?

Videogame Guy: because it's going to be so cool

Interviewer: okay, what is it?

Videogame Guy: Roblox in Minecraft

Blackjack: what??

Interviewer: that sounds really cool! Is there anything else that anyone wants to say about their cards at all?

Blackjack: well I just want to say I've never ever been on a plane, and I'm the exact opposite when he said he likes maths – I hate maths

Interviewer: you hate maths?

Blackjack: it's my worst subject

Interviewer: what do you hate about maths?

Blackjack: I don't know, just subtracting and everything

Interviewer: subtracting, is that one tricky?

Videogame Guy: if maths is your least favourite subject, what *is* your favourite subject?

Interviewer: good question [Videogame Guy]

Blackjack: I've got two

Interviewer: go on?

Blackjack: art and music

Videogame Guy: oh yeah!

Interviewer: ah okay – what do you like about art and music?

Blackjack: dunno, I just really enjoy them

Videogame Guy: wait, I would say those are another two of my favourite subjects, or subjects that I like. Because if that goes up at this rate, then probably all of the subjects would be my favourite subjects

Interviewer: oh really? Okay

Videogame Guy: nearly so I would just say those are the subjects that I really enjoy

Interviewer: okay, and what were you going to say [Buster]?

Buster: I know my favourite subjects

Interviewer: yeah?

Buster: I have two same as [Blackjack]: art because I like doing lots of artistic things, and also P.E because

Videogame Guy: [whisper] oh yeah, I forgot about that

Buster: I chose enjoys sport

Blackjack: oh yeah

Buster: I'm quite sporty, but I'm not very good at throwing and I also want to join a tennis club

Interviewer: thanks very much guys

Child: will we be needing our pencil cases?

Interviewer: yes, this is what we needed the pencil cases for! So we have got this sheet, and there are two questions on the front and a question on the back. And each question has two parts, so the first bit is the question, and then the second bit asks you to explain your thoughts. So shall we read the questions out together? So we can talk about them before you answer them on the sheet?

Videogame Guy: shall we use pen or pencil?

Interviewer: whichever you prefer

Blackjack: do we need to use blue pen?

Interviewer: you can use whatever colour you want

Blackjack: perfect!

Interviewer: okay

Blackjack: pink!

Interviewer: so who would like to read out the first question?

Videogame Guy: me!

Interviewer: go on [Videogame Guy], your hand was up first

Videogame Guy: STEM and archaeology, have your thoughts or feelings about STEM changed during this project? Write or draw an explanation for this below

Interviewer: okay, so you guys know that I've been visiting you all year at school, and we've been having these talks all year at school, so over the course of that – through all the workshops, and all the talks that we've done, have your thoughts or feelings about STEM changed? And there's a couple of lines there to write something, and then it asks you and you can either write your explanation, or you can draw it if you'd prefer

Blackjack: how do you draw that?

Interviewer: you might have something that you want to draw about it, but you might not, you might just want to write about it

Videogame Guy: what about two thought bubbles: one with what you thought at first, and one what you think about it now?

Interviewer: if you can remember what you used to think, then that sounds like a good way of representing it

Buster: can you draw – what was the thing that we made yesterday?

Interviewer: aqueducts

Buster: can we draw an aqueduct and you building by it?

Interviewer: yeah, you can draw whatever you want – go on?

Blackjack: it definitely changed, because before I didn't even know STEM was a thing [laugh]

Interviewer: there we go! That's a good answer!

Videogame Guy: before I knew STEM was a thing, but I just had absolute – well before you started coming, I knew that STEM was a thing, but I had absolutely no idea what it actually was.

Interviewer: okay – so are we ready to answer that first question then guys? The things that you've said sound excellent

[pause in conversation while children work]

[Poppy and Blackjack chat about pencils]

Interviewer: shall we read the next question out together?

Blackjack: I'm not ready

Interviewer: if you're not ready, you can keep doing the question you're on – but if you pause that one a second, then you can come back to it, that's fine. So [Blackjack] can you read out the next question for us?

Blackjack: which skills or personality traits do you have that would help to use STEM in the future?

Interviewer: so, are there any skills or things about your personality that you think would help you to do STEM in the future? And again, you can write your explanation, or you can draw it. And you can also carry on doing the first question if you're not finished with that yet

[pause while children work]

Buster: I'm not sure on the second question

Interviewer: okay that's fine – so what would you like to know about it?

Buster: [pause] I'm not really sure

Interviewer: okay, so it's asking if you think you have any skills or if there's anything about your personality that you think would help you to use STEM in the future. And that could be in a job when you're a grown up, it could be in school, it could be in college maybe when you're a little bit older, it could be in any of the ways that you use STEM in your everyday life? What are you thinking?

Buster: I'm not sure

Interviewer: okay, do you remember we've all been talking about all the skills that we think might be important for somebody who works in STEM, and we've also been thinking about the skills we think describe ourselves? Do you think that there are any skills or there is anything about you that would be helpful in STEM if you did more of it in the future?

Buster: I don't think so

Interviewer: okay, so you can write about what you think

[pause while children work]

Buster: designing new buildings and things like that – can that be in STEM?

Interviewer: yeah

[pause while children work]

Interviewer: are you ready for the next question now?

Blackjack: I need a rubber

Interviewer: so shall we pause just for a second, so we can read out the third question. If you're not finished with the second question, you can keep working on that one afterwards. So would you like to read that one out [Buster]?

Buster: do you think you'd like a job that uses STEM when you're older?

Interviewer: and then you can write or draw an explanation for that below. Only if you're finished with your second question, you can keep doing the second one if you want to

Videogame Guy: you're doing the same thing as me, I think

[pause while children work]

Blackjack: can I draw in pen?

Interviewer: you can draw in pen if you want to

Blackjack: okay

[Blackjack laughs, shows part of her picture that she finds funny to the group. Videogame Guy stops working]

Interviewer: are you finished [Videogame Guy]?

Videogame Guy: yeah

Interviewer: do you girls mind if we talk while you're working?

Child: yeah

Interviewer: it won't be distracting?

[laughing about Blackjack's drawing]

Interviewer: okay, [Videogame Guy] can you please talk me through your answers? So what have you said for the first question?

Videogame Guy: My thoughts were 'yes' because my thoughts have changed a lot

Interviewer: uh huh

Videogame Guy: first I had no idea about it, but now I know about it

Interviewer: okay

Videogame Guy: at first I was thinking "what is STEM?", and then I drew a face that was confused and then I drew a happy face after it thinking: "STEM: science, technology, engineering, mathematics" and I drew an aqueduct there

Interviewer: ah okay. And when you think about STEM, how does that make you feel?

Videogame Guy: [pause] I don't know

Interviewer: okay. So over the project, you've learned what STEM is. Has the way that you think about STEM changed at all?

Videogame Guy: [pause] yes

Interviewer: okay

Videogame Guy: now I think of STEM as science, technology, engineering, mathematics. Before this started then I was thinking STEM like a stem of a flower

Interviewer: ah okay, so the other word stem?

Videogame Guy: yeah

Interviewer: okay. Is that everything you'd like to say about the first question?

Videogame Guy: yes

Interviewer: fabulous, what have you said about the next one?

Videogame Guy: I said that I like maths and technology and engineering, and I said that science is cool

Interviewer: okay

Videogame Guy: I drew a happy picture with maths, and it says a speech bubble, I mean thought bubble with 8x3 is 24

Interviewer: okay

Videogame Guy: and then I did the same except there's a t and there's a computer, and the same again except e and a house, and these lines are scaffolding

Interviewer: very good

Videogame Guy: and there's S except it's smaller because I couldn't fit it in as big

Interviewer: okay

Videogame Guy: and then there's a potion

Interviewer: a potion? Is that to represent science?

Videogame Guy: yeah

Interviewer: what does the potion mean for you?

Videogame Guy: [pause] well when I think of science, I think of potions

Interviewer: okay, what kind of potions?

Videogame Guy: I don't know

Interviewer: okay, what is a potion?

Videogame Guy: something that you drink that gives you a special ability for a certain amount of time

Interviewer: okay, and is that something that relates to science?

Videogame Guy: [pause] well…

Interviewer: only in your mind, this isn't a yes or no answer – this is just what you think

Videogame Guy: yes. Well yeah, that's what I think of sciences

Interviewer: okay. So you've talked about the things you enjoy, is there anything about your personality that you think would be really useful in STEM?

Videogame Guy: well I'm good at maths, I think that would help

Interviewer: okay

Videogame Guy: this might help for getting information because I got a reading age of three years over the age I am

Interviewer: oh really?

Videogame Guy: so that would be helpful for getting information

Interviewer: okay – you mentioned before that you were sensible, do you think that would help you in STEM at all?

Videogame Guy: probably

Interviewer: how do you think that might help?

Videogame Guy: [pause] well if you weren't sensible and you were doing science, then you might cause –something that could happen is it might cause the lab to explode

Interviewer: okay

Videogame Guy: because you could break chemicals and if they go together they might make an explosion?

Interviewer: okay [pause] are there any other things? So sensible is part of your personality, is there anything else that you think would be really helpful?

Videogame Guy: [pause] I don't think so

Interviewer: you also mentioned before that you really enjoy drawing out plans for things that you're going to do

Videogame Guy: yeah, oh yeah. And I was going to say, but I don't physically know – I said about planning stuff for Minecraft

Interviewer: yeah

Videogame Guy: Minecraft is building, and engineering is building so yeah – that might be a little bit helpful

Interviewer: yeah? Okay – is there anything else that you want to say about this question?

Videogame Guy: no

Interviewer: no, okay. Shall we talk about the third question?

Videogame Guy: yes

Interviewer: okay

Videogame Guy: I think I might like to have a job using STEM

Interviewer: okay, you said maybe

Videogame Guy: I drew four pictures, I had to do a key

Interviewer: okay

Videogame Guy: a tick next to it means cool, an 'x' means not cool

Interviewer: okay

Videogame Guy: so science I think is cool and that is me if I were working in science. I'm putting ingredients into a potion cup

Interviewer: and what's this down here?

Videogame Guy: shelves

Interviewer: and what's on your shelves?

Videogame Guy: [pause] poly pockets with stuff in and books and ingredients and stuff

Interviewer: ah right okay, and what's the next bit of your drawing?

Buster: would a baker be in STEM?

Interviewer: a baker? So which part of STEM do you think baking would relate to?

Buster: not sure

Interviewer: what do you in baking, when you're baking something what do you do?

Blackjack: make cakes

Interviewer: how do you make cakes?

Videogame Guy: by using ingredients and putting them together to put in the oven

Interviewer: how do you know how many ingredients to use

Blackjack: you measure it

Videogame Guy: from instructions

Interviewer: and how do you know if you've got enough flour?

Buster: weigh it

Videogame Guy: a weighing bowl or something?

Interviewer: yeah

Buster: or you could have a guess

Interviewer: well you could have a guess, but you could also weigh things out – so you could follow a set of instructions, and put lots of ingredients together, and weigh them out – does that sound like something that would relate STEM to you?

Buster: maybe in a bit maths maybe

Blackjack: maybe in reading

Interviewer: yeah, and also things like – how do you know how long to leave something in the oven?

Buster: it says on the instructions

Interviewer: how do you know whether it's been long enough?

Buster: when the alarm goes

Interviewer: and how do you know – so if you make a cake and you put too much butter in it, what might happen to the cake?

Buster: it might not rise

Interviewer: yeah, and how do you know if the cake's going to rise or not?

Buster: if you've put the right ingredients in

Interviewer: exactly, so you need to know the properties of all those different ingredients and how they work together to make the perfect cake

Videogame Guy: you also need to put it in the oven for as long as you need to, otherwise it wouldn't rise enough or it would rise too much

Interviewer: mm

Buster: so should I write that it is in STEM?

Interviewer: well do *you* think it's in STEM? What do you all think?

Blackjack: yeah, kinda

Videogame Guy: kinda

Interviewer: what do you reckon?

Buster: in the middle

Interviewer: in the middle? I think it probably is in STEM – that's my opinion, I think there's lots of scientific processes that happen when you're making a cake, so knowing that the air bubbles will form – that's down to a scientific reaction that happens because you've put – like you said – the right ingredients in – so your baking soda, or your yeast if you're making bread, that's what makes the bread rise. And that's a scientific process, so understanding all of that – I think it probably does relate to STEM

Buster: okay

Blackjack: wait, does that mean I can draw a bakery person by there?

Interviewer: would you like to be a bakery person?

Blackjack: I would love to! [laugh]

Interviewer: well there you go, if you say it relates to STEM. Because that was just my opinion, it depends on whether it's your opinion or not – that's just what I personally think, and here we're interested in what you think – so it depends what you think about it all

Blackjack: wait so is a nurse one?

Interviewer: yeah, nurses work in medicine

Blackjack: perfect

Interviewer: lots of people who work in medicine work in STEM – is there anyone else who works in medicine?

Buster: my dad is a postman

Interviewer: is he? Brilliant

Blackjack: a postman?

Interviewer: what was our next one on here then?

Videogame Guy: technology

Interviewer: okay, and what are you doing in that picture?

Videogame Guy: in that picture, there's a computer and it's broken so I got a hammer to fix it

Blackjack: [laugh] a hammer to fix it? Wouldn't that break it?

Interviewer: is there anything else that you do with technology?

Videogame Guy: you could make them

Interviewer: uh huh

Videogame Guy: that picture

Interviewer: yeah

Videogame Guy: it could either be fixing a computer, or making a computer

Interviewer: uh huh, okay. Is there anything else that if you work in technology you make? As well as a computer?

Videogame Guy: maybe iPads and iPhones

Interviewer: how do computers – how does this phone work?

[pause]

Interviewer: what are we running right now?

Blackjack: a radio?

Interviewer: this is a programme that we're running on this tiny little computer here isn't it? An app is like a computer program

Videogame Guy: does that mean that a phone is like a tiny computer?

Interviewer: yeah!

Buster: and then inside the phone – that's all just decoration, and inside the phone there's a microchip

Interviewer: yeah!

Videogame Guy: there was one time where I got a new clock and I held it and then I dropped it and my mum had to open it to fix it and I saw all the insides of the clock

Interviewer: okay, so there might be a tiny computer inside the clock as well? Is that everything you want to say about that one?

Videogame Guy: yeah

Blackjack: actually I'm done, I don't want to do the bakery

Interviewer: you're done? Well, that's fine, you can just tell me with your words instead if you wanted

Videogame Guy: by science and technology there's a tick

Interviewer: yeah

Videogame Guy: because I think it's cool

Interviewer: okay

Videogame Guy: and this engineering

Interviewer: yep

Videogame Guy: is a house and it's being built

Interviewer: okay

Videogame Guy: and there's the start of the roof, and then I'm on the top of the house

Interviewer: yeah

Videogame Guy: I've got brick – and I'm going to draw cement and I'm going to put it onto the cement

Interviewer: ah right, okay. So is this for engineering?

Videogame Guy: yes

Interviewer: okay, and do you think that's something that you'd like to do?

Videogame Guy: maybe

Interviewer: maybe, okay. And what was your last bit there?

Videogame Guy: maths

Interviewer: uh huh

Videogame Guy: does that look like it says 1 plus 1 equals 20?

Interviewer: it does a tiny bit, but then when you look here you can see that it says 5 plus 5 equals 10. So you can see what you've done there

Videogame Guy: it kind of looks like 1 plus 1 equals 20 and 5 plus 5 equals 10

Interviewer: yeah it does look a little bit like that, but we know what you mean don't we?

Blackjack: yeah

Interviewer: did you want to say anything else about the maths one?

Videogame Guy: [pause]

Interviewer: would you like to do a job that used maths maybe? When you were older?

Videogame Guy: I don't know

Interviewer: okay

Videogame Guy: well I don't know the types of jobs that are to do with maths – wait, would engineering be to do with maths? So say you were going to build a boat

Interviewer: uh huh

Videogame Guy: you would need to use maths in it wouldn't you?

Interviewer: yeah, how would you use maths when you were building a boat?

Videogame Guy: maybe measurements and how big and how long it would be

Interviewer: okay – what about when you're designing a building, or a bridge?

Videogame Guy: well, you could draw the surface of it

Interviewer: uh huh

Videogame Guy: and then you could write how many centimetres it would be, or how many metres

Interviewer: yeah?

Videogame Guy: or kilometres even

Interviewer: yeah?

Videogame Guy: and you would times it together to find out how many kilometres, or metres, or centimetres squared it would need to be

Interviewer: yeah, so there are lots of jobs that use maths – you're right engineering is one of them. So yeah

Videogame Guy: does that mean *technically* that and that is the same thing?

Interviewer: they're not the same thing, but they help each other. So engineering is helped by maths. Is there anything else out of STEM that uses quite a lot of maths?

Videogame Guy: [pause] science?

Interviewer: yeah!

Videogame Guy: because if you were making a potion

Interviewer: uh huh

Videogame Guy: then well you might need to do maths in order to work out how much of which ingredient you need to put in. Otherwise it wouldn't work

Interviewer: when you're doing experiments, you have to be really careful about what you're using and how you're measuring it out

[pause]

Interviewer: fab, is that everything you wanted to say about your picture?

Videogame Guy: yeah

Interviewer: brilliant, thank you [Videogame Guy]. Would you like to tell us about yours [Blackjack]?

Blackjack: certainly! I could not draw that properly

Interviewer: I think that looks pretty good! I can tell what that is, can't you?

Blackjack: yeah, I can tell what that is

Child: is that an aqueduct?

Interviewer: yeah, we can see the water, we can see the arches. It looks good!

Blackjack: and that's [unclear] Roblox

Interviewer: ah is that Roblox?

Blackjack: it's supposed to be me working, but I wrote Roblox [laugh]

Buster: at the start I thought it was people in the cinema

[laughing]

Interviewer: it does look a bit like that

Buster: but they're all headless

Blackjack: I think I know how to improve that

Videogame Guy: you could put arches there

Blackjack: where?

Videogame Guy: there, there, there, there

Interviewer: that would be one way maybe? So what did you write for your answer to the question 'have your thoughts or feelings about STEM changed during this project?'

Blackjack: my thoughts have definitely changed because before I had no idea STEM was a thing

Interviewer: right, okay. So how do you feel about STEM now? When you think about STEM, how does that make you feel?

Blackjack: when I think of it, I feel like I'm confident

Interviewer: okay, and what about STEM makes you feel confident?

Blackjack: I'm not sure

Interviewer: you're not sure? Okay. Is there anything else that you'd like to say about this?

Blackjack: yeah, I've got something to say: it looks bad

Interviewer: what looks bad? Your drawing?

Blackjack: yeah

Interviewer: ah I like the drawing. What made you choose to draw the aqueduct?

Blackjack: I'm not sure

Interviewer: okay

Blackjack: that's the only thing I could think of and I didn't want to write [laughs]

Interviewer: okay, fair enough

Videogame Guy: it might be the only thing you can think of because we did it just yesterday

Interviewer: okay, yeah maybe that's why it stuck in your mind. Is there anything else you'd like to say about your thoughts and feelings about STEM?

Blackjack: no, not on that one

Interviewer: okay, what was the next question?

Blackjack: which skills or personality traits do you have that would help you with STEM in the future?

Interviewer: yeah, and what did you say?

Blackjack: this answer's probably wrong

Interviewer: there are no wrong answers with this, because this is just what you think remember? So you can't get the answers wrong, because I'm interested to know everything that you think

Blackjack: that I love art, and I know about computers and IT, and I love science!

Interviewer: right, okay. So how would art be helpful in STEM? Or loving art?

Blackjack: if you're creating something when you're an engineer?

Interviewer: absolutely, yeah. Is there anything else that art might be useful? Being artistic might be useful?

Blackjack: maybe when you bake something

Interviewer: maybe yeah

Blackjack: yeah

Interviewer: okay

Blackjack: and then it says "I love" and I drew a computer with Roblox on

Interviewer: ah because you love Roblox?

Videogame Guy: that looks a little bit like 'love' and then pointing to the computer

Interviewer: I love computers? And then you've got computers and IT. What do you love about computers and IT?

Blackjack: I don't know, I just find it –

Videogame Guy: amusing?

Blackjack: entertaining

Interviewer: okay. And what do you love about science?

Blackjack: it's just [pause] fun and I like learning about new things in science

Interviewer: okay and how do you think that all these things will help you use STEM in the future? Why would they be helpful maybe?

Blackjack: because if I'm a scientist, I know that I love that job and I would carry on for a long time

Interviewer: oh okay

Videogame Guy: what about the potions?

Interviewer: you've drawn these…?

Blackjack: potions

Interviewer: so these are potions as well? What is it about science that makes *you* think of potions?

Blackjack: I don't know [laugh] it just pops in my head

Interviewer: okay, so what's this one here? What's that?

Blackjack: it's just like a tube potion

Interviewer: a tube potion? So what is a tube potion?

Blackjack: in a tube shaped bottle

Interviewer: oh right okay, so why do scientists use those tubes?

Blackjack: to store their liquids in?

Interviewer: sometimes? They can use them for lots of different things. Do you know the name for these?

Blackjack: no

Interviewer: those are called test tubes

Children: ohh!

Buster: I've heard of that before

Blackjack: yeah!

Buster: sometimes in the summer I go to a summer camp which we do science in

Interviewer: okay, do you use test tubes in that?

Buster: we don't use test tubes, but we do different kind of experiments

Interviewer: ah okay

Buster: and at the play times, the teacher told me how to make origami butterflies

Interviewer: ah lovely!

Blackjack: cool!

Interviewer: very cool – is that everything you wanted to say about that question? Is there anything else you wanted to tell us?

Blackjack: yeah, I spelt science wrong

Interviewer: ah that's okay, I know what you mean. How would you spell it?

Blackjack: don't know [laugh] but I can tell I put it wrong

Interviewer: so after the 's' there's a 'c'

Blackjack: oh!

Interviewer: but that's okay, I know what you mean. Are you ready to talk about your third question?

Videogame Guy: I spelt it wrong as well

Interviewer: that's okay, I know what you guys mean by it. So 'do you think you'd like a job that uses STEM when you're older?'

Blackjack: I said 'yes, probably a builder or a scientist'

Interviewer: okay, and can you tell me more about that?

[children laugh about drawing]

Blackjack: I don't really know anything

Interviewer: okay, so what have you drawn on here then?

Blackjack: [laugh] builder me

Interviewer: okay

Blackjack: with some bricks and cement, I've got a bit too much cement by there

Interviewer: and what are you thinking there?

Blackjack: I'm saying "I love building!"

Interviewer: ah okay, and which bit of STEM would building be a part of?

Blackjack: engineering

Interviewer: engineering – so would you just be building things, or would you be doing other things as well?

Blackjack: yeah, probably like fixing things as well

Interviewer: oh okay, what about – is there anything else that engineers do?

Blackjack: they probably do, but I don't know

Interviewer: okay, so do you remember yesterday we were engineering those aqueducts?

Blackjack: oh yeah!

Interviewer: what did we do before we started building?

Videogame Guy: we did a plan!

Blackjack: oh yeah yeah yeah

Interviewer: and – go on?

Buster: I was doing the plan, but we changed the plan because it wasn't really going to work

Interviewer: okay, that's a really important part of being an engineer – having a plan, thinking about it, and noticing if there's anything that you don't think will work. Then you can change your plan. So that's a really good step.

Videogame Guy: I *was* the engineer in my group

Interviewer: were you?

Blackjack: me too!

Interviewer: did you enjoy it?

Blackjack: yeah

Interviewer: ah brilliant, so engineers: they think about construction of things

Blackjack: why did I write an 'l' by there? [laugh]

Interviewer: I don't know! What's this picture down here?

Blackjack: he's a scientist and there's lots of test tubes!

Interviewer: okay, and what are you thinking there?

Videogame Guy: that is a lot of test tubes

Blackjack: I'm thinking "I can't do it!" – that's why he's got a sad face

Interviewer: okay, and why do you think you can't do it?

Blackjack: it's too difficult for him – oh her!

[children laugh]

Blackjack: me!

Interviewer: okay

Videogame Guy: you forgot you were talking about yourself then!

Interviewer: so do you think that you *would* like to be a scientist? What would happen if you were a scientist and you found something that was difficult – and you thought “I can’t do it”?

Blackjack: I’ll ask someone to help, or say “can we work together?”

Interviewer: okay, so would that make you –

Blackjack: because teamwork makes the dream work!

Interviewer: [laugh] would thinking –

Videogame Guy: what I would do is:

Interviewer: one second [Videogame Guy], because I’ve got one more little question for this. So if you were a scientist and you got to something that was hard, and you thought “Oh I can’t do it”. Would that make you want to carry on being a scientist?

Blackjack: it would, I just couldn’t do that bit

Interviewer: ah so it’s just *that* bit that you can’t do? And you would – like you said – ask for help?

Blackjack: yeah

Interviewer: so even if you found things difficult, you think you’d like to carry on being a scientist?

Blackjack: I think I should say “I can’t do it yet”

Videogame Guy: yeah, that’s what I was going to say!

Interviewer: ah is that what you were going to add? Go on, tell us what you were going to say

Videogame Guy: I was going to say, take the thought bubble and write ‘yet’ on the end

Interviewer: ah there you go, maybe you’d like to add that in? Is that everything that you wanted to tell us about that?

Blackjack: [pause] probably

Interviewer: probably? Well if you think of anything else, let us know. But we'll have a chat with [Buster] now. So what have you got on yours?

Buster: I wrote at the start I didn't really know what STEM stands for

Interviewer: uh huh

Buster: but now, we've had quite a few lessons with you, I do know what STEM stands for

Interviewer: okay, and how do you feel when you think about STEM?

Buster: I didn't really write what I feel

Interviewer: okay

Buster: but I feel like I'm learning something new

Interviewer: okay, and what's the picture that you drew there?

Buster: I drew a picture of me building the aqueduct and it's the actual aqueduct that we did build

Interviewer: okay, and how did you feel when you were building the aqueduct?

Buster: I felt like it was going to work, and then when we lifted it up, there was a hole in the bottom, so the thing that was protecting the box – lots of it came out

Interviewer: okay

Buster: we still had some in there, but most of it fell out

Interviewer: okay

Buster: and when we did it – the aqueduct, it was leaking

Interviewer: ah right okay – and how did that make you feel?

Buster: I'm not sure

Interviewer: okay, that's fine. Is there anything else you'd like to tell us about that answer?

Buster: no

Interviewer: okay, are you happy to move onto the next question?

Buster: yeah

Interviewer: okay, brilliant. Which personality traits or skills do you have that would help you to use STEM in the future?

Buster: I wrote: "I'm not sure if there is a job that I would like to do, but maybe designing houses"

Interviewer: okay – and what's your picture there?

Buster: I have a piece of paper and a drawing of a house, and then me there looking happy

Interviewer: ah okay. And what skills do you have – what things are there about you, that you think would make you successful at designing houses?

Buster: [pause] maybe – I'm not sure

Interviewer: you're not sure, okay. You mentioned before that you were quite creative and imaginative

Buster: yeah

Interviewer: do you think that those might be helpful?

Buster: yeah

Interviewer: how might they be helpful?

Buster: because if the owner of the house thought it was quite dull and thought it needed some new paint, but the owner couldn't really paint very well, so I could do the painting for her or him

Interviewer: okay, what if somebody came to you, and they said "I don't have a house, but I need someone to help design it" – what is it about you that would make you good at that?

Buster: I'm not sure, but sometimes my brother lets me play Minecraft and I get to build things like railway tracks and hotels

Interviewer: ah okay

Videogame Guy: sometimes my mum plays Minecraft

Interviewer: does she? Is there anything else you'd like to say about that one [Buster]?

Buster: no

Interviewer: no? okay. And what was your final question? You've drawn loads for that

Buster: yes, and no

Interviewer: okay, can you explain that for us?

Buster: I drew the pictures of what jobs I might want to be when I'm older

Interviewer: okay

Buster: the first one is a hair dresser, and I wrote "not in STEM"

Interviewer: okay

Buster: and a picture of me cutting hair, then a builder – building is in STEM because engineering is building.

Interviewer: okay

Buster: and I wrote "is in STEM". House designing is in STEM because you will get to build it once you've drawn it

Videogame Guy: that house looks posh

Interviewer: and designing it – do you remember yesterday we had to design before we built, so that's a really important stage

Buster: a baker, which is in STEM. Then I did me having some flour on my face

Interviewer: [laugh] okay

Buster: then a bowl which has the cake mixture, and an arrow saying 'make it turn into a cake'

Interviewer: ah okay

Buster: that's in STEM, because you said that all the measurements and things like that. And then I've got author and illustrator. I've drawn me and a book with some writing in and two people

Interviewer: uh huh

Buster: and a pencil and a paintbrush

Interviewer: so at the moment you're not really sure what you'd like to do when you're older?

Buster: yeah. I'm not sure if an author or illustrator is in STEM or not

Interviewer: what do we think guys? It might depend what you write about I suppose?

[pause]

Interviewer: so it might depend on what you choose to make your stories about. Maybe if you decided that you wanted to write science fiction

Videogame Guy: oh yeah

Interviewer: you might use a kind of imagined futuristic idea of what science might be? So one thing I've noticed here – do you guys remember that L said she felt that she was very imaginative and creative? Oh you thought you were artistic sorry

Buster: yeah, and also imaginative

Interviewer: and I think every single one of these jobs, whether it's in STEM or not in STEM, would be really suited to someone was who was imaginative and creative. You can't design a house without using your imagination and being creative and artistic can you?

Videogame Guy: no

Interviewer: so I think, that you probably do have lots of skills that would really help you with all of those.

[pause]

Interviewer: so does anyone have anything that they'd like to say about their drawings that they haven't talked about before?

Videogame Guy: well this isn't about a drawing

Interviewer: that's okay

Videogame Guy: when I grow up, I want to build robots – would that be in STEM?

Interviewer: I think it probably would be: which bits of it do you think would be in STEM?

Videogame Guy: well probably technology or apparently it's called robotics engineering

Interviewer: yeah!

Videogame Guy: engineer is in STEM so…

Interviewer: yeah, I think you're absolutely right. So you think you'd like to be a robotics engineer?

Videogame Guy: yeah

Interviewer: that's really cool! Are we all happy that we've said everything that we'd like to say?

Children: yeah

45 Appendix 33: Pupil task-based interview 3, YP

Title: Pupil interview 3

Date: 26th June 2019

Speakers: Poppy Hodkinson (interviewer), Pippin, Molly, Barry and Stanley

Interview duration: 73 Minutes

Interview location: YP

Interviewer: so before we begin, shall we remind ourselves what STEM stands for?

Molly: science

Stanley: technology

Barry: engineering

Pippin: mathematics!

Interviewer: exactly, excellent guys

Barry: yeah, we were talking in the car before school, we were talking about it

Interviewer: oh were you? What were you saying about it?

Barry: we're gonna build a Roman bridge

Interviewer: ah so you knew what you were going to do in the workshop?

Molly: because we got a letter

Barry: because my mum told me

Interviewer: ah because the letter told you? Fab. So shall we just remind ourselves as well – what we did in the last sessions? What did we do the first time?

Barry: we looked at bones

Interviewer: yeah! What did we do in our interviews? What was the first activity that we did up here?

Pippin: oh I remember!

Molly: there were cards

Stanley: we had cards and we said which ones are important for people

Pippin: you got to pick six or seven

Interviewer: yep

Molly: and then things that were important to us, or things that we thought we were: so like clever, friendly…

Interviewer: absolutely, well remembered. And then what did we do the second time? Because you [some of you] weren't here. Can you fill us in?

Barry: we kind of did the same thing?

Stanley: yeah

Interviewer: what did we have extra last time?

Stanley: we did the same thing but we just –

Barry: oh! We talked about who was in our family doing STEM

Interviewer: yeah

Stanley: oh yeah! And you had those cards of your friend!

Interviewer: yeah exactly. So we talked about the people in our lives that worked in STEM or were interested in STEM, so we talked about [Stanley's] dad and we talked about [Barry's] mum

Molly: oh my dad works in STEM

Interviewer: does he? What does he do?

Molly: he technically – do you know a car MOT?

Interviewer: uh huh

Molly: well he technically inspects ships when they come in

Interviewer: like a ship MOT? Wow

Molly: yeah

Barry: does he drive them as well?

Molly: well he used to have a job on a ship

Interviewer: yeah?

Molly: he was guiding the ship?

Interviewer: okay

Pippin: my mum or dad doesn't do anything in STEM, but my brother does because he's about to do his GCSEs and he's doing biology?

Interviewer: oh yeah?

Pippin: yeah

Interviewer: so your brother's interested in STEM?

Pippin: yeah, he really really likes science

Interviewer: ah awesome

Pippin: and he really wants to be a marine biologist

Interviewer: a marine biologist? That's very cool isn't it? Okay, so. When we were talking about the words last time, we were talking about them – we were thinking of the people we know, and then which cards we thought would be important for them. And today we're going to pick the five cards that we think are most important – and it can only be five – so we have to decide which is more important than which. So we're going to choose the five cards that we think are the *most* important for somebody who works in STEM or is interested in STEM. And then we're going to pick the five that we think are the *least* important

Child: okay

Interviewer: And there's lots of words here, so we're going to have to make sure that we look at every single one, and think about it. We don't have to talk about them all separately, but make sure that you've looked at each one

Barry: I'm just picking it out

Interviewer: so you're going to pick five? We need to decide five as a group, not each

Molly: I'm going to take five here – really random ones

Pippin: oh I think this one's *really* important

Interviewer: what? Enjoys dancing? You sounded a little bit sarcastic there [Pippin]

Molly: I've just taken a few random ones and I'm going to look at them

Interviewer: okay that's fine

Molly: and then see

Pippin: listens to other people's opinion

Barry: clever! Clever!

Pippin: this might be

[unclear chatter]

Interviewer: you like that one?

Pippin: likes dancing

Molly: likes to learn new things

Barry: visiting other countries

Interviewer: do you think it's the *most* important for someone who works in STEM?

Children: no!

Interviewer: tell us your opinion!

Stanley: some people in their jobs, they go to other countries

Barry: yeah, maybe to build stuff

Pippin: yeah like biologists

Interviewer: yeah?

Molly: and the thing that you do!

Interviewer: archaeology?

Molly: yes!

Interviewer: do you remember that I said –

Stanley: and my dad because my dad designs aeroplanes and he goes to Toulouse, Norwich

Interviewer: ah okay

Stanley: once he went to South Africa, even China

Interviewer: wow, very cool

Stanley: and New Zealand

Interviewer: okay, so a lot of STEM jobs - you might go to different countries when you're doing them?

Child: yeah

Molly: I've got two in my pile that I think are good

Pippin: I think these two are really good, and this one is really good

Interviewer: okay

Pippin: enjoys maths

[Interviewer asks children to take turns speaking]

Interviewer: let's talk about one of your words first, so which one do you think there is one of the most important?

Molly: listens to other people's opinions

Interviewer: listens to other people's opinions? So what can you tell us about that one? Can you explain what you thought?

Molly: well, if you're working in a group then if you're not listening to anyone else, then you won't know what to do

Interviewer: okay, and why might that be important if you work in STEM? So if you're a scientist or a mathematician or a technologist?

Molly: because you usually have to work together, not apart

Interviewer: okay

Molly: if you had to find bones, like you do

Interviewer: yep

Molly: or stuff in the ground, well you'd have to work as a team to pick an area – like maybe if you saw a Roman coin that had been dug up or something, if you saw one there, but you didn't speak to anyone like "oh I'm gonna keep this place for myself"

Interviewer: keep it a secret?

Molly: yeah, then maybe in the other places you won't find much?

Interviewer: so the idea of working with other people and sharing knowledge and listening to their opinions?

Molly: uh huh

Interviewer: excellent, thank you [Pippin]. Does anyone else have anything to say about that one?

Barry: I have two

Interviewer: does anyone have anything to say about listening to people's opinions? Do you think it's really important? Do you think it's maybe less important?

Barry: I think yeah, because if you do the same thing as [Molly] – you find a Roman coin – maybe in the other place you find nothing and the place you were in, there would be lots and lots of stuff

Interviewer: mmm?

Barry: cool to do

Interviewer: okay, thank you [Barry]. And what we're you going to say about that one [Pippin]?

Pippin: well this is for other people's opinions, so say you're about to do a science experiment

Interviewer: yeah

Pippin: you have to listen to other people to try and find out how you can probably make it. Like how it might work. So there's one thing gone wrong

Interviewer: yeah?

Pippin: you have to make sure that everyone knows that that's happened and you have to work together to [pause] fix it

Interviewer: okay

Pippin: but you have to listen to other people and try and make a way to do it

Interviewer: okay, brilliant. So what's our next word? Have we got one to talk about? Go on [Stanley]

Stanley: enjoys history

Interviewer: enjoys history, and do you think that's one the of the most important or one of the least important?

Stanley: I think it's pretty important because if you find something which looks very old and you haven't learnt about history you might not know what it is, and you might just put it back down.

But it might be worth billions so you might – instead of sitting and watching TV all day you could learn a little bit of history. Because my dad – when he was a kid, he found something very old and then he learned about it in school

Interviewer: okay

Stanley: then he sold it to a museum and he got worth billions of money

Interviewer: billions? So why is that important for someone who works in STEM to enjoy history?

Stanley: because they might – with dinosaurs, some people learn about them, you might want to know which bones are which, and once you find them, loads of bones of the same animal and you might put it together and you might give it to a museum

Interviewer: okay, so there are bits of STEM that you might need history for?

Stanley: yeah

Interviewer: okay, which pile do you think that should go on? Most important or least important?

Barry: most

Pippin: most

Molly: I'm not sure

Interviewer: you're not sure? Shall we leave it there for now?

Pippin: in the middle

Stanley: I'll put it on top

Interviewer: put it on top for now. Okay, yes [Pippin] – what word would you like to talk about next? We'll do yours next [Barry]

Pippin: enjoys maths

Interviewer: tell us about enjoys maths

Pippin: because STEM – the M stands for maths

Interviewer: okay

Pippin: and if you don't enjoy maths or don't really know anything about maths you can't really join in with STEM. Because there's not much that you could do

Interviewer: okay

Pippin: and [pause]

Interviewer: does anyone else think anything about enjoys maths?

Stanley: I like maths

Barry: if you were in high school and you were level 1 in maths, and you go to STEM you would help because you would know how many degrees that would turn to burn maybe?

Interviewer: to burn what?

Barry: to burn a bone

Interviewer: oh okay

Barry: how many degrees would it need to burn a bone

Interviewer: yeah

Barry: because maths is all about numbers and things like that

Interviewer: okay, thank you [Barry]. Go on [Stanley]? Did you have something to say about enjoys maths?

Stanley: no

Interviewer: no okay – do we have anything else we want to say about enjoys maths before we move on? Do we think it goes on most important or least important?

Pippin: most

Interviewer: most? Everyone else?

Barry: most

Interviewer: what was your word then [Stanley]?

Stanley: this one

Interviewer: creative? Go on, tell us about that one

Stanley: because you could design lots of stuff which are very creative, and things which are not useless, but they're useful, they might be useful in the future

Interviewer: okay

Stanley: and if you sell them, then somebody thinks it's really good, you might earn quite a lot of money after you sold one or two

Interviewer: okay, what kind of things might you create or be creative about if you're in STEM?

Stanley: lots of stuff, but not sure which ones because they're all very good

Interviewer: okay, can you think of one example of something you might create in STEM? Can anyone else think of an example of something you might create in STEM?

Barry: you could create a –

Molly: a telescope

Interviewer: a telescope? Someone had to invent the telescope didn't they? Was that creative when they invented the telescope?

Molly: what?

Interviewer: was that creative when –

Molly: yeah

Barry: you could invent a cupboard which is automatic

Interviewer: what's automatic about the cupboard?

Barry: you have a control

Stanley: that's just lazy!

Molly: do you're just lying down in bed and just like "bring me some clothes'

Barry: no I didn't mean like that. When you're on the sofa, someone is going – they don't have the control, you can just press the button for them

Interviewer: ah okay, so it might open the cupboard for them?

Molly: I have a good idea about an electric wardrobe

Interviewer: oh go on [Molly], tell us about the electric wardrobe

Molly: so, maybe no one steals your clothes

Barry: you could hide your clothes in the attic

Molly: no, you put a hand print or you could have a finger print

Barry: no I want it on my door

Molly: or you could have this little thing on the wall with what style you want, so like jazzy, denim so you just click on that design you want and this thing would turn around: denim ding ding!

Interviewer: and the wardrobe gives you the outfit?

Molly: yeah

Interviewer: I like that! I'm sold

Stanley: what about if the thing scans your body

Pippin: no scans your eyes, that's what happens in all films. They literally scan one of your eyes

Interviewer: so what would happen after it scanned your body?

Stanley: it knows how –

Barry: tall and weight you have and stuff like that

Stanley: weight you have?

Interviewer: is that what you were going to say?

Stanley: no – if it scans you and say that it's my house and [Barry] just comes in, then he wants something from the wardrobe and scans himself, then the computer will –

Pippin: it won't recognise him

Barry: it will say [waa waa sound]

Interviewer: oh so [Barry] couldn't use your wardrobe?

Stanley: yeah

Interviewer: I liked your idea as well, so was your idea – if it scans your body, what would it know?

Barry: if it scans your body, it needs to know your weight, what's your eye but it's not just what do you have on you, how tall are you and your hair

Pippin: but your hair grows!

Interviewer: and what would it do with that information then?

Barry: it would recognise you instead of my brother

Interviewer: could it then choose your outfit based on how tall you are and what your hair colour is?

Stanley: I have one other thing: if you're doing lots of stuff in the kitchen, you could have this knife stuck onto a machine and you put a fruit or something underneath it then the knife just chops it

Interviewer: ah okay

Stanley: then there's something pushing it so the knife just goes like that and the [unclear]

Interviewer: ah so we've just been creative there haven't we?

Stanley: my grandad, he was a nurse when he was younger and he turned into [pause] and now he's really good at making stuff, he's in middle of designing one of them

Interviewer: oh something to chop fruit up?

Stanley: and he's a really good cook

Interviewer: ah okay, so he's used his love of cooking and his inventiveness? So where do we want to put creative then?

Barry: ah definitely there

Interviewer: most important or least important?

Pippin: middle

Molly: middle

Interviewer: not the most important? Okay

Barry: I have three

Stanley: can I have one more?

Interviewer: we're doing [Pippin's] next

[chat about turns]

Molly: I choose honest – so if you're an archaeologist, like you are

Interviewer: yeah

Molly: and you found something, if you found five pounds under the ground and you kept it, but then you felt like really bad – to be honest

Interviewer: okay

Pippin: or you could have an honest opinion, so if someone gives you an opinion, you have to give them an honest opinion back

Molly: yeah like if you didn't like their idea –

Barry: you need to be honest

Molly: you have to be honest because it might not work. So you'd could go "we could try your idea out first but I don't think it's going to work". So we could try it out first

Pippin: then change something that's wrong

Molly: yeah maybe we can change something

Interviewer: okay

Barry: I have three

Interviewer: so honesty would that go on most important or least important?

Pippin: most

Barry: most

Interviewer: most, okay. Look, we've got five on there now, so now we need to start thinking: do the words that we have – are they more important than the ones we've got here? Are we going to move anything around? So what's your word [Barry]?

Barry: enjoys science

Interviewer: enjoys science and what do you think about enjoys science?

Barry: science is like STEM because it's in the word: science, technology, engineering, maths. Because when we were building that roman bridge, we didn't have all the water in the bucket, so if we were more scientific, we could make it all go in. Could get all of the water through to the end and into the bucket

[alarm goes off]

Interviewer: okay, so enjoys science: do you think it needs to replace anything here? Do you think it's most important or least important?

Pippin: which one do you think it is?

[chat about break time]

Interviewer: do you think it should go on the 'not important' pile or the important pile?

Child: important

Barry: I don't know actually

Interviewer: you're not sure? What does everybody else think?

Pippin: important

Molly: not important

Interviewer: you think not important? Why do you think it's not important?

Molly: it isn't as important as the stuff we've already got down

Interviewer: you don't think so?

Molly: but it is important. Oh maybe it could replace enjoys history

Barry: yeah

Interviewer: why do you think it might replace enjoys history?

Barry: because you wouldn't really find most history stuff I think in STEM

Pippin: not every single part is history

Interviewer: ah okay

Child: yeah

Stanley: you sort of do have to enjoy it though don't you?

Barry: but I don't think history should go 'not important', I don't think that

Interviewer: okay, because we're only going to choose five *most* important

Pippin: I think I've got one which is least important

Stanley: I said these two are in the middle

Interviewer: oh those are in the middle? So shall we put them there and then enjoys science on most important?

Barry: yeah

Interviewer: go on then [Pippin] let's hear your one

Pippin: I have least important – enjoys dancing

Interviewer: tell us about that one

Pippin: well in science, technology, engineering and maths, I don't really need dancing

Stanley: yeah, but you like it – lots of people like it

Pippin: yeah but you don't need it for STEM – so 'most important things in STEM'

Stanley: what about enjoys sport?

Molly: if it was a work do or something –

Barry: I think can take risks

Molly: then yeah it would be good to enjoy dancing

Interviewer: oh if you're dancing at work

Molly: if you're at a work do and there was champagne or something, you'd get drunk so dancing would take your mind off the alcohol

Interviewer: [laugh] right okay, do you think a lot of people working in STEM drink a lot of champagne at work?

Molly: not at work, at work dos

Interviewer: oh okay, if they go to a party?

Stanley: that's not very important though [laugh]

Interviewer: So where do we want to put that one then?

Pippin: not important

Interviewer: if you work in STEM – so if you're an engineer, does that mean you can't enjoy dancing?

Barry: no!

Interviewer: what does it mean?

Pippin: it means you don't need it in the work – you don't need it in the work

Molly: yeah

Interviewer: okay

Stanley: this might not be very important, but enjoys sport?

Interviewer: enjoys sport, tell us about that one

Stanley: because one of our teachers he really likes sport

Barry: he's a sports teacher

Interviewer: why do you think enjoys sport might not be important?

Stanley: because it keeps you fit, but too much sport makes you really tired and stressed

Interviewer: okay

Stanley: with footballers, they really enjoys sport and they keep healthy and they have rest and so they won't be feeling stressed or anything. They're not playing sport every day, they have two hours off sport, which is quite a lot for footballing

Interviewer: okay

Stanley: and rugby

Interviewer: so where would you like to put that card then?

Pippin: but is it used in STEM?

Barry: middle or worst

Interviewer: do you think it's the most important or the least important? We're not really doing the middle today – just most and least important

Barry: least

Interviewer: you think least?

Barry: I've got a least

Stanley: I think middle

Interviewer: we're not really doing middle, we're just thinking about these two. Which one have you got there [Barry]?

Barry: I think it could be least: can take risks

Interviewer: what do we think about that one, why do you think it might be the least important?

Barry: because it might be 10% chance it will work, and that's not a % to make this project work

Interviewer: okay, does anyone else think anything about taking risks? Yeah Mo?

Pippin: in can take risks, I think it's actually important

Barry: how?

Pippin: because if you take a risk and try something out, it might work really well so you never know until you try

Barry: but it might not work, so…

Pippin: but you never know until you try

Barry: it's 50:50 %

Pippin: you never know

Interviewer: go on [Stanley]

Stanley: clever

Interviewer: what do you think about that word?

Barry: you don't need to be clever

Stanley: you don't need to be clever –

Barry: but it would be good

Stanley: nerds are very clever

Interviewer: who's very clever?

Stanley: nerds

Interviewer: who's a nerd?

Pippin: sweets!

Interviewer: the sweets? I like those – who's very clever?

Stanley: lots of people are very clever

Barry: nerds

Stanley: nerds, nerds are like

Pippin: yeah [Friend's] really clever but he's not a *nerd*

Stanley: it's like

Molly: no one's *really* a nerd, it's just some people look geeky.

Interviewer: is a nerd and a geek the same thing?

Child: no

Molly: kind of

Interviewer: what's the difference between a nerd and a geek?

Barry: a geek is the opposite of a nerd I think

Pippin: what's the difference between a nerd and a geek?

Barry: I have no idea

Interviewer: you're not sure? So [Stanley] where would you like to put that card?

Molly: I know what the difference is

Interviewer: go on

Molly: nerds are just like [English accent] "oooh I've got to work out this problem", but geeks they're just like [high pitched] "oooh thank you for saving me!"

Interviewer: okay, what kind of context is that in?

Child: like Penfold! [Danger Mouse reference]

Stanley: what about just clever?

Interviewer: go on what about clever

Stanley: my dad's very clever, he's not a nerd. But lots of people like you – you're clever

Interviewer: am I? okay

Pippin: you're meant to say thank you very much

Stanley: and then it's good to be clever because you know –

Pippin: a lot of stuff

Stanley: you know more than ten stuff – you know about 100 stuff

Interviewer: 100 things?

Stanley: which is very important. Let's just say if [Molly] was really clever

Molly: oh so you're saying I'm not clever!?

[laugh]

Stanley: she *is* clever, but if she was really clever then [Pippin] was stupid or something

Pippin: that should swap around please!

Molly: ah yeah she's smarter than me

Interviewer: let's be nice to each other guys

Stanley: this is an example, it's not real

Interviewer: okay, so it's just hypothetical? Okay

Child: wait what does that mean?

Interviewer: hypothetical means not real –

Pippin: like an example?

Interviewer: yeah, you're just using it as a 'thought experiment'. So carry on [Stanley]

Stanley: [Molly] would know lots of stuff, [Pippin] would know one or two stuff

Pippin: I know quite a few things

Stanley: but [Molly] would know about 50 stuff and it's good to know science, maths, English, welsh and it's good to learn other languages

Interviewer: okay, so for somebody who works in STEM, which pile would you put it on for them? Would it be most important or least important?

Stanley: I think – which one do you think?

Pippin: I think, I would say most

Stanley: what about you [Molly]?

Molly: wait, what are we talking about?

Pippin: cleverness

Interviewer: for someone working in STEM

Molly: yeah I think that's most important

Barry: I have an opinion

Interviewer: go on, please share it

Barry: if you are clever, you know lots of stuff but then when you're working sometimes it can mix up. Because maybe if you're in an English lesson and you're writing something down, you might think of something else instead. Like maybe in STEM that won't happen. So I say most important, yeah

Interviewer: okay, pop it on most important

Stanley: that's our top five

Interviewer: So we've now got a top five. So we need a few more things for least important.

Barry: I'm going to pick three

Interviewer: Is there anything that you think really isn't important if you work in STEM?

Stanley: enjoys computer games! That's really silly

Interviewer: okay, enjoys computer games, what do we think about that one?

Molly: enjoys reading? No!

Interviewer: let's talk about likes computer games, and then we're going to talk about [Molly's] card. So what do we think about likes computer games?

Stanley: you can spend too much time on it – with me I'm only allowed 15 minutes on the weekend and my friend, he has about 6 or 4 hours

Interviewer: really okay?

Stanley: and sometimes you can get a little bit addicted

Interviewer: do you think?

Pippin: that's like my brother with his phone

Interviewer: so you think that liking computer games:

Stanley: it's not very important

Barry: not important in STEM, no way

Interviewer: why's it not important for STEM [Barry]?

Barry: because you would only think of that maybe

[teacher enters, recording stopped]

Interviewer: you were telling us why you thought

Barry: computer games

Interviewer: might not be important for someone who works in STEM

Barry: because honest, enjoy maths, listen to other people's opinion, enjoys science, clever: they can fit into STEM. But I don't think – computer games can't because you would be addicted. Say you were addicted to computer games and you worked in STEM, you would just think of computer games

Interviewer: okay

Molly: I have something to say about likes computer games

Interviewer: go on [Molly]

Molly: well, so if it likes computer games then it can make a computer game *on* STEM? Like a computer game so it's like educational

Stanley: so you could have a game to find bones and learn about them

Molly: yeah!

Stanley: so there could be episodes of finding a bone and learning about it

Molly: so you could find a specific thing

Stanley: BUT you won't really get money for that would you?

Barry: that's technology, that could fit in technology

Interviewer: so liking computer games could fit in technology?

Barry: but I don't think it's that important

Interviewer: okay so which pile do we want to put this on?

Barry: still there

[Interviewer assures Molly that her opinion has been recorded, and will be part of the write up]

Interviewer: okay, what have you got in your hand there [Molly]?

Molly: I have got competitive

Interviewer: please tell us about competitive

Molly: I don't think it's important to be competitive

Stanley: that goes with sport

Barry: yeah!

Stanley: like "I'm gonna win this game"

Molly: because if you're competitive like "Who can find the most bones?"

Interviewer: yeah

Molly: if someone doesn't find as much bones and then you're really mean to them, that could bring your job apart. Then you'll find even less bones and stuff and then you might get paid less

Interviewer: okay

Molly: so that's why I think competitive should be on least important

Interviewer: on least important? Do we all agree?

Barry: yep

Pippin: I'm very competitive

Interviewer: are you? So have we got anything else? It might be that there isn't anything else

Child: likes to learn new things

Interviewer: you might not think that there's anything else. You might just want to leave it on four

Pippin: I may have not looked at this one, I think it's very important

Interviewer: go on, what is it?

Pippin: wants to understand how things work

Interviewer: why do you think that's very important?

Pippin: because if you want to learn how things work. Say you're a technologist and you don't know how one thing works and you don't really want to learn about it because you don't enjoy learning, you're not really going to find anything out are you?

Interviewer: okay

Pippin: so it's really good if you want to understand how things work

Interviewer: okay, and which one do you think it should replace on there?

Pippin: oh no! [pause] listening to other people's opinions

Barry: no! no enjoys science, please no please no

Interviewer: do you all agree that wanting to understand how things work is more important than listening to other people's opinions?

Barry: no

Pippin: no, actually I want to swap that

Interviewer: you've changed your mind? For honest? What do we think about that?

Barry: it's not that important

Molly: yeah, it's not that important

Barry: well it is important

Stanley: it is important to be honest

Barry: but I don't think you –

Stanley: say that you lied, you said "I've found £100 on the floor" then everybody says "Well what did you spend it on then?" and you said "a computer" – if computers were £100 –

Pippin: say someone comes to your house, they're just like "where's the computer?" and you say "I sold it!" and "where's the money for it?"

Stanley: and then "I gave it to my mum then my mum spend it on a dress", then "where's your mum's dresses then?" "I don't know"

Interviewer: okay

Stanley: but then your friends won't really believe you

Interviewer: okay, are we happy with the placement of the words at the moment?

Child: yeah

Interviewer: are we happy we've got all the right words?

Barry: we need one more

Interviewer: you need one more? If you don't think any of the others fit on there, then that's fine. So you don't have to if you think nothing else fits

Stanley: I have one: enjoy reading is *very* important. Say that you can't read?

Molly: I found a 'maybe'

Interviewer: we're not looking for maybe today, just really important and not important

Molly: then this is really important

Interviewer: okay

Molly: to be determined

Interviewer: okay, why's that really important?

Molly: like you're determined to find at least one thing

Interviewer: okay, what does everyone else think? Which one would you change that for?

Barry: what?

Molly: enjoys maths

Barry: nooooo

Interviewer: you think being determined is more important that enjoying maths?

Barry: you *have* to enjoy maths

Molly: you don't have to enjoy it – it's just you have to know how to multiply and

Interviewer: so you don't have to enjoy it, you just have to know how to do some maths [skills]?

Barry: what does everyone else think?

[explains more activities will follow this one]

Barry: let's just put this in that

Interviewer: so you think likes learning languages is the least important

Barry: it could be, but I'm going to say

Stanley: can I do one? Enjoys reading

Barry: you've already said

Stanley: I think this

Interviewer: so you think it's more important than those five [Stanley]?

Stanley: yeah

Interviewer: which one do you think it's more important than?

Stanley: I think it should replace this one

Pippin: no!

Interviewer: so enjoys reading is more important than listening to other people's opinions?

Barry: yeah

Pippin: I don't think that

Interviewer: why do you think that?

Stanley: if you read, and somebody gives you a letter which is really important and you can't read

Barry: yeah but you *could* read

Pippin: it's *enjoys* reading

Barry: you would be through school, through high school, through college!

Pippin: and otherwise if you couldn't read T then you wouldn't be let into STEM

Barry: yeah

Interviewer: is the difference the word 'enjoys'? Is that the difference?

Barry: yeah

Interviewer: okay, so [Stanley] you're saying if you can't read, that might make it difficult. Which I think I would probably agree with, but it's the 'enjoys' bit everyone else is disagreeing with?

Barry: yeah *enjoys* reading

Stanley: yeah but if there was a card saying

Barry: just reading: probably, but enjoy??

Interviewer: are you happy with the placement of these words now?

Pippin: I'm not happy about that – I think it should be other people's opinion

Interviewer: okay, well shall we put them next to each other?

[Interviewer explains next activity, where children choose five words to describe themselves]

Interviewer: okay, let's do some time management together, so we've got 40 minutes and we're going to choose the five cards that we think represent ourselves and then we also have this worksheet, so what do you think is fair for the next activity – how long do you think you might need?

Molly: maybe ten minutes

[chat about timings of following activities]

[child speak about cards, discussion over where cards might be, which cards they're choosing]

Interviewer: so can you tell us your five words and why you chose them please?

Pippin: can work in a team, artistic, enjoys history, enjoys dancing – I don't want to say this one: gets all the answers right

Interviewer: okay, now please tell us about those cards and why you chose them

Pippin: well, enjoys dancing: most people know that I *love* dancing

Barry: yeah, you're in dance [unclear]

Pippin: I used to be, but now I go to street dance classes

Interviewer: okay

Pippin: and contemporary

Molly: I quit because the teachers are really mean – I used to go

Interviewer: ah that's not very good is it?

Pippin: enjoys history: I *love* learning about history

Interviewer: oh yeah?

Pippin: most –

Barry: because Horrible Histories

Pippin: yeah – mostly I like learning about the Victorians and the Tudors

Interviewer: okay

Pippin: they're really interesting. And there's artistic – I *love* art. Every day

Barry: you go to Clwb Celf [art]

Pippin: yeah I used to go to Clwb Celf

Stanley: and she does sewing club

Pippin: yeah I do sewing club and I do – what's it called? I *love* fashion, so I'm always designing clothing, stuff like that

Interviewer: okay

Pippin: work in a team: me and [Molly] – we really want to make a shop for fashion

Interviewer: oh cool okay

Pippin: and then there's can work in a team: I work better in a team

Interviewer: yeah?

Barry: I don't

Pippin: than alone

Molly: that's why we're doing the thing together

Pippin: and then: gets all the answers right

Stanley: that's just silly

Pippin: I like to think of myself as a bit of a perfectionist

Stanley: yeah my sister always gets them right for some reason

Pippin: I like to have *everything* right

Interviewer: so you like to get things right – do you think that you do get things right?

Pippin: yes

Stanley: not most of the things

Pippin: almost everything

Barry: 50:50

Interviewer: okay, [Stanley] did you want any of those cards?

Stanley: yes, enjoys history

Interviewer: okay, pass it over. Do you have anything else that you'd like to say about your cards [Pippin]?

Pippin: no I do not

Interviewer: okay well thank you for telling us about them. [Molly], let's hear yours next? Which have you chosen and why have you chosen them?

Molly: I have chosen: sensible, hardworking –

[children laugh]

Molly: why are you all laughing?!

Interviewer: not very sensible to laugh at that is it?

Barry: I have no idea why I laughed

Interviewer: okay, so sensible

Molly: that's why I chose it, not you. Likes visiting other countries

Interviewer: yeah

Molly: organised

Interviewer: okay

Molly: what?? I organise my drawers very well thank you!

Pippin: yes, but in your room it looks like a bomb went off

Interviewer: okay – guys we all listened when [Pippin] was telling us hers, so we're going to listen to [Molly's] ones as well

Molly: there has been times when she came to my house

Interviewer: so organised, what was your last one?

Molly: clever

Interviewer: please tell us why you chose those cards

Molly: I chose sensible because

Barry: because you are

Molly: sometimes when all my friends are buying truckloads of sweets, I buy some salted popcorn and put a big carton with all my money, so then I don't have a sugar rush

Interviewer: okay

Barry: but sugar's important

Stanley: that's not very sensible is it? Getting a whole carton of popcorn??

Molly: when you're sharing with someone else

Stanley: well then they would have a mega sugar rush

Interviewer: can you think of any other examples where you're sensible?

Molly: because…

Barry: you don't break things?

Stanley: well, she does

Interviewer: did you say you don't break things?

Molly: yeah, I don't break things a lot

Barry: but you have

Molly: I have broken like one or two things, but I don't break a lot of things

Barry: in school as well

Molly: so can I go onto hardworking?

Interviewer: of course you can

Molly: hardworking: because when I was in year two I used to be a very big day dreamer

Interviewer: okay

Pippin: oh yeah!

[children agree]

Stanley: she was literally like this

Interviewer: okay

Pippin: and then [Teacher] would be like [Molly] have you finished because it's time for play and she'd be like [panic] "I haven't started!"

Interviewer: okay, tell us more about hardworking then [Molly]

Molly: then this year I thought well "I'm going to finish my work in the time I have like everyone else and not day dream". So I've done that

Barry: yeah you have

Molly: and I feel really proud of myself

Interviewer: do you? Brilliant, well done

Molly: okay, likes visiting other countries because so far I've been to about 11 countries

Interviewer: that's a lot of countries

Stanley: I've been to 50

Interviewer: what do you like about visiting other countries? What do you like about it?

Molly: I like to see all the culture they have there?

Interviewer: yeah

Molly: like in Rome, I haven't been there but I did go to Venice and I saw the opera house

Interviewer: oh lovely, okay

Molly: and I really like seeing landmarks and stuff

Interviewer: okay

Molly: I also really like swimming pools abroad

Interviewer: [laughs] swimming pools abroad are nice

Molly: organised: like I said I need to organise my clothes drawers

Interviewer: you like to organise your clothes?

Molly: yes

Interviewer: Okay

Molly: mainly because my mum told me to but "okay!"

Interviewer: okay, are you organised with anything outside of your clothes?

Molly: yes, because I do have a junk drawer and I do organise it every now and then, but I'm not organised on my desk

Interviewer: oh okay – on your school desk or your desk at home?

Molly: on my desk at home

Barry: I don't have a desk

Interviewer: there's just stuff everywhere is there?

Molly: yeah

[chatter about mess and desks]

Interviewer: are we listening to [Molly]? It's her turn

Molly: and then clever

Interviewer: yeah, tell us about that one

Molly: well I feel like I'm clever because when I was in Year 1 I was *really* dumb. Because we were doing a spelling test in year 2 and we had to do stuff like [welsh words] and put a reason and I did 'hi' which means her, and I did 'h' and then 'y'

Interviewer: yeah? Is this in welsh?

Molly: yeah

Interviewer: so can you tell us why you've chosen clever today?

Molly: because I get most of my spellings right and I can read really thick books

[children talk about thickest books they've read]

Interviewer: is there anything else that you want to tell us about your cards [Molly]?

Molly: no

Interviewer: no, okay thank you for sharing those with us. [Stanley] did you want any of those cards?

Stanley: yes

Molly: oh clever!

Stanley: likes visiting other countries

Barry: I wanted that one!

Interviewer: so you're going to borrow that one, and then we'll pass it on to [Stanley]

Barry: which other one? I am not sensible, I'm hardworking.

Interviewer: okay, please tell us about your cards then [Barry]

Barry: hardworking because in maths I concentrate off maths and sometimes I really do hardworking

Interviewer: uh huh are you hardworking at anything else?

Barry: science

Interviewer: science okay

Barry: because at maths, sometimes I get all of them right or one wrong in maths because I've been hard working

Interviewer: okay

Barry: science because I like to see what other stuff is out in the world you can make

Pippin: oh yeah, your mum

Interviewer: like what?

Barry: like [pause] I don't know. Because I know a water illusion

Interviewer: yeah

Barry: and that's in science, so I like it

Pippin: and he really likes science because his mum is a science teacher

Interviewer: yeah we talked about that before didn't we?

Barry: so that's why I enjoy science

Interviewer: because you like learning other things about the world?

Barry: yeah. I enjoy sport because I do a lot of sport in the weeks: I do rugby, I do football…

Stanley: do you do tennis?

Barry: no I used to

Interviewer: okay

Barry: but I do a lot of stuff sporty, and I do it in school. So I like sport

Interviewer: yep

Barry: I like visiting other countries, I've been to Spain, France, and Scotland

Interviewer: okay, and what did you like about visiting those other countries?

Barry: Spain because of the hot nice weather

Interviewer: yeah

Barry: France because – likes visiting other countries, you don't know other stuff

Interviewer: yeah?

Barry: about the countries, because in Spain I didn't like orange juice and they didn't make apple juice, which I liked. So my mum and dad was trying to make like orange juice, and I did so then I could drink orange juice in Spain instead of apple juice

Interviewer: okay, so being in another country encouraged you to try something different?

Stanley: in Spain, when I went to Spain: this guy is really strong, he just used his hands to open the orange up, he squeezed all the orange juice and then I tried some: it is delicious

Interviewer: yeah I bet it is! So what was your last word [Barry]? Or were you still talking about likes visiting other countries?

Barry: in Spain, I went – there was this orange machine, so you put oranges in, and you would turn this thing and it would make orange juice

Interviewer: okay

Barry: without the nuts and skin, and pips

Interviewer: have you talked about enjoys maths?

Barry: maths because I when I was in year 2 or 3 I was good at maths

Interviewer: okay

Barry: so then I want to carry it on, instead of just leaving it behind

Interviewer: okay

Barry: that's why I enjoy maths

Interviewer: what do you enjoy about it?

Barry: you can divide, add, takeaway – you can make odd numbers and it's a really big subject with lots and lots of numbers

Interviewer: uh huh

Barry: and one fact about it: there's no bigger number in the world, and so if there was no bigger number in the world, I could make any sums

Interviewer: ah okay

Barry: and I would like to do that

Interviewer: okay, so you like the idea that there's so much to do in one thing? That's interesting, thank you. Do you want to tell us anything else about your cards at all?

Barry: no

Interviewer: no? Brilliant, thank you. [Stanley] have you got your five now?

Stanley: yeah

Interviewer: so please tell which words you have and why you've chosen them

Stanley: creative, likes visiting other countries, enjoys sport, enjoys reading and enjoys history

Interviewer: okay, so why did you choose those cards?

Stanley: because I like all of them, especially visiting other countries

Interviewer: okay, what do you like about visiting other countries?

Stanley: because I've been to lots of countries and I've even lived in some of them

Child: he was born in [place outside the UK]

Interviewer: so what do you like about being in other countries?

Stanley: when I went to Scotland, I learned a lot of stuff about Scotland, even though it's 13 hours away

Barry: 13 *hours*?

Stanley: yeah, and when I was about two months old, I was living in [place outside the UK]

Barry: do you know any words in [Language of place outside the UK]?

Stanley: yes

Child: are you fluent?

Interviewer: so that's why you like visiting other countries?

Stanley: I've been to about 50 countries

Interviewer: that's a lot of countries – what was your next card then [Stanley]?

Stanley: creative!

Interviewer: tell us about that one, why did you choose that one?

Barry: because you *are* creative

Stanley: because I like Minecraft and Minecraft is really creative

Barry: there's a creative mode and everything

Stanley: and creative, I like building stuff

Interviewer: okay, what kind of stuff do you build?

Barry: hotels

Stanley: I build stuff out of Lego, and my grandad he helps me with building kites and…

Molly: can I ask you a question? What do you like building?

Interviewer: good question [Molly]

Stanley: building? The main thing is building shed – I like building sheds

Interviewer: you're building a shed?

Stanley: my grandad he sold about 15 of them

Interviewer: oh really? And you help him?

Stanley: yeah and I help him and he sells them, and because they're very hard and they could actually – some of them he put a kitchen in and he put wheels on the back and then you can put it on the back of a car or something

Interviewer: okay, so is there anything else about creative – about *you*?

Barry: I have a question: what's the least thing you want to build?

Stanley: I actually want to build a –

Barry: rocket

Stanley: no not a rocket, they're already invented – I want to make a floating something.

Interviewer: ah okay

Stanley: so put loads of fans underneath something and then – really powerful fans – then land on top of it, and it hovers

Interviewer: okay

Stanley: there could be anything on top of it

Interviewer: that is very creative – so what were your next words?

Stanley: Enjoys sport

Interviewer: yeah? Tell us about that one

[unclear]

Interviewer: what do you like about sport?

Stanley: keeps you fit and I just like it because whenever I have time to do something, I just play sport

Interviewer: okay

Stanley: and I go athletics club, and I just like running, I like doing long distance and in [place name] there's a track its 100m and I really like it. I like running around it

Interviewer: okay

Stanley: and we do it as a team, so first we do a race around it then we have ten minutes of plank then we do another one which is long distance, then we go round the track five times

Barry: so 500m

Interviewer: okay, so what was your next card then? So you enjoy sport and you do loads of different types of sport, and you like football. So what is it about enjoys reading, why did you choose that card?

Stanley: I just like reading and I like reading books which are like [unclear]

Interviewer: what's your favourite kind of book?

Stanley: probably Diary of the Wimpy kid and David Walliams

Interviewer: ah okay – what do you like about them?

Stanley: they're very funny and some people say the best books are Harry Potter but I don't think that

Interviewer: you disagree?

Stanley: because in my opinion, I don't really like Harry Potter

Interviewer: that's fine, you have your opinion

Child: me either!

Child: I'm *addicted* to it

Interviewer: okay did you want to say anything else about enjoys reading?

Stanley: yeah – I like reading stuff with my dad – he's very clever with reading, he helps me read

Interviewer: ah so you like reading with your dad?

Stanley: yeah and the longest book is 2000 pages

Interviewer: wow that is long

Barry: have you read it in one day?

Stanley: no, I'm nearly finished – I'm on page 905

Interviewer: so you'll get there soon! And what about enjoys history? Tell us about enjoys history

Stanley: I just like history because it's very interesting

Interviewer: yeah?

Stanley: and you can learn lots of stuff, and I looked up my family tree and one of my cousins – my great grandfather he's still living somewhere

Interviewer: really? Ah that's interesting to know isn't it?

Stanley: and he was born before WW1

Interviewer: oh wow okay

Barry: how's he still alive?

Stanley: because

Barry: some people can live over 100

Stanley: he's over 100

Barry: he's probably going to die today or tomorrow

Stanley: he's still alive

Interviewer: okay, so is that everything you wanted to tell us about those cards?

Stanley: yep

Interviewer: fab, thank you very much – can you pass those over to me?

[Interviewer outlines timing for next activity]

Interviewer: the last thing here, we've got three questions to think about – and on each one it says you can write or draw an explanation, but because we're a little bit short for time, can you write your explanation? Otherwise we might not have time to talk through all of our drawings. So is it okay if we write explanations for this one?

Children: yeah

Interviewer: okay, so the first question is 'have your thoughts or feelings about STEM changed during this project?'. and you can answer that question and then write an explanation for why your thoughts or feelings might have changed – if they have

[quiet as children work]

Interviewer: are you ready for the next question?

Pippin: how do you write creating?

[Interviewer spells out creating]

Interviewer: okay, if you finish your answer before everyone else, you can have a little draw if you want to. You don't have to sit there doing nothing. But you don't have to – that's fine

Molly: I really wish I was singing that song right now – I went to the Elton John thing

Interviewer: oh did you?

[pause in chat]

Pippin: what else did we do last session?

Interviewer: are we all done with question one?

Stanley: I'm nearly finished

Interviewer: okay, let me know when you're done.

[pause]

Interviewer: who's this [Barry]?

Barry: me

Interviewer: you? Nice. All good? Are we ready to go onto the next question everybody?

Children: yes

Interviewer: you can go back to your drawings if we've got time

Molly: might need a rubber though

Interviewer: so our next question is: 'which skills or personality traits do you have that would help you to use STEM in the future?'. So is there anything about yourself that you think would help you use STEM in the future?

Stanley: which things?

Interviewer: yeah, so which skills have you got? What traits are there? So you remember we said that being honest might be really useful?

Pippin: I tell you, if there's one person who's honest – it's not me

Interviewer: oh okay, you can put down a different skill that you think might be useful for STEM. And this is STEM in the future, so it doesn't have to be a job, it could be at school, at college…

Molly: I'm trying to remember how to write it

Interviewer: well if you need a hand with the spelling I can help you

Pippin: how do you write resourcefulness?

Interviewer: resourceful: [spells word]

Barry: how do you spell high school?

[Interviewer spells word]

Pippin: I've just forgotten what it means – sorry. I keep forgetting what things mean! And I've forgotten again. Oh I've completely forgotten what it means

Interviewer: which word?

Pippin: resourceful

Interviewer: okay, let's have a look

[children speak about being finished with the question]

Pippin: how do you write easy?

Interviewer: okay, so has everyone finished question two?

Children: yes

Interviewer: shall we go onto question three? On the back yeah! Do you think you'd like a job that uses STEM when you're older? And then again, you can write your explanation. So do you think you'd like a job that uses STEM when you're older? That doesn't have to be every part of STEM, it might just use a bit of STEM

Barry: like maths?

Interviewer: yeah, exactly

Molly: what if it's 'no'

Interviewer: you just write your opinion – that's what I want to know. Whatever your opinion is, that's right

[chat about apostrophes]

Interviewer: all done? You can keep drawing pictures if you want? Is that you? It's a good picture of your hair – I like it!

Stanley: it's when I was small

Pippin: when he was small his hair was like – it was huge!

Interviewer: okay, so once you've finished writing your answer for question three, you can go back and finish your drawings

[chatting about rubbers]

[school finishes and interview ends]

46 Appendix 34: Pupil task-based interview 3, SP

Title: Pupil interview 3

Date: 4th July 2019

Speakers: Poppy Hodkinson (interviewer), NJ, Skull Trooper, Blossom and Cupcake

Interview duration: 60 Minutes

Interview location: SP

Interviewer: Okay so we've got all of these words here, and today we're going to think about which five we think are the *most* important – so there might be loads that you think are important or useful, but today we're going to talk about the five that are the most important, in your opinion – if you work in STEM. But also the five that you think are the least important if you work in STEM? So if there's anything that you think "actually, you don't need that at *all*'

[pause while children consider cards]

Interviewer: so we're going to choose five overall together

NJ: take one each?

Interviewer: yeah you could maybe do that – do you want to talk about your first word [NJ]? Which one do you think might be the most important out of the ones you've got there?

NJ: listen to other people's opinions

Interviewer: uh huh – why might that be important if you worked in STEM?

NJ: because if you [pause] do maths, you might get a wrong calculation but then someone else might help you get it right

Interviewer: oh okay? Does anyone else think anything about that one? About listening to other people's opinions?

[pause]

Interviewer: no? Okay so which pile did you want that to go on? The most important or the least important?

NJ: most important

Interviewer: most important, okay. Can you start a most important pile for us please [NJ]? Have we got anything else that we think might be most important?

Skull Trooper: clever – you have to be clever because if you're an archaeologist and you're looking at all those bones, you have to be clever to figure out which bones are which

Interviewer: okay, does anyone else think anything else about clever?

[pause]

Interviewer: can you think of any other examples where you might need to be clever in STEM?

NJ: in maths

Cupcake: otherwise you'll just be crazy and you won't know what to do

NJ: in all of them, you've got to be clever in all of them

Interviewer: okay so why do you have to be clever to do them?

NJ: because you want to know what you're doing

Skull Trooper: you just want to know what you're doing

Interviewer: okay, so where would you like to put that one then?

NJ: important

Skull Trooper: important

Interviewer: okay, pass that over. Go on?

Blossom: I've got two [laugh]

Interviewer: okay, go on then [Blossom]

Blossom: likes to learn new things and can take a risk

Interviewer: okay, which do you think it the most important out of those two? Which one would you like to talk about? Likes to learn new things, okay can you tell us about that one?

Blossom: every time you learn something, you get smarter and smarter

Interviewer: okay

Blossom: when you don't learn new things you don't really learn anything

Interviewer: okay

[pause]

Interviewer: so why might that be really important in STEM?

[pause]

Interviewer: if you work in STEM, or if you're learning some STEM?

Blossom: maybe if you don't know what to do in STEM, you have to learn what to do and then you'll get it?

Interviewer: okay, yeah good suggestion – does anyone else have anything they want to say about that one?

Interviewer: which pile would you like to put it on [Blossom]?

Blossom: important

Interviewer: and what have you got there then [Cupcake]?

Cupcake: I've got two, I put one down because I didn't think it was important, but I don't know which one to talk about: enjoys science, enjoys maths

Interviewer: okay, so which one would you like to talk about? If you're not sure which is more important, which one would you like to talk about?

NJ: they can both go on because we need five

Cupcake: that's true

Skull Trooper: and I've got one

Interviewer: there might be some other ones – is there anything else in here that you think?

Cupcake: I'm going to go with enjoys science

Interviewer: okay, tell us about enjoys science [Cupcake]!

Cupcake: because – if you're working in STEM it's to do with science. And if you want to do the job, you have to like what you're doing

Interviewer: okay

Cupcake: you have to like what you're doing so

Interviewer: okay, has anyone got anything they'd like to say about enjoys science? Got anything to add to what [Cupcake] said?

Skull Trooper: mostly when you have STEM you might think you do science a lot because it's even in the STEM name: science. And with science, you might want to know some science facts just in case you're going on a risk

NJ: what do you think maths is? Science, technology, engineering, *maths*

Interviewer: so where would you like to put the science card? Over there on important as well

Skull Trooper: I've got one more

Interviewer: okay, [Skull Trooper's] got another one

Skull Trooper: can work in a team

Interviewer: can you tell us about that one please [Skull Trooper]?

Skull Trooper: because if you work in a team, you can figure stuff out easily. You don't want to just be too independent because if you are, people might want to learn from you, and you don't really say anything because you're too independent. And you might want to work as a team because if you're working in STEM there's a lot of people, so if you wanna help other people, they need to be in your team

Interviewer: okay – what were you going to say about that [Cupcake]?

Cupcake: you don't always have to work in a team, you can work by yourself – you don't just have to work in a team

Interviewer: okay, when might you choose to work by yourself?

Cupcake: maybe when you're looking at bones – you may not need a team, you may just look at them by yourself

Interviewer: okay – what do you think about that [Skull Trooper]?

Skull Trooper: I think that's a good thing

NJ: I think you need to enjoy history, because if you're an archaeologist, you need to be able to look at the bones, and the bones are history and then you know history

Cupcake: yeah, yeah

Interviewer: okay – what about someone who was a computer programmer?

Cupcake: no

NJ: they have teams

Interviewer: yeah oh so they would work in teams as well? Would they need to enjoy history?

Cupcake: yes

NJ: partly

Interviewer: why partly?

NJ: because the creators of the first phones and all that, they need to look at them. And get admired by them

Interviewer: ah so they might get inspiration from historical people? You want this one on the important one? What does everyone think about enjoys history?

Blossom: I think that's also important – but then it's… you know

Interviewer: okay so where shall we put that one then guys?

Blossom: it is a good one, but I don't know which one

Interviewer: okay well we'll leave it over there for now

Skull Trooper: I've got two

Interviewer: okay, well we'll listen to [Blossom]

Blossom: I've got four

Interviewer: S you've got *four*? Okay so which one do you want to talk about?

NJ: the bad one, we need bad – like ones that are not important

Blossom: okay I've got a bad one

Skull Trooper: yeah, I've got two bad ones

Interviewer: so the things that are not important? What's your one that's not important?

Blossom: likes playing computer games [laughs]

Skull Trooper: do you play Fortnite? Me and him [NJ] play Fortnite together

Interviewer: okay, what do you think about liking computer games?

Blossom: when you play computer games all the time, you won't really learn anything because then you're just playing computer games [laugh]

NJ: but what if you make a computer game

Skull Trooper: true

NJ: and you want to test it out

Blossom: but what if you've already played it?

NJ: what if you want to make it better? Improve it

Interviewer: like we were doing with our aqueducts?

Blossom: true

Interviewer: so is it that liking that computer games is bad – because someone said that it was bad – is it bad?

Children: no

Skull Trooper: no because people enjoy computer games – more than other stuff sometimes

Interviewer: so liking computer games, we don't think it's bad, but you thought that maybe it wouldn't be useful for STEM?

Blossom: no

Interviewer: but [NJ] had another point of view there – you thought it might be useful for STEM didn't you [NJ]?

NJ: yeah

Interviewer: how do you think it might be useful?

NJ: because if you want to make and game, and you want to check it works, you can go on it and then

Blossom: no, that's not really for STEM

NJ: yeah it is

Blossom: you don't really

NJ: yeah because technology

Cupcake: yeah technology

Blossom: true

Cupcake: this is about technology

Interviewer: okay, some interesting points about that guys

Cupcake: I feel like that should go in the middle

Blossom: yeah

Cupcake: of them both, I don't really know which one

Interviewer: would you be happy with that [NJ]?

NJ: yeah

Skull Trooper: I think working in a team can go in the middle as well

Interviewer: okay

Blossom: I've got two ones that are bad and stuff: enjoys dancing, gets all the answers right. I'm going to put this one down, so I'm gonna do enjoys dancing

Interviewer: okay, so what would you like to say about enjoys dancing?

Blossom: well because you don't dance when you're looking at bones –

Cupcake: I do!

Interviewer: [laugh] you might?

[Skull Trooper counts cards, has 6]

Blossom: and you don't need it in STEM. It's not important about it – it doesn't help you with STEM

NJ: I think that's the only not important one

Interviewer: you think dancing is the *only* not important one?

Skull Trooper: well I've got a not important one, for STEM at least – enjoys sports, because you don't to be sporty. You don't need to like sports just to be in STEM

Interviewer: okay

Skull Trooper: STEM is for lots of different stuff, but I don't think sports would be good for STEM because it's not really anything like science, technology, engineering or mathematical

Interviewer: okay, so if we put enjoys sport and enjoys dancing together? I've got a question about those two – so if you work in STEM, does mean that you can't like dancing or sport?

Children: no

Interviewer: okay, does anyone want to talk a little bit more about that?

Children: no

NJ: I think we've covered most things with that

Interviewer: yeah? Okay

Cupcake: those two, they could go in the middle – we don't *need* them STEM

Interviewer: okay

Cupcake: you can *enjoy* dancing, you know?

Interviewer: whereas the teamwork and the computer games you might want to do in STEM?

Cupcake: yeah

Skull Trooper: I would say most of these are for working in STEM

Cupcake: you don't need to get all the answers right

Interviewer: you don't need to get all the answers right do you? We'll come to you in a second L if that's okay? Does anyone have anything to say about getting the answers right?

Blossom: no, I've got one to say about the computer games though

Interviewer: what do you think about getting all the answers right [Cupcake]?

Cupcake: it's not about being the best and getting all the stuff right, it's about trying your hardest to get answers correct, but say if you get them wrong wrong next time you can –

Skull Trooper: work on it

Cupcake: yeah you can work on it

Interviewer: okay – does anyone else have anything else to say about that?

Children: no

Interviewer: which column would you like to put it in?

Cupcake: I think – I don't know

Skull Trooper: middle?

Blossom: middle

Interviewer: why the middle [Skull Trooper]?

Skull Trooper: I would say the middle because [pause] it's not 'yes' because you don't *have* to get the answers wrong – in the middle you just got the answers wrong by accident – or something

NJ: I sort of think the same

Interviewer: yeah? So if you get an answer wrong by accident - ?

Skull Trooper: it isn't really much of a deal

NJ: nobody's died

Interviewer: okay – so lets' have a look at what we've got here. So we need five in this column, how many have we got at the moment?

[child counts to six]

Interviewer: do we need to have a rethink then? Are there any that can come out of there?

Cupcake: yeah this one

NJ: no

Cupcake: this one

Blossom: creative

Interviewer: so you want to take creative off? Why was creative on there in the first place – I don't think we talked about that one – who put that one on there?

Children: not me

Interviewer: was that there by accident?

Children: probably

Interviewer: Okay, is there anything else then out of these words that you think is more important than anything in that first column?

NJ: no

Skull Trooper: wait, I've got something

Blossom: I've got something

Interviewer: [Skull Trooper] we said we'd talk about your one next – so which one do you think is more important than those five?

Skull Trooper: I think likes visiting other countries, because you might want – in Wales you'll know everything about the old stuff in Wales, and now you might want to visit other countries instead of just being in the same country all the time?

Interviewer: okay – what does everybody else think?

NJ: yeah

Cupcake: I don't think that's *important*

NJ: I think that can take off [pause]

Interviewer: you want to take off one of those two?

NJ: I think history

Interviewer: you think liking visiting other countries is more important than enjoying history?

NJ: because you'll end up learning history if you go to another country

Interviewer: okay – what do you guys reckon?

Cupcake: going to other countries, it's not super important in STEM, so I'd put it in the middle?

Blossom: middle – yeah

NJ: but you'll learn new things in those countries – and you'll learn the history of the country

Interviewer: so there's a lot of opportunity to learn new things if you do visit another country? Okay. What do we all think? Where shall we put that one?

Skull Trooper: I think middle

Interviewer: what do you guys think?

NJ: I think it's [history] in the least important

Interviewer: you think least [NJ]?

NJ: because if you go to other countries you'll end up just learning history so…

Interviewer: so move enjoys learning history because you're going to other countries?

NJ: yeah

Interviewer: so [Skull Trooper] you put that where you think it needs to go?

[chat about moving card]

Interviewer: and why did you think that one wasn't important [Cupcake]?

Cupcake: it's just because visiting other countries – I wouldn't say it's part of STEM

Blossom: yeah

Cupcake: it's more you like visiting other countries, but not *in* STEM

Skull Trooper: like for fun

Cupcake: yeah, so I would put it in the middle

Interviewer: okay, is there anything you think should be in that first column instead of likes visiting other countries?

Blossom: this one

Interviewer: go on then [Blossom], and [Cupcake] we'll talk about both of those as well

Blossom: like helping others

Interviewer: okay, [Blossom] – why do you think that's one of the most important things?

Blossom: [laugh] because I [unclear] all the time – you can help others

Interviewer: how might you help others if you worked in STEM?

NJ: give them an answer

Interviewer: giving some answers maybe yeah? Anything else?

Blossom: helping them work out things?

Interviewer: okay – what do you guys think about likes helping others?

Cupcake: I think it's important

Skull Trooper: I don't think it's that important – I think it should go in the middle – it's important if others want you to teach you stuff, sometimes you don't want to teach them stuff, but then mostly you do if some people don't want to teach other stuff what they know sometimes – it might be in the middle sometimes

Interviewer: okay, so you might not always want to help other people?

Skull Trooper: no, but you mostly would though

Blossom: it's nice to be helpful

Skull Trooper: yeah I know

Cupcake: I think that needs to go in the first column

Blossom: that's what I think

Interviewer: so we've moved visiting other countries to the middle, and we think helping others should go where?

Cupcake: in the first

NJ: I don't think we can move any more because we've moved [unclear]

Blossom: I've got something

Skull Trooper: I've got one more

Cupcake: I've got two more

Interviewer: okay, shall we listen to [Cupcake's] one – we need to think about what we want in the last column as well

NJ: can we just put all of these one?

Interviewer: everything else just goes on the last one? Go on [Cupcake], tell us about your one?

Cupcake: enjoys maths

Interviewer: what do you think about that one?

NJ: okay, that can swap with likes helping others

Cupcake: maths is in the STEM – you use it in your job, so [pause] if you want to enjoy your job, you need to enjoys maths, science, stuff about technology because that's the stuff that you using in your job

Interviewer: okay, what does everybody else think about that one?

NJ: yep it can swap with this one

Interviewer: so likes helping others has gone to the middle now? And we've got enjoys maths there

[child places all remaining on 'not important' – chat about whether we actually want that]

NJ: methodical's quite important

Skull Trooper: I've got three middle or important and then one

Interviewer: okay, well today we're thinking about really important, and not at all important

Skull Trooper: yeah that's what mine is

Interviewer: okay, so which one do you think is really really important?

Skull Trooper: wants to understand how things work

Interviewer: okay, tell us more about that one

Skull Trooper: I think it's that because if you're new to STEM, you need to know what things to do in STEM. Because if you don't know, you might want to ask someone to help you

Interviewer: okay, what does everyone else think about that?

Blossom: what if you already know how things work?

NJ: but then new STEM? How that works?

Interviewer: so where do we want that one to go?

Children: middle

NJ: the middle's the longest one

Skull Trooper: yeah the middle. I've got three more

Interviewer: have we got any that we think aren't important at all? Are there any left that we think need to go on not important?

Skull Trooper: yeah I've got two

Interviewer: okay, so which two do you think are not important at all [Skull Trooper]?

Skull Trooper: determined and competitive

Interviewer: okay, can you tell us about the first one of those please?

Skull Trooper: determined I don't think is really not important because when you're determined you're just really really really, really really annoying to other people

Interviewer: how could it be annoying to other people if you're determined? Why might it be annoying?

Skull Trooper: because you might always say "I'm determined to get there" and stuff like that

NJ: yeah that's right

Interviewer: so what does determined mean guys?

Cupcake: no, I think it would go in the first one – I think it should, because maybe you want to be determined to finish the challenge that you've been set

NJ: I think it will have to go middle because they're all really good

Cupcake: I've got one bad one and one good one

Skull Trooper: and I've got one more that I don't think is that important

Interviewer: okay, so we'll hear [Cupcake's] one and then we'll talk about your one. So which one do you think is not important [Cupcake]?

Cupcake: well I've got quite good in there as well: artistic and organised

Interviewer: okay, tell us about those

Cupcake: think I'm going to go with organised because in STEM, you need to be organised about what you're doing. If you're not organised you'll have bones everywhere – you won't know where your pencil is to write, you won't know where stuff is – it's gonna be everywhere, and it's gonna be very messy

Blossom: and you need to be tidy

Cupcake: yeah, you need to be all tidy and when you finish, you need to clean it all up so it's all nice and tidy

Blossom: nice and tidy tidy tidy!

Interviewer: so where do you think organised should go then?

Blossom: middle

Interviewer: so because I'm interested today in which ones are the most important, and which ones are the least important – are we happy that we've got the most important and the least important ones set?

Children: yes

Interviewer: don't move them just yet because I want to take a picture of them

Skull Trooper: I've got another not important one

Interviewer: oh okay, [Skull Trooper's] got a not important one for us to talk about – go on [Skull Trooper]

Skull Trooper: competitive

Interviewer: tell us about competitive

Skull Trooper: you don't want to be competitive to others because then, when you're in STEM you kind of want to work as a team

Interviewer: yeah?

Skull Trooper: if you're competitive, you're kind of bossing everyone around and no one wants to be bossed around

Interviewer: yeah

Skull Trooper: and when you're competitive you might think you're being just a normal person, but then other people are getting really sad that they're being bossed around – so I don't think it's really important

Interviewer: okay – what does everyone else think about competitive?

NJ: yeah it can go in the last

Interviewer: do you agree with what [Skull Trooper] said?

Children: yes

Interviewer: that being competitive can make you –

Cupcake: sad

Interviewer: and can make other people sad was it?

Skull Trooper: yes

Cupcake: I've got another one

Interviewer: is yours not important?

Cupcake: yes

Interviewer: go on then

Cupcake: artistic

Interviewer: tell us about that

Cupcake: because in STEM, you don't always need to be artistic – it's not about drawing and stuff like that, it's about working hard and solving challenges and finding bones and stuff like that

NJ: engineering – you need an architect to engineer, to see what you're gonna build

Interviewer: might an engineer need to be artistic do you think?

NJ: no – I think we've covered

Interviewer: okay, are we happy with this?

[recording is paused]

Interviewer: so we've done our first activity, there are two more activities now

Blossom: really?

Interviewer: yeah

Cupcake: are we doing them now as well?

Interviewer: is that okay? Is that alright with everyone?

Children: yeah

Interviewer: so what we're going to do now, is we're going to pick the five words that you think most describe yourself out of these. And remember that you can share the words

[chat about sharing words]

Cupcake: clever?

Blossom: yes we need clever

Interviewer: you don't have to share them, you can have your own words as well

Skull Trooper: yeah we know, just me and [NJ] like the same thing. Me and [NJ] both play Fortnite together, so that's why

[chat about how Blossom and Cupcake will also share their words]

Cupcake: the two boys are sharing and the two girls

Blossom: enjoys sports?

Cupcake: yes

Blossom: yeah, we've got our five!

NJ: I enjoy sports

Interviewer: would you like to have it instead of one of those words?

NJ: hardworking – I can't focus

Interviewer: [Skull Trooper] are you going to keep hardworking?

Skull Trooper: no – I love sports as well

Interviewer: [Cupcake] and [Blossom] is there anything on here that maybe one of you identifies with that the other doesn't that you'd like instead?

Cupcake: likes helping others?

Blossom: we both like it

Interviewer: you both want that one?

Cupcake: shall we swap it for this one?

Blossom: yeah

Interviewer: so you're keeping enjoys sport and likes helping others, but you're getting rid of clever? Am I okay to put all these other words away now? Okay fab, so who would like to tell us about their words first?

Blossom: can use computers, creative, enjoys sport, enjoys dancing, likes helping others

Interviewer: okay, can you please tell me why *you* chose those words?

Blossom: because I really want to know how to use computers because I'm not really that good

Interviewer: okay – why do you think you're not really that good?

Blossom: because I don't really know how to do things on computers

Cupcake: yeah, it's hard

Interviewer: things like what?

Cupcake: maybe like logging into stuff, logging into Hwb and stuff like that

Blossom: because it gets quite hard when the password doesn't work

Cupcake: yeah that's annoying

Blossom: and then you try like ten times and you realise it's the wrong one?

Cupcake: yeah

Interviewer: so this one says can use computers – so you guys just said that sometime you find computers a bit hard, but do you think you also can use computers?

Cupcake: yeah

Skull Trooper: can we swap it me and [NJ]?

Interviewer: so you're swapping out likes to learn new things for can use computers?

Skull Trooper: I'm really good at computers, everyone in my class comes to me

Blossom: the next one is creative

Interviewer: okay [Blossom]

Blossom: so I like to – I can't really, I forgot how to say it

Interviewer: that's okay, do you want to come back to creative?

Blossom: yeah. Enjoys dancing [laugh]

Interviewer: why have you chosen enjoys dancing?

Blossom: because every day I always do dancing

Cupcake: always do dancing

Blossom: even in school, because in school - dancing

NJ: yeah I went to see them dancing

Interviewer: what kind of dancing do you do?

Cupcake: I like street – I do street

Interviewer: What kind of dancing do you like [Blossom]?

Blossom: tap dancing and street dancing

NJ: I used to dance for Cardiff

Skull Trooper: I use to do break dancing

Interviewer: so you guys all like dancing?

Blossom: I used to go to tap dancing when I was six, but it's shut down

Interviewer: oh okay – do you want to say anything more about enjoys dancing [Blossom]?

[Blossom indicates no]

Interviewer: okay, do you want to move onto your next one?

Blossom: like helping others

Interviewer: okay, tell us more about that one

Blossom: [laugh and pause]

Interviewer: do you want to have a think about that one and come back to it? Are you ready to talk about creative?

Blossom: yep

Interviewer: tell us more about creative then

Blossom: because I like to be creative

Interviewer: what kind of things do you like to create?

Blossom: how things work and everything

Interviewer: what kind of things?

Blossom: [pause] how things work

Cupcake: like the aqueduct sort of thing?

Blossom: yeah things like that

Interviewer: did you think that was creative?

Children: yes

Interviewer: you guys think it was? Okay, do you have anything else you want to say about that one [Blossom]?

Blossom: no

Interviewer: okay, tell us about likes helping others? Are you ready? We can talk about a different one instead? We can talk about sports instead

Blossom: so I like helping others because I like to be kind. Other people always help me with my work when I'm stuck so

Interviewer: that's nice of them

Blossom: that's all

Interviewer: okay – did you want to tell us about enjoys sports?

Blossom: I don't really have much to say because I just really like sports

Interviewer: okay, what kind of sports do you like?

Blossom: running – is gymnastics sport?

Children: yes!

NJ: so is dancing

Interviewer: yeah – you like gymnastics?

Skull Trooper: I wouldn't really say dancing is sport, but I know it is

NJ: because you move about

Interviewer: so is there anything else you want to say about those [Blossom]?

Blossom: no

Interviewer: okay, lovely – thank you very much for sharing them. R can you tell us why you chose those words please?

Cupcake: so I chose use computers because I can use them, but sometimes I struggle to use them, but then it's really fun to use them

Interviewer: what do you find fun on computers?

Cupcake: I like using Hwb – making graphs on google classroom. I like to make iMovie's – yeah

Interviewer: okay

Cupcake: next I'm going to do enjoy sport: I like sport – I like running

Interviewer: do you do distance running?

Cupcake: sometimes I run with my mum

Interviewer: yeah? Okay are there any other bits of sport that you like?

Cupcake: I like gymnastics and dancing [pause] what else do I like? I like skipping

Interviewer: oh okay

Cupcake: yeah, I like those and the next: creative. I like to be creative with – can you be creative with dancing? You create new –

Blossom: you create new moves?

Cupcake: yeah, I like to create –

Interviewer: yeah!

Cupcake: a solo because I do a solo in the dance competition

Interviewer: fab, okay so you like to be creative in dance yeah?

Cupcake: and I like dancing – I love dancing. I think it was about three months ago I joined my friend's dance school called popstars and it's just street dance – I think [Blossom's] – I really like learning new moves. We do a competition every month so it's really fun to do competitions because I never really get to do them apart from in dance

Interviewer: okay, do you like to win your competitions?

Cupcake: yeah, I got through to the semi-finals with one of my solos

Blossom: really?

Cupcake: yeah

Interviewer: excellent!

Cupcake: and then likes helping others – I like to help [Blossom] and lots of people on her table help because they get stuck sometimes. And I also have to help some of my friends

Blossom: yeah

Interviewer: okay

Cupcake: yeah so I like doing that – and that's all

Interviewer: is that everything?

Cupcake: yeah

Interviewer: brilliant, thank you very much. Okay guys, who would like to talk first?

NJ: me

Interviewer: go on then [NJ], what would you like to talk about first?

NJ: I enjoy maths because I like my maths lessons at school

Interviewer: okay, what do you like about your maths lessons?

NJ: I just like them [pause] I just like doing maths

Interviewer: okay, how do you feel when you're doing maths?

NJ: happy

Interviewer: okay – is there any bit of maths that you like best?

NJ: division

Interviewer: division okay

NJ: I like computer games because I've made a few

Interviewer: wow, that's very cool – how do you make a computer game?

NJ: I code them and then my dad just checks that I've coded them right and then he does the rest

Interviewer: ah and then you can play them?

[NJ indicates yes]

Interviewer: awesome – have you ever played any of his games [Skull Trooper]?

Skull Trooper: no

NJ: not many people know I can do it

Interviewer: oh really? Is it a bit of a secret?

NJ: uh huh. I can use computers because I can code

Interviewer: yep, is there anything you code apart from games?

NJ: I've coded a computer

Interviewer: yeah?

NJ: it's called a Kano – you get this thing and you have to code it, and then you can make your own – like Minecraft and YouTube on it

Interviewer: oh that's cool, so you can use computers because you can code

NJ: I like listening to other people's opinions so I can get lots of sides of stuff and then I can see which one's the best one

Interviewer: okay

NJ: I enjoy sports because I play rugby, football and tennis, and I do swimming three times a week, and I did a running competition for our school and we came fourth in the relay

[teacher speaks to children]

Interviewer: so you were in your running competition – did you say you came fourth?

NJ: in the relay

Interviewer: well done! Is there anything else that you wanted to tell us about those words?

NJ: no

Interviewer: okay, thank you [NJ]. [Skull Trooper]?

Skull Trooper: I enjoy maths because when I – I'm very good at it and my favourite thing to do in maths is probably – for the best I am

[other children find a science book in the library, interviewer asks them to listen to Skull Trooper]

Skull Trooper: my favourite thing is adding because I'm best at adding – I mean the best at adding out of all my maths – taking away and stuff I'm the best at that

Interviewer: okay

Skull Trooper: when I do my maths in school I feel very happy and my friends struggle a little and they always ask me what to do for some reason – so I just help them

Interviewer: that's good of you

Skull Trooper: I like computer games because you can play with your friends on Fortnite and stuff, and I think it's a little good for your learning kind of. Because you could learn how to code stuff like [NJ] said, and if you learn about them now, if you have them when you're older you won't struggle?

Interviewer: okay?

Skull Trooper: A little bit, when you're older you won't struggle

Interviewer: okay

Skull Trooper: I can use computers because I can

NJ: you just can!

Skull Trooper: yeah – I like computer games, I can use them

Interviewer: do you use computers for anything other than games?

Skull Trooper: yes – I use them for some homework sometimes and I have a little – quite rubbish – phone to text my friends

Interviewer: okay

Skull Trooper: and then I like listening to other people's opinions on how they think – I like listening to other people's opinions because sometimes people have a different opinions to me and I would like to hear what they say

Interviewer: yeah? Okay

Skull Trooper: about how much they like English or how much they like school. I enjoy sports because I play rugby with [NJ] and I used to do a swimming class, but now I just go regularly. [pause] I try to go every week on my rugby, but then sometimes I really hurt myself. When I broke my arm

Interviewer: you broke your arm playing rugby?

Skull Trooper: no not playing rugby

Interviewer: oh, you broke your arm and then you couldn't play rugby?

Skull Trooper: yeah, I broke it three times

Interviewer: oh no! not in the same place I hope!

Skull Trooper: not in the same place but same arm – this arm

Interviewer: okay, well you have to be dead careful with that then – [NJ] be careful sitting next to him! [NJ is on side of broken arm]. Do anyone else have anything about their words that they'd like to say?

NJ: no

Interviewer: are you ready for the next activity?

Child: yeah!

Blossom: is this the last one?

Interviewer: the last one yeah, is that okay?

Skull Trooper: is this to do with the pencils?

Interviewer: this is why we've got the pencils – yes absolutely. Okay, so this one is a thinking and a writing – and if you'd like to – also a drawing task

Children: yes!!

NJ: and don't go in too much detail because then we'll be gone for four hours

Cupcake: we can be creative!

Interviewer: yeah we can't be gone for four hours, no. Okay so let's read through the first question together and then we can have a go at answering it – so who would like to read out the first question? Go on [Cupcake]

Cupcake: have your thoughts or feelings about STEM changed during this project? yes

Interviewer: okay – so you have a little space there and it says 'write or draw an explanation for this below'. So since I've been coming in and doing all the workshops with you, and we've been having these chats in the library, have your thoughts or feelings – has the way you think about STEM – changed at all?

Children: yes

Interviewer: okay

Skull Trooper: I don't know

Interviewer: it doesn't have to have – it might not have, but if you just put down whether it's changed and then you can either write or draw an explanation

Cupcake: you can't draw with a pen

Blossom: yeah I can

Interviewer: it's okay for this

Blossom: what are you drawing?

Interviewer: if you're drawing your explanation, then will you explain it to me as your drawing it?

Cupcake: okay, so what are you drawing?

Interviewer: you can write an explanation if you don't want to draw [Skull Trooper], that's fine

Blossom: I'm going to draw a person who's using STEM

Skull Trooper: I'm going to draw a person using a computer and they've got a desk and a bone

Interviewer: okay

Blossom: I don't know what to draw

Interviewer: and [Cupcake] you're drawing a person doing what?

Cupcake: using STEM

Interviewer: okay

Skull Trooper: I'm quite good at 3D drawing

Blossom: I don't know what to draw

Interviewer: have your thoughts or feelings changed about STEM: well you don't have to draw something, you could write something about instead – write a little sentence about it?

[pause while children work]

Blossom: I'm gonna draw a person

Interviewer: is that us [NJ]?

[NJ indicates yes]

[Children chat about P.E.]

Interviewer: if you've finished your drawing could you please explain what you've drawn?

NJ: I've drawn a picture of us on the table because I've started to think about, and understand a bit more

Interviewer: okay, and what do you think you've understood more about STEM? Is there an example?

NJ: the reason that you would use science or technology or engineering and maths

Interviewer: okay – thank you, is there anything else you wanted to say about your drawing?

[NJ indicates no]

Interviewer: fab, thanks for sharing. Are you done [Skull Trooper]?

Skull Trooper: yeah

Interviewer: could you tell us about your drawing please?

Skull Trooper: my drawing is when we were looking at those bones in 2018

Interviewer: yeah?

Skull Trooper: we were looking at those bones and I draw a picture of a person on a computer and a bone in her hand – in his hand. And they're trying to figure out what bone is the animal from

Interviewer: okay – and how does that show how your thoughts have changed? Or if your thoughts have changed?

Skull Trooper: I think it had because, usually I wouldn't really think of people searching up bones that much – because I don't really think about bones, but I like old shark teeth. Like this

Interviewer: oh cool! Very nice

Skull Trooper: I went to a volcano as well the week before last because I was on holiday in Greece – I went to [Greek island]

Interviewer: lovely!

Skull Trooper: with the volcano, and one was smoking and one was actually boiling, and I wore sandals

Interviewer: I bet your feet were hot! So you think that your thoughts about STEM have changed, because before you didn't know that people looked at bones –

Skull Trooper: at bones that much – as much as people do

Interviewer: okay – but now you do know that?

Skull Trooper: yeah

Interviewer: okay, brilliant thank you

NJ: can we do the second one?

Interviewer: yeah sure – do you guys want to crack on with the second question?

[child reads Q2]

Interviewer: so is there anything about yourself – do you have anything that you're interested in, is there anything that you're good at – that would help you do STEM in the future?

NJ: I'm just gonna draw a computer

Interviewer: are you two done with your drawings?

Children: nearly

Interviewer: when you're done, you can tell me about them? Please

Skull Trooper: I've got a good idea

Cupcake: I'm nearly done, I've just got to finish the grass

Girls: done!

Interviewer: okay, so go on then [Cupcake] – can you tell us about your drawing please? How have your thoughts or feelings changed about STEM during this project?

Cupcake: because I liked it because you've used maths. I liked it because we were looking at bones and we've never really done that before

Blossom: yeah we've never touched a bone before

Cupcake: I haven't

Interviewer: on inside of your body?

NJ: I've touched one

Skull Trooper: I've touched a lot, I've been in a museum a lot

Interviewer: very cool

Blossom: I've been in a museum

[school bell]

Interviewer: so we were listening to what [Cupcake] was thinking – how have your thoughts about it changed during the project?

Cupcake: it's been nice building, I liked building the aqueduct and looking at the bones and what animals they've come from

Interviewer: okay, and has that changed the way you think about STEM at all?

Cupcake: yes

Interviewer: how?

Cupcake: at the start, I didn't really –

Blossom: weren't interested in it you think?

Cupcake: yeah, when you started it I didn't really – was very interesting, and at the start before you came I didn't even know the word STEM even existed

Interviewer: yeah?

Cupcake: and now I know lots more about STEM, and it's made me think that maybe I wanna do STEM in my job when I'm older

Interviewer: maybe? Brilliant

Skull Trooper: wait is this our last session here?

Interviewer: yeah, because you guys are going into Year 5 then aren't you?

Cupcake: so you're not coming here?

Interviewer: well maybe

Skull Trooper: she's gonna come for the next year 4

Interviewer: maybe not even for Y4, it depends if [Teacher] will let me come back or not

Cupcake: done!

Skull Trooper: [Teacher] is going into Y3

Interviewer: is he? Well a different teacher maybe.

NJ: can me and [Skull Trooper] go back?

Skull Trooper: no because there's more

NJ: oh there's more?

Interviewer: do you want to do your last question?

Skull Trooper: look on the back

Interviewer: you don't have to do that last question if you don't want to – you can go back if you want to. [Blossom] can you tell us have your thoughts or feelings changed in this project?

NJ: I've haven't really got a picture I can draw for this

Interviewer: is there something you can write maybe?

NJ: maybe

Blossom: I've done a picture of somebody looking at STEM that they don't really know about – a coffee mug and a bone

Interviewer: okay, and can you tell us how your thoughts and feelings have changed about STEM?

NJ: [background] because I like computers

Blossom: well, I didn't really know STEM existed – I only thought about STEM like a –

[NJ goes back to PE lesson]

Blossom: I only thought STEM existed like a –

Skull Trooper: tree stem

Interviewer: like the stem of a leaf?

Blossom: yeah! And I didn't really think it would be science, technology, engineering and maths – I'm done now

Interviewer: so you guys are going to do the second question? [read Q2] So is there anything about you – anything you like, anything you're good at – that would help you do STEM in the future?

Cupcake: dancing!

Interviewer: would that help you do STEM in the future?

Child: no!

Interviewer: [Skull Trooper] has got an answer for that, so can you tell us your answer please [Skull Trooper]?

Skull Trooper: I have got a vet on a computer searching what to do with a cat

Interviewer: oh okay

Skull Trooper: because its leg is broken?

Interviewer: okay, what is it about you? Are you the vet in the picture?

Skull Trooper: yeah

Interviewer: and what is it about you that might make you good at being a vet?

Skull Trooper: because I really love animals, and I mostly go to the vet a lot because my cat is always a flea bag and then my dog sometimes gets bit by other dogs, and she's only got three legs

Interviewer: okay, and what is it about you that would make you good at being a vet? As well as seeing what the vets do a lot, is there anything about your personality that might make you good as a vet?

Skull Trooper: because I know how to use computers quite well, and vets have to use computers a lot

Interviewer: okay

[pause]

Interviewer: is there anything else in STEM that vets do at all?

Skull Trooper: [pause] science?

Interviewer: yeah

Skull Trooper: because they need to know the bones in animals bodies?

Interviewer: yeah! So do you think you have any skills that would help with that?

Skull Trooper: [pause] no, no more

Interviewer: okay, would you like to do the last question now then?

Skull Trooper: yeah

Interviewer: okay, so what is the last question?

Skull Trooper: [reads Q3]

[Cupcake chats about her drawing – drawing the nose and plaits of a person]

Blossom: I forgot [unclear]

Skull Trooper: I'm done

Interviewer: so you'd like to be a vet when you're older?

Skull Trooper: yeah

[Skull Trooper leaves, interviewer thanks him]

Interviewer: are you ready to talk about your drawings yet you two?

Blossom: done

Interviewer: tell us about your drawing [Blossom]

Blossom: I think I'm really good at maths – I don't think I'm that good because I – so I've done this. In maths I think I do higher than my group because in my group there's different to me and I don't really know why, so I just do maths

Interviewer: okay, you think you're good at maths – how do you think that would help you with STEM in the future?

Blossom: because the word STEM has got maths in it, with a 'm', and I think it would be really good

Interviewer: okay, fab is there anything else you want to say?

Blossom: nope

Interviewer: okay, lovely. Tell us about your one [Cupcake]?

Cupcake: so I kind of want to be a nurse or something

Blossom: I want to be a nurse

Cupcake: do you?

Interviewer: so you both want to be a nurse? What is it about you, that might make you good at being a nurse?

Blossom: because you're smart [laugh]

Cupcake: because – my sister has type 1 diabetes so she has to manage stuff, my family had to go through lots of tests about what to do with it. So I think I'd be quite good to help people

Blossom: to help your sister?

Cupcake: yeah – to do stuff to do with diabetes in a hospital?

Interviewer: oh okay

Cupcake: like that

Interviewer: so what's this picture of down here?

Cupcake: so this is a person who's ill

Interviewer: okay

Cupcake: and this is me as a doctor

Interviewer: that's you being the doctor?

Cupcake: yeah with the piggy nose

Interviewer: the piggy nose was an accident?

Cupcake: yeah

Interviewer: okay, thanks for telling us about that. Shall we do the last question?

Cupcake: yeah

Interviewer: so the last question is – [Cupcake] you can read that one out

[Cupcake reads question 3]

Blossom: I don't think that could be a picture or anything

Cupcake: maybe

Blossom: maybe, that's what I put on my sheet of paper

Cupcake: I said 'maybe'

Interviewer: okay, so you can put maybe on there then

Cupcake: I'm going to put a picture of somebody going 'hmm?'

Interviewer: someone who's thinking?

[pause while children work – girls chat about their drawing technique]

Blossom: I don't know how to do a maybe face

Cupcake: do it so it's straight

Blossom: nearly done I think

Cupcake: this is the worst drawing I've ever done

Interviewer: that's okay, if you explain it to me

Cupcake: so he has a straight face – like that – because he's thinking "do I wanna-"

Interviewer: he? Who is this person?

Cupcake: she! It's me

Interviewer: it's you?

Cupcake: thinking 'should I do it or no? should I not?'

Interviewer: which job do you think you might want to do if you did?

Cupcake: maybe a hospital – a reception area, maybe in a hotel working with computers?

Interviewer: yeah

Cupcake: because I quite like checking people into their rooms and stuff like that

Interviewer: okay – what about the things that you were talking about here? Who was this person?

Cupcake: ah that was me!

Interviewer: and what are you doing in that picture?

Cupcake: helping people

Interviewer: yeah

Cupcake: it depends which one

Interviewer: and why are you helping people in that picture?

Cupcake: I like helping people – say if somebody's ill, say if somebody got knocked over by a car and they're lying down on the pavement and all the cars have stopped – don't just look at them then walk off, you need to help them because they've been hurt

Interviewer: okay, and what was your job in that picture?

Cupcake: to make sure that they're okay and to check if any parts of them are hurt, just until the proper nurse has come

Interviewer: so were *you* a nurse in this picture?

Cupcake: yeah

Interviewer: you were? So being a nurse, that's a job in STEM

Cupcake: is it?

Interviewer: so sometimes when people write out STEM – you know how when we write it, it only has one 'm'?

Cupcake: yeah

Interviewer: sometimes people write it with two 'm's and the second one stands for medicine – which is what nurses do

Cupcake: oh!

Interviewer: does that help you answer this question at all?

Cupcake: wait so it goes [draws out STEMM]

Interviewer: yep

Cupcake: science, technology, engineering, maths

Interviewer: and then the second M stands for medicine

Cupcake: really?

Interviewer: yeah, does that help you think about this question a bit more?

Cupcake: yeah, but then I do have another ambitions – not to do with STEM, like dancing, so it depends

Interviewer: it depends? Okay. What do you think would change your mind either way? What would be the thing that would make you make up your mind?

Cupcake: well maybe if we did more stuff in school to do with STEM, that may help me change my mind about doing that. But it depends

Interviewer: okay

Cupcake: because I may get better in dance, then maybe I want to be a dancer when I'm older. It just depends

Interviewer: fair enough – how old are you guys now?

Cupcake: 9 nearly 10

Interviewer: well you've got a lot of time to decide haven't you?

Cupcake: yeah

Interviewer: there's lots of things that could change

Blossom: I'm 8

Interviewer: okay, are you ready to tell us about your picture [Blossom]?

Blossom: yeah, I tried to decorate the floor and do the light and everything

Interviewer: excellent, so what can you tell us about your answer?

Blossom: I done maybe and [Cupcake] told me to do a straight line so I did [pause]

Interviewer: why maybe?

Blossom: because I don't really know what I wanna be when I'm older, and what I'm gonna be so I put maybe because it could be a no or a yes

Interviewer: okay, so you're just not sure yet?

Blossom: no

Interviewer: okay, do you think that you might like to do something that was related to STEM when you're older?

Blossom: yeah

Interviewer: any ideas what kind of thing related to STEM?

Blossom: I really wanna be a nurse

Interviewer: you'd like to be a nurse as well? So nursing is part of STEM

Blossom: because my aunty and my nan is a nurse

Interviewer: okay – thank you very much guys is there anything else you wanted to say before we go?

Children: no

[interview ends]

47 Appendix 35: Pupil task-based interview 3, NB

Title: Pupil interview 3

Date: 8th July 2019

Speakers: Poppy Hodkinson (interviewer), Jelly, Apple, Pepperoni and Cleo

Interview duration: 43 Minutes

Interview location: NB

Interviewer: so we are thinking about – firstly: what does STEM stand for?

Children: science, technology, engineering, mathematics

Interviewer: thank you guys, so do you remember last time we met together? What did we talk about?

Apple: emotions wasn't it?

Interviewer: kind of yeah? Kind of about our emotions

Cleo: who we know works for STEM

Interviewer: absolutely yeah, so people we know in our lives who work for STEM – so you talked about all your family members and your friends who did – and I spoke about some of my friends. And today we're going to be thinking again about which of these things – so which parts of their personality, or maybe their emotions like you said M – which of these things would be useful for them in their STEM job. So we're going to choose the five that we think are the most important – as a team, and we're going to choose the five that we think are the least important. Okay? So if you'd like to have a look at the words, and we've got the glossary as well here

Cleo: I think these are definitely good: wants to understand how things work

Apple: wait, was it each?

Interviewer: just as a group

Cleo: likes to learn new things

Apple: I'm this one!

Interviewer: which one's that [Apple]?

Apple: can use computers

Interviewer: okay

Jelly: I think you'd also need to be very practical

Interviewer: practical okay, and which one did you pick [Pepperoni]?

Pepperoni: loves sports because I love sport

Interviewer: okay, is that the most important for someone who works in STEM?

Pepperoni: yeah

Interviewer: yeah okay

Pepperoni: well for me it is

Interviewer: for you it is? So at the moment we're thinking about just *anyone* who works in STEM

Pepperoni: oh, I work in STEM

Interviewer: yeah okay

Jelly: listens to other people's opinion, that's good but I don't think it's the very *most* important

Pepperoni: I think this is the *most* important

Interviewer: how many have we got so far?

Apple: four

Interviewer: shall we talk about those words and see if there are any that we want to add to it. So which words did you pick out [Cleo]?

Cleo: I picked out likes to learn new things, and wants to understand how things work

Interviewer: okay, so can you please tell me why you chose those words?

Cleo: I chose likes to learn new things because to get further in life you need to learn new things and it would be boring if you just knew everything

Interviewer: okay

Cleo: and it would help you as a career in STEM

Interviewer: how would it help you?

Cleo: so if you learn new things, you become smarter and if you made a mistake and you learn from it, it would help you move on

Interviewer: okay, does anyone else have anything to say about that one? Go on [Pepperoni]

Pepperoni: yeah, but I kind of disagree with her

Interviewer: okay, why do you disagree?

Pepperoni: it's because they teach you to learn everything, so –

Jelly: not everything

Cleo: you need to learn from stuff

Pepperoni: no, they want you learn something – learn everything

Interviewer: who's they?

Pepperoni: us – don't know, someone

Interviewer: someone?

Pepperoni: a person

Interviewer: okay

Pepperoni: a person

Interviewer: so do you think it's important or not important to learn new things?

Pepperoni: I think it's important and I don't know why – a little bit

Interviewer: you think it's a little bit important?

Pepperoni: yeah

Jelly: it's very important to learn new things because if you never learnt anything, you'd just be dumb as a rat

Interviewer: okay. I think rats are quite clever to be fair

Jelly: yeah they are! I don't know why I used that word

Pepperoni: but

Apple: dumbs as a bat because bats are colour blind

Jelly: dumb as a brick

Interviewer: okay – so learning new things, what does that do for you?

Cleo: it makes your brain bigger

Interviewer: it makes your brain bigger was that [Cleo]? Is that what you said?

Pepperoni: it doesn't do anything to me because

[children speak over each other, Interviewer asks to take turns]

Pepperoni: I've for gotten what I was saying now

Interviewer: have you remembered?

Pepperoni: yes! Actually no, let [Jelly] go first

Jelly: it doesn't matter how big the brain is to know if you're smart, it's how sophisticated your brain is

Interviewer: true, it doesn't matter how big your brain is

Jelly: an ant has a very small brain, not even a centimetre big, but it's one of the most intelligent animals on the planet

Interviewer: okay, so it's not to do with size it's to do with what you –

Apple: know

Pepperoni: I know now

Interviewer: or how you use your brain? Go on [Pepperoni]

Pepperoni: even though people don't teach me anything, I still learn by myself

Interviewer: okay – and how do you learn by yourself?

Pepperoni: I just – my dad never taught me sewing and I just done it at school

Interviewer: okay – what were you going to say [Cleo]?

Cleo: how would you learn how to speak if no one was speaking to you? You wouldn't even know what speaking was

Interviewer: that's true

Jelly: that's like what I had to go through, because it took me three hours to learn how to say duck – because I had that bad of eyesight

Interviewer: ah okay

Jelly: and one of the main reasons why we speak is how our lips move, so I wasn't able to see how my mum or my dad's lips moved, so I had to get glasses when I was about three months old

Interviewer: oh okay

Jelly: I can't remember the last time I haven't had glasses

Interviewer: yeah, same! [laugh] My little sisters had to have glasses when they were really young as well

Pepperoni: I might have to have glasses, don't know why

Interviewer: ah that's okay

Pepperoni: I don't want them

Interviewer: oh glasses are fine

Jelly: once you get used to them, they don't irritate your nose as much

Interviewer: yeah, they're pretty good. So are we all happy that wants to learn new things is an important thing? Do we all agree?

Jelly: yes

Pepperoni: yeah

Interviewer: what do you think about it [Apple]?

Apple: I think that's a really good thing because what [Jelly] and [Cleo] said that if you don't know how to talk, you can't really do much

Interviewer: okay – so shall we start an important pile?

Jelly: you can communicate with people with sign language, I had to learn sign language when I was a baby

Interviewer: you can

Pepperoni: I didn't

[Jelly signs]

Interviewer: what does that mean?

Jelly: butterfly lion

Interviewer: ah okay

Jelly: that's one of my favourite books

Interviewer: that is a nice book isn't it? What was our second card? Can you remember [Cleo]?

Cleo: this one: wants to understand how things work

Interviewer: and why do you think that might be one of the most important things?

Cleo: because if you like to learn new things, one of the key points is if you're working in STEM is wants to understand how things work. Because for science you need to understand how the human body works

Interviewer: okay

Cleo: technology: you need to understand the technology itself, and also the engineering: for the engineering you need to understand the points of the type of engineering you're doing. And for maths you need to understand how to do equations

Interviewer: okay yeah – thank you [Cleo]

[other child speaks to Interviewer]

Interviewer: does anyone have anything else?

Pepperoni: oh yes! Enjoys sports!

Interviewer: is there anything that anyone still wants to say about understand how things work?

Pepperoni: yes

Interviewer: what do you want to say about that one?

Pepperoni: [pause] I don't really know

Jelly: I think it's very important because I want to know how the periodic table works, what the periodic table is, what the periodic table can be used for – what the things in the periodic table can make

Interviewer: yeah?

Jelly: what the things in the periodic table are

Interviewer: okay

Jelly: I'm obsessed with the periodic table now

Interviewer: I can tell! So where do we want to put this card? C thinks on the important one, what do you think [Apple]?

Apple: I think middle

Jelly: I'd say middle

Interviewer: why do you guys think it might be in the middle? Remember we're not doing the middle today, we're just doing most and least important

Jelly: okay, most

Pepperoni: least

[children repeat]

Interviewer: which one do you think [Pepperoni] and why?

Pepperoni: least because I can learn things without anyone

Interviewer: this is wants to understand how things work

Pepperoni: oh, I don't even understand what that means

Interviewer: okay, so does anyone else reckon that they could explain to [Pepperoni] what that means? Go on [Apple]

Apple: if you don't know how a thing works, you would want to know how that works

Pepperoni: I can work out that on my own

Interviewer: okay, but is that because you *want* to understand how that thing works or because someone's telling you to?

Pepperoni: because I want to

Interviewer: so this one is *wants* to understand how things work

Pepperoni: least

Interviewer: you think least important?

Pepperoni: least yeah

Children: most

Interviewer: you guys all think most?

Pepperoni: least!

Interviewer: it's three against one so we're going to put it on the most at the moment – and what was our next word [Pepperoni]? What did you want to talk about?

Pepperoni: sports!

Interviewer: okay, so enjoys sport – do you think it's the most or the least important for someone who works in STEM?

[children chant least and most]

Cleo: it might be the middle actually

Interviewer: okay, so we've got lots of opinions here. Can we hear what [Pepperoni] thinks first? So why do you think it's the most important?

Pepperoni: because it's fun

Interviewer: okay – anything else?

Pepperoni: [laughs] no

Jelly: I don't think enjoys sport is a good thing

[children talk over each other – Interviewer asks them not to]

Jelly: sorry!

Interviewer: thank you [Jelly]. so why do you think it's the most important [Pepperoni]?

Pepperoni: I think it's most important because it keeps you fit, I don't know

Interviewer: okay

Cleo: I think it's neither, because if you're bored at home and you weren't working, and if you wanted to do something you could experiment with sport. Because if you like sport you could check your heartrate in exercise and you could see before and after

Pepperoni: that's what I meant

Interviewer: yeah?

Cleo: so it's like, if you enjoy sport you could do stuff like more research about it using STEM

Interviewer: ah okay, so you could use STEM to explore sport more?

Pepperoni: that's what I meant

Cleo: but I don't think it's the most important

Interviewer: you don't think it's the most important? Okay [Apple], [Jelly] what do you guys think?

Jelly: I think least because if you were learning about science or engineering or mathematics, sport wouldn't really be involved in any of those things

Interviewer: okay

Jelly: yes it can tell you the heart rate and you can learn science about that, but in mathematics, when you're a scientist it wouldn't really help, it would distract you

Pepperoni: no it wouldn't

Interviewer: how would it distract you?

Jelly: because if you were just playing with a football, you could cause a whole station to explode. Because what if you hit a powerline and it causes it to malfunction and hit multiple things?

Pepperoni: I can't kick that high

Interviewer: okay, what did you think [Apple]?

Apple: I think least because you might be in the middle of a very important part of your job, but then you have a game to go to, and also like [Jelly] said, if you started playing sports in where you work, it could break something

Interviewer: okay – go on [Cleo] did you want to add something to that?

Cleo: I disagree with that because you wouldn't be playing sports in work, you could play it as a hobby, and also for mathematics you could measure the distance that you can go before needing a break, and different people – like sporty people and people who sit down a lot and read

Interviewer: so you could use maths skills in sports and you could use science skills in sports?

Cleo: yeah

Interviewer: okay – does that change anybody's mind at all?

Pepperoni: it's three against two

Interviewer: the fish sadly doesn't get a vote today [Pepperoni] – so what do we think then?

Apple: it's two against two

Interviewer: okay

Pepperoni: what side are you on?

Interviewer: what side am I on? I'm not on any side – I'm just interested in what you guys have to say

Jelly: I think it should be in most now

Interviewer: so we'll have it here – where we're not sure. I've heard all your opinions and I've recorded them all on here, so I'll remember. So what was our next word?

Jelly: I think it's practical

Apple: it was my one

Interviewer: what was your one?

Apple: can use computers

Interviewer: okay, tell us about can use computers

Apple: I thought it would be important because if you can use computers it would be helpful for DNA and things like that

Interviewer: what's d and a sorry? – oh DNA?

Apple: yeah

Interviewer: okay, I understand now

Apple: and you could see how much – you could examine something, so if you went out and found something, you could bring it back and see what is was or something like that

Interviewer: oh okay

Jelly: you use certain equipment for that

Interviewer: yeah – any ideas about what kind of equipment?

Jelly: I know what I'm thinking of, I just don't know what the name is

Interviewer: okay – and is that equipment related to using computers?

Jelly: yeah a bit because it is technology, it's similar to a computer

Apple: computers are tech and tech is part of the STEM

Interviewer: okay

Pepperoni: I don't even really know what we're talking about

Jelly: I'd say computers would be in most

Interviewer: you think can use computers is in most okay – what do you think [Apple]?

Apple: most

Interviewer: what do you think [Cleo]? you disagree?

Cleo: because if you put it in most, for example, it's like can use [pause] I was thinking of something

Interviewer: can you describe what you were thinking of if you can't think of the word?

Cleo: so can use computers – it would be like 'can use maths' it could be like that and if they weren't in there, I don't see why 'can use computers' should be

Interviewer: oh okay – so you don't think it's important because it's

Cleo: it could be other things rather than…

Interviewer: so other things are more important than that one? Okay [Pepperoni] what do you think?

Pepperoni: yeah!

Interviewer: do you want to talk about why?

Pepperoni: because you can play games and calculate maths sometimes

Apple: wouldn't that be that one? [computer games card]

Interviewer: okay so where do we want to put can use computers guys?

Apple: important

Jelly: I'd say middle

Children: middle

Interviewer: okay, well we're not really doing a middle today but I'll put it there. So what were our other words for most important?

Jelly: we've got organised and practical

Interviewer: [Jelly's] going to do a word now [Pepperoni]

Interviewer: so which one would you like to talk about [Jelly]?

Jelly: organised

Apple: practical's funny isn't it?

Interviewer: we'll talk about that one in a second – practical: there's a couple of things that practical can mean, like funny –

Jelly: can we talk about organised?

Interviewer: we'll talk about organised – so practical: like a practical joker might mean that they're a bit silly, but practical in this sense is one that we're going to read off the glossary here. So practical means

Apple: good with their hands, good at doing tasks like experiments or making something

Interviewer: so in this context, practical means that you really like being hands on and seeing how things fit together

Pepperoni: and you practice a lot

Interviewer: yeah, and you can practice as well, okay so let's talk about organised O. Do you think it's most or least important?

Jelly: I'd say it's most because if your desk was just 'blib blob blib', you'd find it very hard to find something, say if you were trying to find a very special piece of equipment and you find out it's snapped in half, I don't think that would be much help

Interviewer: okay, so what does everybody else think?

Pepperoni: I agree

Apple: I've got a toybox at home that everything's just chucked in

Interviewer: ah okay, so that's *not* organised

Apple: and I take something out that I want to play with and it will be broken or scratched

Pepperoni: my room isn't very organised to be honest

Interviewer: that's okay, so organised we want on most important?

[discussion about time management]

Interviewer: you'd like to talk about likes computer games? Go on [Pepperoni]. So what do you think about likes computer games?

Pepperoni: they're so fun and it keeps me happy all day, I love it

Interviewer: okay, so is liking computer games important or not important for somebody who works in STEM?

Apple: not important

Interviewer: someone who works in STEM, we'll do about you in a minute

Apple: I think it's important because if you like computer games it might help you with all the keyboard, keys and things like that

Interviewer: okay, so it might give you computer skills?

Apple: yeah

Interviewer: does anyone else think anything about that?

Jelly: yeah, but you'd have certain skills for playing computer games: yes you'd know where the keys are, but it would get you more distracted: when I get home "will I get a new high score?"

Cleo: yeah, you just daydream and you get distracted

Interviewer: okay, so computer games can distract you

Apple: it might help you type really fast as well

Jelly: computer games can be very distracting

Cleo: or you could get addicted to it and miss work

Jelly: you get *addicted* to it and play it on your work computer

Apple: but it might help you type faster because if you're in the middle of a thing and you've only got ten minutes to type down 200 words

Jelly: yeah but sometimes rushing isn't good

Pepperoni: I'm addicted [unclear]

Apple: you could type really fast at it

Interviewer: okay, so [Apple] you think that playing computer games can give you computer skills to help you use computers?

Jelly: yeah but rushing isn't good, because you could make a very big mistake

Interviewer: okay, well we're not talking about rushing, we're talking about liking computer games

Pepperoni: I'm addicted to computer games

Jelly: if you rush you might make a huge mistake and you might end up accidentally sending it to the government

Interviewer: you could, but we're not talking about rushing at the moment, we're talking about likes computer games. So where is the card – and what do you think about it [Cleo]?

Cleo: I don't think it's very important

Interviewer: and can you explain why?

Cleo: because if you like computer games, it's not really helpful for STEM. You could be using a computer, but what's it going to be helpful to your job? Because liking something and learning about stuff in that computer game, you might just forget about the stuff that you've learnt about in the past

Interviewer: okay, so which pile do you think it should go on [Cleo]?

Cleo: either least or middle

Interviewer: least or middle? What do you think?

Pepperoni: [pause] highest

Interviewer: you think most? [Jelly] what do you think?

Jelly: I think it would probably go in the least because it's not *that* important that you need to be worrying about it in your job

Interviewer: okay, and [Apple] what do you think about it?

Apple: I think it's either highest or middle

Interviewer: okay so how many thought most? Two and two, so we're going to pop it there. But remember we're doing most and least important, so we need two more words and we're going to talk about practical now. But maybe have a think about which other word needs to go on most important. And then we're going to think about some which are the least important, and then we need to move onto the next activity okay?

Pepperoni: yep

Interviewer: so [Jelly] tell us about practical

Jelly: I think you need to be very practical in science because you need to be very focused, hardworking, and you don't really want to dilly-dally

Interviewer: okay, so you kind of mean waste time? So practical means that you're good with your hands and you're good at working with your hands?

Jelly: yeah like I am

Cleo: it's like hand eye coordination kind of?

Interviewer: yeah kind of – so do we think that's the most or the least important?

Children: most

Interviewer: okay, and what have you got there [Pepperoni]?

Pepperoni: reliable

Interviewer: okay, what do you think about that one?

Pepperoni: because you have to be reliable – I said this last time, but you've probably forgot

Interviewer: tell me again

Pepperoni: because if someone leaves you with something and you're not reliable, if you're in a team in STEM, you could get your team fired or something for not doing it

Interviewer: okay, what does everybody else think?

Apple: I think it should be most

Interviewer: and what do you think?

Jelly: I think if you were a scientist, you'd mostly work alone because you'd be examining DNA, but in other cases, like in maths, engineering and all of them, you'd have to be reliable

Interviewer: okay

Jelly: so I would put it in most for certain jobs

Cleo: I think it should be for all jobs, because if you're studying DNA, some people have to do some parts because you can't do all of it yourself

Pepperoni: yeah

Cleo: and you need to work as a team

Interviewer: okay

Cleo: and you could be working with different parts of STEM to create something like a project

Interviewer: okay, thank you

Apple: I feel like since I said DNA in my one, everyone's started saying DNA

Interviewer: you put that little bug in everyone's head have you about DNA? Go on [Pepperoni]

Pepperoni: well my dad works for BT sport, and he's got a team what he works with and sometimes he's the only person in his team who gets left with all the jobs, and then he just does it and every year he just gets a prize, he's the only person

Interviewer: ah so where do you think reliable should go? Most or least important?

Pepperoni: most

Interviewer: most okay, so we've got our five most important – now are there any that you think are least important that you'd like to talk about?

[chat about current placement]

Interviewer: okay, C what would you like to say about that word? What have you chosen?

Cleo: competitive because if you're competitive you might not focus on your work, and there might be a deadline and you're focusing on beating someone. And all you're doing is trying to get good things in, but you don't complete it in time. So competitive would not be helpful and it can lead to some problems

Interviewer: okay – what does everybody else think about competitive?

Apple: bad

Jelly: I agree with her

Interviewer: you agree with [Cleo]? You think it's bad [Apple], why do you think it's bad?

Apple: because of the same reasons

Interviewer: okay, so where would we like to put that word then?

Cleo: least

Interviewer: least, okay – shall we put that there. What have you got there [Jelly]? Are these ones for least?

Jelly: I've got enjoys dancing and gets all of the answers right

Interviewer: okay

Apple: least both of those

Interviewer: both least okay? Tell us what you think then

Jelly: gets all of the answers right, you'd never have to go to school, you'd just do whatever you want

Cleo: it would be boring

Pepperoni: I would like that

Interviewer: yeah? You would like to get all the answers right?

Pepperoni: yeah

Jelly: getting all of the answers right isn't learning

Apple: because if someone came up to you and gave you a really hard question, you could just say the answer and it wouldn't be very fun

Interviewer: okay

Cleo: yeah, and also in school if you knew all of the answers, you'd just be bored and think it's a waste of time. But you can't not do school as a child

Interviewer: okay, so where do you three think that one should go?

Children: least

Interviewer: and [Pepperoni], you said that you would *like* to get all the answers right, can you talk more about that one for us?

Pepperoni: because then I [pause] when they're all finishing I can just sit and not do anything

Interviewer: ah right, so you'd like to be able to finish your work before everyone else?

Pepperoni: yeah

Jelly: yeah but wouldn't you get bored of having to do nothing all the time? Because one day you're gonna get bored of getting all the answers right

Pepperoni: well I never do, but I would like to anyway

Interviewer: okay, fair enough

Jelly: sometimes you need to think more

Interviewer: – what was the last card then?

Jelly: enjoys dancing

Interviewer: and also imaginative? Okay, so [Cleo] tell us about why you've chosen imaginative

Cleo: imaginative because you need to think logically, and working with STEM most of the time you're thinking about – if you're working with science – if these two liquids were put together, you need to think about one of those liquids with another liquid to see the reactions

Interviewer: okay

Cleo: So it's kind of like predicting it, but you need to be logical in your predictions because if you're just imagining you're like [impression of day dream] rainbows, clouds – and stuff like that, it won't help and it's not useful

Interviewer: okay, thank you [Cleo] – what were you going to say about imaginative?

Pepperoni: it will probably blow up if you've done that

Interviewer: okay. So where do we think imaginative should go then?

Apple: least

Pepperoni: middle

[Apple asks Pepperoni about time she has to leave school]

Interviewer: so [Jelly] what was your last one there then?

[chat about time management]

Jelly: enjoys dancing – because if you were very obsessed with it, you'd just spend all day going [dances]

Interviewer: so enjoys dancing, you don't think is important? Does anyone else have an opinion on that?

Apple: yeah because when you're working, you might be dancing and you might get something wrong

Interviewer: ah right, okay

Cleo: I disagree because it's like sport, because it's a type of sport

Interviewer: okay

Jelly: it hasn't actually been classified as a sport yet

Interviewer: okay -so where would we like to put that card then guys?

Apple: least

Interviewer: is that three for least? And [Cleo] you think it's the same as sport?

Cleo: yeah

Interviewer: so I'm going to take a picture of this now really quickly, and then we're going to move onto the next one

[Interviewer takes a photo of the cards]

Interviewer: so for this next activity – if you don't mind, please choose five words that you think describe yourself and then we're going to talk a little bit about why we've chosen those words. And remember you can share words, so if there's anything that you think someone else has that describes you, you two can share it

Pepperoni: where's mine? Where's my good one? Oh I love sport

Interviewer: you can share that one guys

Pepperoni: where's computer games?

Apple: I've got it

Interviewer: you guys can share that one too

[chat about choosing words]

Apple: this is definitely the funny practical

Pepperoni: I've only got two words to describe me

Interviewer: you don't want to choose five?

Pepperoni: no

Interviewer: okay

[chatting about sharing]

Interviewer: are we all ready to talk? [Apple] can you tell us about your words first?

Apple: I've got likes computer games, inventive, practical – which is the funny practical – can take risks and can use computers

Interviewer: and can you tell us why you chose each one of those please?

Apple: this one because

Interviewer: likes computer games yeah

Apple: because I like computer games – I just do

Interviewer: okay

Apple: because I'm a boy

Interviewer: okay

Apple: inventive because I like being engineers, and stuff like that

Interviewer: what kind of stuff do you like to invent?

Apple: I like inventing – my dad's got this computer game on his PC, that I like. And it's got a book that goes with and I like using his book on the computer game to make some animation things on there

Interviewer: okay

Apple: practical because sometimes I'm funny

Interviewer: okay

Apple: can take risks because I like doing funny and silly stuff

Interviewer: okay

Apple: can use computers because if someone asks me – if you've got one of them new laptops – if they wanted to know how to put their fingerprint in, I know how to do it

Interviewer: ah, so you could use your computer skills to teach someone else?

Apple: yeah

Interviewer: okay, thank you very much [Apple]. [Jelly] have you got five?

Jelly: I've ended up getting six

Interviewer: okay, well you need five so we'll let you decide, and [Cleo] you can tell us about your five?

Cleo: I'm clever, I like being outdoors, I can work independently, and I enjoy sport, and I'm also very sensible

Interviewer: okay, can you tell us why you chose those words please?

Cleo: I chose sensible because I don't join in with silly games – so if there was something of people running and laughing and they might be breaking rules, I wouldn't join in – I would just leave it

Interviewer: okay

Cleo: and I'm clever because [laughs] I'm just clever

Pepperoni: she is clever

Cleo: and I can work independently because I'm clever

Interviewer: okay, what *is* being clever?

Cleo: it's kind of like being at a different level to other people – kind of?

Interviewer: okay

Cleo: and I enjoy sport, because I do a lot of sport and I like being outdoors to do sport

Interviewer: ah okay, so those two link together?

Cleo: yeah

Interviewer: brilliant, thank you [Cleo]

Apple: [talking about his worksheet] I put 'com g' because that's computer games

Interviewer: okay – [Jelly] can you tell us your words and why you've chosen them please? Thank you [Cleo]

Jelly: enjoys science, enjoys history, enjoys maths, clever and likes learning languages

Interviewer: okay, tell us a little bit about why you've chosen those words

Jelly: I enjoy science because I like to experiment with different things

Interviewer: okay

Jelly: so mixing uranium with titanium

Interviewer: okay

Jelly: carbon dioxide mixed with oxygen and all of that

Interviewer: so you like experimenting?

Jelly: yeah, I just like seeing the outcome – I don't care if it blows up in my face – I don't care if I get something really stinky, I'll just write down what I get

Interviewer: okay

Jelly: And then enjoys history because I enjoy about what the past is about certain things like the past of Germany, the past of Britain, the past of Newcastle. And all of that because I've just always just liked the Romans and I don't know why, but I'm just so interested in them so that's one of the main reasons why I love history

Interviewer: okay

Jelly: and then enjoys maths because I enjoy maths because I've got used to it and I want to be able to get really good at maths

Interviewer: okay

Jelly: because I want to be a scientist, and in some points you need to be really good at maths to sometimes do science

Interviewer: okay – what kind of science do you need to be good at maths for?

Jelly: [pause] mathematics?

Interviewer: okay

Jelly: and I'm clever because I can answer very hard questions in a very short amount of time, and easy questions I take like an *hour* to do

Pepperoni: so like "what is your name" [pretends to pause for an hour]

Interviewer: okay thank you

Jelly: and I like learning languages like German, and [counts to 20 in German]

Interviewer: okay, wow so you like learning languages?

Jelly: yeah and I can already count up to 999,999 in German

Interviewer: oh wow – we *definitely* don't have enough time for that right now, but that's excellent

Apple: can you count to ten in German?

Jelly: I just counted to 20

Interviewer: you did? Okay – are you done with those now? Have you told us everything about your words? Thank you very much. [Pepperoni] can you please tell us about your words and why you chose them?

Pepperoni: enjoys sport because it's really fun

Interviewer: yep, anything else?

Pepperoni: because [pause] sport is good because it can keep you fit and it can – I don't know, it can just do stuff

Interviewer: okay

Pepperoni: can take risks because sometimes I just [pause] yeah I can take risks because yesterday night dad cooked some brownies and I kept on sneaking into the kitchen to try and get some

Interviewer: ah okay

Pepperoni: likes computer games because they're really fun

Interviewer: okay

Pepperoni: and they're very [pause] what's the word?

Jelly: very imaginative?

Pepperoni: no

Cleo: exciting?

Jelly: what kind of thing are you thinking about?

Pepperoni: I don't know

Cleo: intense?

Jelly: insane?

Interviewer: do you need a bit more of a think about the word?

Jelly: what kind of thing are you thinking about?

Pepperoni: ah! Entertaining!

Interviewer: ah so you find them really entertaining? Great. Are you ready to move onto this one now? Have you told us everything about those words?

[Interviewer introduces worksheet, reads first question]

Interviewer: so if you're finished with the first question, you can move onto the next question

[chat about timings and returning to classroom]

Interviewer: [second question] so is there anything about yourself, anything that you like, anything that you think you're good at that would help you to use STEM in the future?

Apple: can use computers?

Interviewer: yeah, you can write about that

Jelly: is 'I am a nerd' something to write? Because I am a nerd in science and that's pretty much all I know about

Interviewer: if that's what you think, then write it down. This is your opinions remember guys. So why is being a nerd helpful in science?

Pepperoni: nerd?

Interviewer: What is a nerd?

Jelly: I call myself a nerd because a nerd is someone who likes to study certain things

Interviewer: okay

Jelly: it doesn't mean a certain thing it just means someone who likes to study

Interviewer: okay

Jelly: and that's me

Interviewer: you think that about yourself? Okay

Pepperoni: I thought people – all the boys are saying that it means you're an idiot or something

Interviewer: maybe those boys are just being mean

Jelly: people use nerd as an insult as well because people think studying is stupid, so they call it an insult – saying "oh you're a nerd"

Interviewer: some people might do that yeah – are you okay with the first question [Pepperoni]?

Pepperoni: no

Interviewer: [reads Q1]

Apple: what about this bit?

Interviewer: so you can use computers, how do you think that would help you in the future with STEM?

Pepperoni: I don't know

Interviewer: if you're not sure what to write that's fine

[all speak over each other]

Pepperoni: it's very fun – it's not really the question, but it's very fun

Interviewer: So you think STEM's fun? What did you think about it when we started the project?

Pepperoni: I don't know

Interviewer: okay. So the second question is [read Q2] so what are you good at? What do you like?

Pepperoni: sports

Interviewer: and how would that help you use STEM in the future?

Pepperoni: don't know

Interviewer: so there's a question on the back as well [Cleo] and [Apple]. It's okay [Pepperoni], if you don't have anything else to write for that question you can just move one

Pepperoni: oh computer – I'll just do computer, even though it's not my best but

Interviewer: it's not your best thing?

[chat about detail of drawings]

Interviewer: and there's one more on the back, so do you think you'd like a job that uses STEM when you're older?

Pepperoni: I want to be a youtuber or something like that

Interviewer: being a youtuber, would that use STEM?

Jelly: I want to be a scientist or an archaeologist

Pepperoni: maybe because you might have to count up how many subscribers you've got

Interviewer: what do you use as a Youtuber?

Cleo: technology

Pepperoni: ah footballer!

Jelly: when you're a youtuber, you can just get a certain app that counts up your subscribers and every time you subscribe your number goes up

Interviewer: you can just say this out loud because we're going back up to the class room now – do you think you'd like a job that uses STEM when you're older?

Cleo: yes, because I would like to be a sports presenter or commentator

Interviewer: okay and how would that use STEM?

Cleo: it would use technology, it would use [pause] it might use some maths because you would need to know the scores and stuff, and league tables maybe

Interviewer: fab! Okay, thank you so much guys!

48 Appendix 36: Pupil task-based interview 3, BF

Title: Pupil interview 3

Date: 9th July 2019

Speakers: Poppy Hodkinson (interviewer), Olivia, Black Cat, Bumble and Bluebell

Interview duration: 77 Minutes

Interview location: BF

Interviewer: okay, so before we start can we remind ourselves: what does STEM stand for? Go on [Bumble]

[children clamour to answer]

Bumble: science, technology –

Child: archaeology!

Bumble: archaeology, mathematics

Interviewer: very close, you're almost there. So science

Bluebell: science, technology, engineering and mathematics

Interviewer: yes, [Bluebell] – so archaeology

Bumble: you made me muddle up!

Interviewer: that's okay, there's no right or wrong answers here is there? We're just talking about our opinions. So Archaeology comes under STEM, but it's not one of the letters. So if you'd like to take a couple of minutes to look and find which cards you think are the most important for someone who works in STEM

Olivia: they have to be resourceful, they have to be able to work in a team because that's what they need to be able to do – they need to learn new things because that's good and of course they need to be whatever this is called

Interviewer: okay, so remember we're discussing all these as a group, so it's good to pull out ones that you think, and we're going to talk about them as a group, and choose which ones we think are the most important

Bluebell: I don't know!

Interviewer: there's a glossary there

Bumble: how many are we allowed?

Interviewer: we're choosing five overall, as a group

Bumble: but can we take as many as we like?

Interviewer: you can, but today we've got three things that we need to do. Normally, we only do two things that we need to do – there's a third thing today. So you can pick as many as you like in the time that we have

[pause]

Interviewer: we've got to choose five between us all

Black Cat: what does practical mean?

Interviewer: have a look on here

Black Cat: I'm definitely taking practical

Bluebell: I need one more

Interviewer: I tell you what, shall we all share for now?

Bluebell: enjoy dancing

[child laughs]

Interviewer: Talk about one of your words, so out of the words you have, which one do you think is the most important for now?

Bluebell: I didn't really pick up important stuff

Interviewer: that's okay, you can also pick up ones you think are least important. So which is the most important of the words that you've picked up?

Bumble: creative

Black Cat: reflective

Olivia: determined

Bluebell: likes visiting other countries

Interviewer: okay, so let's talk about [Bumble's] word first. So why do you think that being creative – do you think it's the most important or the least important?

Bumble: I think it's a middle important

Interviewer: okay, so today we're talking about most and least important

Bumble: I think it's the most then

Interviewer: okay

Bumble: because archaeologists are sometimes creative

Olivia: they need to build stuff

Bumble: they imagine it, then they draw it and they work out if they can build it or not

Interviewer: so archaeologists needs to be creative sometimes, and imaginative – what did you say to add to that [Olivia]?

Olivia: sometimes if they might need to build stuff to help them figure out what it might be

Bluebell: technology

Interviewer: okay, yeah? How are you creative in technology?

Bluebell: you build it

Interviewer: build what?

Bluebell: technology

Interviewer: just technology in general? So there are different parts of STEM where you need to be creative?

Black Cat: yeah or you might need to make a good sum to work out – you might need to know numbers, so you need to get the right sum and then you can have the answer

Interviewer: okay, so being creative with your sums? So which pile shall we put creative on? Important or not important?

Children: important

Interviewer: right okay, where would you like the important pile to be?

[chat about pile]

Interviewer: [Black Cat] which word do you think is the most important out of the ones that you picked up?

Black Cat: reflective

Interviewer: reflective, can you tell us about that please?

Black Cat: because if you have – like what we just did with the aqueducts – if we built something, like out of technology and then it doesn't go as we planned, then we talk as a team what we could do better next time to make it again

Interviewer: okay, does anyone else have anything to add to that?

Olivia: yeah – so say you built something wrong, you could reflect to that and see what you could do differently. And then give your ideas to the other people in your team. So say [Black Cat] was in my team, and we were building the aqueducts and we accidentally missed something, and I reflected back quickly, I could give her my opinions what we could do differently

Interviewer: okay, so reflecting on your own projects is good, but reflecting on other people's work too? Which pile would you like to put reflective on [Black Cat]?

Black Cat: Important

[chat about whether children can see cards]

Interviewer: [Olivia], which one have you picked out?

Olivia: determined because you need to be able to do it over and over again to be a scientist, you can't just do it once and then not do it anymore. Because that's basically not trying, so you need to be a bit inquisitive or –

Black Cat: resilient

Olivia: and resilient

Bluebell: which one again?

Interviewer: we're talking about determined

Olivia: and also you need to do it over and over again because maybe if you done it first time and you got it wrong and you don't try again, but actually if you did try again, you might have got it right

Interviewer: okay – what do you guys think?

Bluebell: there could be loads of different ways, and you only choose one way

Interviewer: okay, [Bluebell] – so there's lots of different ways, and you can choose –?

Bluebell: any way, and if that one doesn't work then you can choose another way, until it's the right one

Interviewer: until you get the right one? Or the one that's best for you? Okay, carry on [Olivia]

Olivia: and the more difficult it is, I think it's better because you can try harder when it's more difficult. When it's easy you can just do it straight away – it's just because I like the more challenging because it makes me actually think

Interviewer: okay, so you like something to be challenging? You like to be challenged to be determined? Okay. What do we think about that word? Were you going to say something [Black Cat]?

Black Cat: if we don't keep on trying it might be something important – a teacher might have said that we have such and such time left to do it, but then you really panic, but you shouldn't panic because then you might not get it done

Interviewer: okay

Black Cat: so you should – if you first did it and it didn't go right, you should use your left over time maybe to do the rest

Interviewer: okay, fab. So where do we want to put that word guys?

Black Cat: important

Interviewer: does everyone agree? Does anyone disagree?

Bluebell: I don't know

Olivia: I don't know

Interviewer: we'll put it on most important for now, if some people aren't sure, but one person is sure

Olivia: it's because determined is quite important to be a zooarchaeologist, because you need to be quite determined to find out what it is

Interviewer: yeah, sometimes you have a tricky bone you need to work out what it is

Olivia: yes

Interviewer: Go on [Bluebell], what was your word?

Bluebell: likes visiting other countries

Interviewer: and do you think that that's the most important or the least important?

Bluebell: most

Interviewer: most okay, explain that for us please?

Bluebell: there might be jobs in other countries where you have to visit and you've got to maybe – you might not like that country

Interviewer: okay – anything else? Go on [Black Cat]

Black Cat: maybe if you've got half of an animal but there's one bone missing, there might be only that bone in that country because it might have got moved – somebody might have found it in that country

Bluebell: or they might have lost it

Black Cat: so you might have to go to that country for a week or so to find it

Interviewer: so you might need to go and do parts of your job in another country if you work in STEM?

Olivia: well you need to like other countries to go and work there, because if you don't like them, you can't really work there. If you don't like it, you just want to go home and you wouldn't be able to do the job that you're paid for

Interviewer: okay

Black Cat: Whereas if you like the country, you can actually work there and you won't actually give up your job

Bluebell: at that place

Olivia: and say you found a few bones and you nearly finished a project making that animal, but there was just one small bone missing, you could go all around the world trying to find that bone, so you might have to actually like the countries

Interviewer: okay, so you need to like where you work? What were you going to say [Black Cat]?

Black Cat: I was thinking if you went to a different country and you worked with them, you might need –

[recording interrupted by bee in room]

Black Cat: so if you go to a different country and you work with them – if they're having trouble with their work, you could go over there and help them, but you're going to have to know how to communicate so there might be a different language or a slight accent, or a few different words, so you're going to have to learn them

Olivia: before you go to the country

Black Cat: yeah, it's important because they might not understand you, then they might think –

Bluebell: they might know where that bone is, and you don't understand their language or what they're saying

Interviewer: okay. So you, said you can go to other countries to help the people who live there, what if you have a problem, and no one in your country knows the answer?

Black Cat: you could go to another country

Bluebell: but what if they don't know?

Bumble: then you go to another country!

Black Cat: go to a country that actually knows

Interviewer: so, maybe as well as us going to other places to help people, people in other places might be able to help us as well – so we could go somewhere else to learn something new couldn't we?

[wobbly table causes discussion]

Interviewer: okay, so [Bumble] did you have another word that you'd like to add?

Bumble: enjoys science because science is actually one of the STEM things

Interviewer: okay, is there anything else that anyone would like to add to that?

Bumble: science is also part of technology

Interviewer: how is science partly technology?

Bumble: because you need to know how stuff works, and that's science isn't it?

Interviewer: okay

Bumble: if you know how things work, so then technology: you need to know how technology works – if you can do science, you can do technology

Interviewer: if you can do science you can do technology? Okay, thank you [Bumble], does anyone want to add anything to that? Go on [Bluebell], and then [Olivia]

Bluebell: I think science is partly technology because there might be something that you actually need technology to work out

Interviewer: okay, like what?

Bluebell: [pause] I'm not sure

Interviewer: have you got an example [Black Cat]?

Black Cat: you might need to work out – your friend might have sent you this bone on the computer and she doesn't know it – or he – and then you work it out with them, but then you're not near each other, so you could send texts or stuff like that for what you've worked out so far

Interviewer: okay, so the technology would help with your communication? Did you have an example of technology in science?

Bumble: I also think that technology's with science because scientists probably actually do use technology quite a lot

Interviewer: okay, do you think that technologists ever use science?

Bumble: I think they also make technology

Interviewer: okay, thank you. What were you going to add to that [Olivia]?

Olivia: I was going to say that you need to enjoy science to be a scientist, because if you don't enjoy science

Bluebell: what's the point of being a scientist?

Olivia: yeah – what's the point? Because you don't even want to do science, but you're doing a science job. So I think you need to be able to like it to be able to do your job

Interviewer: okay – what does everybody think then? Where shall we put that card?

Bumble: important

Interviewer: where shall we put that card? Important? Okay

Bluebell: and if somebody might say "[Black Cat] send a picture of a bone!", they might send it – the real bone, they might need something that can scan it – or something and it tells you what animal it is?

Interviewer: oh that would be good, although then I wouldn't have a job would I? If you could just put it in a scanner and that would tell you – no one would want me to do it for them…

Bumble: I thought that they could already do that – put it in a thing, scan the bone and it tell you what kind it is

Bluebell: yeah, that's what I thought as well

Interviewer: well it kind of depends what you're doing with it

Bluebell: what if it doesn't tell you

Interviewer: so I'm not sure whether there's a programme. As a zooarchaeologist, because I can tell what different bones, are by looking at them – I don't need to scan them – but quite often –

Bluebell: some places might not have the scanner thing

Interviewer: so if you're out in the field, so normally I have lots and lots of drawers with all different animal bones in. And if I've got a bit – I can go and compare it, but you don't have all those drawers when you're out doing an excavation. So what some people have started using is 3D models on an iPad. So you can look at a 3D model of a bone and that can help you work it out

Bumble: can't you just look at the bone and match it to something you've already found if it's the same thing?

Interviewer: yeah, you can do that too. Absolutely. Okay, which word shall we talk about next?

[Bluebell leaves room for water]

Black Cat: I've got clever – you don't always need to be clever if you're working with STEM, because you might find things difficult. You might be doing a test, other people have done it, but you haven't, but you might need to work it out so you might be a bit resilient or a bit independent because you're not allowed to ask other people for help in the test

Interviewer: okay, and so which column would you like to put clever on?

Black Cat: not that important, because you might not just need it – because you might need to work it out, and you don't always know the answer. So it's not about how smart you are, it's about your thinking

Interviewer: okay, so being resilient might be more important? What does everybody else think about that?

Bumble: I think it's important

Olivia: I don't think it's that important because you don't really need to be clever to be a scientist

Bumble: yeah you do

Olivia: no you don't

Interviewer: so what's your opinion [Bumble]?

Bumble: I think you need to be clever to be a scientist

Interviewer: okay

Bumble: because you need to know what things mean, and what they are, and how they work and stuff like that

Interviewer: okay

Black Cat: you might know that stuff, but you might not know some other stuff that you really need to have this job – so you just work it out

Interviewer: okay, so –

[Bluebell re-enters room]

Interviewer: [Bluebell] we're talking about clever – do you think that might be most important or least important?

Bluebell: important?

Olivia: I don't think it's important

Bumble: I think it's important

Interviewer: [Bumble] thinks it's important, [Black Cat] and [Olivia] think it might not be important

Bluebell: because you need to be clever on that thing you need to do

Bumble: you need to know what it is, what it's used for, why it's there

Bluebell: why do you need it

Bumble: yeah what did they use it for – what was it, how do you use it, how does it work?

Interviewer: okay

Olivia: yeah, but you might not need to be clever to do that

Black Cat: you might have a solution already planned up – someone might have said "can you find an aqueduct?", and then you know "okay, I'm gonna find an aqueduct, I'm going to need to think what do I know already? okay, I know where it's from, I know what they used it for". But I might not know what it's made out of, so I can go to Rome maybe and see, because you can see it

Bluebell: so you need to be clever in parts of it, but not in other parts maybe

Bumble: you need to be good at maths. You don't need to be clever in all of it, but with machines

Olivia: I'm mostly saying you don't need to be clever, some things you do need to be clever about. Like how to use some of the technology

Bluebell: yeah, but that's on technology and things that are on important

Interviewer: so you think you need to be clever for technology –

Olivia: and the rest I think you don't need to be clever

Interviewer: okay,

Bluebell: important stuff, you need to be clever maybe

Interviewer: okay, what's important that you need to be clever on?

Bluebell: technology

Interviewer: okay

Black Cat: or maybe you might need to be clever on the subject. Or you might not need to be clever on the subject, because you might have learnt it in school, but then you can work it out again. And that means you're gonna learn again

Interviewer: okay – so even if you forget things, you can still learn them again?

Black Cat: yeah

Interviewer: So because we've got quite a split opinion on clever – and that was a really good discussion, than you everyone for joining in with that one – I'm going to put it 'unofficially' in the middle to show that people had different opinions about that one. Okay?

Bluebell: maybe it might change to bad or good

Interviewer: it might change as we go – absolutely [Bluebell]

Olivia: this is a not important one

Interviewer: okay

Olivia: this is enjoys dancing – you don't really need to enjoy dancing to do it. Because dancing you don't really have –

Bumble: does that say "I enjoy dancing?"

Interviewer: it says enjoys dancing

[child laughing]

Interviewer: Why do you think that you don't need to do dancing?

Olivia: because that's not really in the job, you could get a job that's dancing

Bluebell: dancing teacher?

Olivia: but you actually have to like it, and it's not part of STEM. Because STEM is science, technology, engineering and maths – it's not

Bumble: [Olivia] what does dancing have to do with maths, technology, science?

Interviewer: this is what she's saying – she's saying that she doesn't think it's important. Aren't you [Olivia]?

Bluebell: oh yeah, you can choose to talk about not important one

Interviewer: yeah you can choose things that you think aren't important as well. So I've got a question about dancing: if you are a scientist, or a technologist or an engineer, does that mean that you can't like dancing?

Children: no

Black Cat: no, your hobby might be dancing but then your job can be a scientist. So you can still enjoy it – but you might just have a different job than your hobby. It doesn't mean just because that's your hobby that has to be your job. But then that could be your hobby and that's your job. It doesn't really matter which way round

Interviewer: you were going to give an example there were you?

Olivia: like my mum's friend who's a scientist, she still does dancing and she's a helper and on exam day for our presentation she always helps me

Interviewer: does she? With your dancing? Okay, so what have we decided? Dancing might not be important if you work in STEM, but if you work in STEM you can still like dancing?

Black Cat: yeah, you can still like dancing

Interviewer: what do you two think?

Bluebell: yeah?

Bumble: I think it's not really important

Bluebell: could be a hobby

Interviewer: could be a hobby?

Bumble: I don't really think that dancing is that important to STEM

Interviewer: okay and what do you think [Olivia]?

Olivia: it can just be a hobby

Black Cat: it doesn't have to be your job

Interviewer: okay, so start the not important column

[chat over where the column will go]

Interviewer: okay, do we have another word that we'd like to talk about?

Bluebell: enjoys sport

Interviewer: tell us about enjoys sport

Bluebell: I think it could go with that because it's like a hobby

Child: yeah, you don't really need to

Interviewer: you think it could go with enjoys dancing? Does anyone else have anything that they'd like to say about enjoys sport?

Black Cat: maybe like dancing, it could be your hobby. But you could celebrate by doing sport – like if you got the job?

Bluebell: or you might go to presentations and they'll reward you

Olivia: you do that in dance as well

Bluebell: a presentation is a thing for sport!

Interviewer: do you do it for both maybe? In dancing and in sport?

Bluebell: you do it in football, my sister likes football and she does it

Olivia: and it's also in dance – where you get your medals from your showcase

Bumble: so getting medals and showing off?

Interviewer: it's showing what you can do

Olivia: and showing the different dances

Interviewer: okay, so where would we like to put enjoys sport?

Bluebell: in the none important pile

Interviewer: does everyone agree? [Bumble] did you have another word that you'd like to talk about?

Bumble: honest – so if you said the design has gone perfectly, and it hasn't, they will think it has and they'll build it like you said, and then it will go wrong

Interviewer: okay, so do we think being honest is important or not important?

Bumble: because you could lie and nobody would know

Bluebell: you could say you know how to do it, and they say "do it", and then you don't actually know how to do it and then you don't know how to do it

Olivia: I've got an example

Interviewer: go on [Olivia], what's your example?

Olivia: so basically, say you can do football and they said "can you teach me?", and you actually have nothing to do with football, and you can't actually show them, and you just make up silly things

Interviewer: okay

Bluebell: and then you're making big lies

Olivia: and they want to be in the club and they say "I know how to do football" and then they show, and they're like "that's not right", so basically it will be all your fault

Interviewer: okay – go on [Black Cat]

Black Cat: if you say to your teacher "I've done my homework, it's on the computer" and then they check it, and then it's not there, but that was the deadline, you might get told off. But then you should be honest, so you could say to your teacher "Sorry I didn't have time" or "I didn't have the right things or anything like that to do my project so that's why I haven't brought it in, am I allowed a bit extra time?"

Interviewer: okay, so where shall we put honest? Which column shall we put it on?

Children: important

Interviewer: important? Okay, pop it on there then [Bumble]. Okay, so we have now got five on the important things column. Do you have anything, or is there anything on this pile, that you think is more important than what we've already got on here?

Olivia: I think it's just important

Interviewer: do you think it's more important than these five?

Olivia: I just want to say enjoys reading.

Child: can take risks

Olivia: Because you have to enjoy reading to be able to –

Bluebell: you don't have to enjoy it, you've just got to know how to do it

Olivia: and if there's a book that you read to go and find facts, you have to kind of enjoy books

Interviewer: so do you think it would be more important than honest, creative, reflective, determined or enjoys science?

Black Cat: no

Olivia: maybe a bit more than reflective

Interviewer: you think enjoys reading is a bit more important than reflective?

Olivia: only a bit

Interviewer: what does everybody else think?

Black Cat: reflective is a different ball game

Bluebell: it's completely different thing

Interviewer: so is being reflective more important, or less important if you work in STEM, than reading? What do we think?

Black Cat: yes

Bumble: more important

Interviewer: you think more important?

Bumble: actually, no I don't

Interviewer: okay, you think enjoys reading is more important?

Bumble: no, I think being reflective is more important

Olivia: say there's a bone that you get, and you have to try and find it in a book, you have to kind of enjoy books to be able to actually find that

Interviewer: so I tell you what, because we've got different opinions, shall we put that one there? [Black Cat], the word you're about to talk about, is it more important than those five?

Black Cat: I might have two

Interviewer: you might have two, and you think they're more important than some of those five? Go on then

Black Cat: I've got sensible, because if you're going to have this big job, and your boss is counting on you to do it right, then you should do it sensible. If you don't do it sensible, you might not get the job done and then you might be in a different country and your time is up, and you have to go back and you haven't done it because you've been busy doing all your shopping and like that

Bluebell: I think that one might be more important than that

Interviewer: more important than creative?

Olivia: no, you have to be creative – you can't just not be creative

Bluebell: you don't have to be creative in maths though

Olivia: in art, you've got to. You've got to be creative thinking about what the bone is. Because sometimes creative can mean –

Black Cat: other things. Not just "oh I'm just going to make something"

Olivia: you can also have creative thinking

Interviewer: okay – would you use creative thinking in maths?

Olivia: yeah

Black Cat: a bit yeah, because would you just have to make a sum up, but it's not right –

Bumble: I don't think you can just imagine and make a sum up

Interviewer: you might be able to

Olivia: you have to be creative to pick the right numbers – say you got a sum, you have to be creative to find out what the answers is. You can't just be silly, you have to be creative and think creatively

Bluebell: what's our word again?

Interviewer: so sensible is the word we're talking about, do we want to swap any of these for sensible?

Bumble: no

Bluebell: I've got a thing for sensible. You might have to do this important job – you might not be sensible and you might break the bone

Interviewer: okay

Bluebell: or break the thing you've got to be careful with

Interviewer: okay, and what would happen if you broke something?

Bluebell: you might get told off by your boss, and you might get fired

Black Cat: or you might be trusted because you've been trusted in a lot of other jobs, but then you go to this museum, to collect a box or something of bones, so your team can look at it for a while, but then you might not be sensible enough to do it, and then you just don't do it correctly

Interviewer: okay so where would you like to put sensible [Black Cat]?

Bluebell: I think it should be in this one

Black Cat: yeah

Interviewer: and which one would we take out of this one to put sensible in?

Bluebell: enjoys science

Olivia: no because you have to enjoy science to be able to do that job

Bumble: I don't think you should swap that for any of them

Interviewer: you don't think we should swap any of them [Bumble]?

Olivia: I think reflective

Interviewer: reflective? What does everyone think? Reflective out and sensible in?

Children: yeah

Interviewer: what do you think [Bumble]?

Bumble: [pause]

Interviewer: you don't think any of them should be swapped?

Bumble: no

Black Cat: actually I think they should all be there, even reflective

Interviewer: so we're just choosing the five most important, so let's put sensible and reflective together. So have we got any words, and are there any in here that we think aren't important at all?

Olivia: you don't really have to be artistic

Bluebell: I think this one – likes helping others

Bumble: you have to help others

Interviewer: artistic and likes helping others – so you think artistic isn't important [Olivia], and can you tell us why you think that?

Bluebell: it depends on the job – the job might being an artist, and trying to improve on someone else's art – making it brighter, stuff like that. And you might have to be artistic for that

Bumble: if you want to design something, you need to know what type of pencil you need to design something

Bluebell: in some cases, you get loads of different shades of pencils

Bumble: I think art actually links to maths because you need to know how long sometimes

[teacher enters room and speaks]

Interviewer: so we were saying that artistic can link to maths – how does artistic link to maths?

Bumble: because you need to know how long the thing you're drawing is

Bluebell: and the margin – you might need to do that really neat

Black Cat: but you use a ruler

Bluebell: there might not be a ruler?

Black Cat: say somebody was using it, you could just wait for somebody

Bumble: you just use a pencil because the pencil's straight

Bluebell: you could be artistic and do your own line

Interviewer: what were you going to say [Black Cat]?

Black Cat: for art, if you were going to paint or draw this fossil, it might have different shades of colour. There might not be a really dark dark pencil, so you might need to buy something else.

Like black paint, and let it dry and then you're going to have to get the detail, so you have to know how to do that as well

Interviewer: okay

Black Cat: because you'll learn it in primary school or secondary school so you can bring it to your job

Interviewer: okay, so where shall we put artistic then? Where do we think it goes? Most important or not important?

Olivia: I think you don't really need to be artistic because you would have to be artistic if you were an artist, but STEM: you don't really need to worry about art because it's not one of the four things

Bluebell: are we still on artistic?

Interviewer: yeah, can you be artistic when you're doing different things?

Black Cat: yeah, in science

Olivia: sometimes, but not all the time

Interviewer: can you be artistic in science?

Black Cat: or engineering

Bluebell: you might need to draw a bone!

Black Cat: something engineering

Bluebell: if you're going to copy it

[Poppy asks children not to speak over each other]

Black Cat: in engineering, you might need it – so say you're gonna build an aqueduct, you're going to need to draw it. But then you're going to need to draw them correctly, with the right thickness because you don't know how thick you want it to be, so you're going to have to estimate and then draw it out. So then we have a definite plan

Interviewer: okay, so you might be artistic in engineering, thank you. [Bluebell] what were you going to say about artistic?

Bluebell: I've forgotten

Interviewer: ah sorry! So is there any part of STEM you might be artistic in? If you remember we'll come back to you

Olivia: maybe sometimes archaeology – or technology, technology is already there, so you don't really need – if you were somebody who makes it, you would have to be creative/ artistic to make it. But you might have to have blue paper, like those things that they plan houses on?

Interviewer: a blue print?

Olivia: yeah

Interviewer: [Bluebell] what were you going to say?

Bluebell: there might be something that you have to draw, and you can't mess up – you have to do it completely perfect

Interviewer: okay, so do we all agree that you can be artistic in STEM?

Olivia: a bit

Interviewer: a bit? So where would we like to put artistic then?

Bluebell: I think important

Bumble: no it can't

Interviewer: okay, so [Bumble] thinks not important, [Bumble] thinks important

Black Cat: I don't think it's important

Olivia: I think it's middle

Interviewer: okay, so we'll put it here – is there anything else that we think is not important?

[chat about placement of cards]

Black Cat: this is gets all the answers right, I don't think it's that important because you don't have to get it right. If you have this maths question, you don't always have to get it right because you could learn from it – you might do it again, but then you might not get that right, but then you just do it again and again until you can do it

Interviewer: okay

Black Cat: you don't always have to get all the answers right. If you have this bone, and you have a sheet to fill in, estimate of what the bone is and then your boss says "can you please make your estimate correct, or almost correct", but then you say "oh this is a deer's bone" but when it's a bear's bone, so then it's a bit different, but then you just have the rest of the sheet to fill in if you didn't get it right

Interviewer: okay, so where do we think gets all the answers right should go?

Olivia: unimportant

Bluebell: I think in the middle

Bumble: actually, I think important

Interviewer: why do you think important [Bumble]?

Bumble: actually, no I think it's not important. Because then you know how to make it better the next time, and it will actually be better. Because next time, maybe you'll have a better idea than you did the first time

Interviewer: okay thank you. And what did you think [Bluebell]?

Bluebell: you might have learnt it every day, and when it comes to a test and you've got to do that sum, but you get it wrong

Interviewer: so do you think it's the most important or the least?

Black Cat: I think it's the least actually

Interviewer: okay, we've got quite a lot of people saying least so I'm going to put it on least, but I'll remember that you thought it was in the middle [Bluebell]. Okay, is there anything else that we want to add to the least important pile?

Black Cat: I think definitely likes computer –

Bluebell: likes helping others

Black Cat: - where's the computer game?

Interviewer: there's the computer games, tell us about likes helping others [Bluebell]

Bluebell: I don't think like helping others is very important

Interviewer: okay, why do you think it's not very important?

Bluebell: [pause] maybe because it will be them who's improving, not you who's improving?

Interviewer: okay?

Bumble: you might have one of your best ideas ever and you might tell them and they'll use them, and it will be like you're the second person to use your actual idea

Bluebell: and you come up with the idea, and you want to maybe build it, but they build it and they get the reward. When the person who figured what it should do, should get the reward

Interviewer: are you two going to say something else about that one? Go on [Black Cat]

Black Cat: maybe you give the answer or the method to somebody – say if I gave the method or the answers to [Olivia]. And then I forget the method or the answer, but then she gets it right and I don't

Interviewer: oh okay

Black Cat: but I also think it's quite important because they might be really stuck and you might be almost finished so you could help them because you might have a certain amount of time so you could just help them because it would be kind. And kind is one of our citizenship values

Interviewer: ah okay. Go on [Olivia], tell us what you were going to say – what do you think about likes helping others?

Olivia: I think it's actually quite good, because say you're finished and somebody's really stuck, and they're only on the second or first question – when there's about five questions – you have to help them because time's nearly out. So you could – not give them the answer – but just give them some solutions

Black Cat: support

Olivia: yeah, support them. But you can't just not help them because if you don't help them –

Black Cat: they might lose their break or something

Olivia: yeah they might lose some of their break and they're your friends and you wanted to play with them

Interviewer: okay, so speaking of time nearly out – we might need to move onto our next activity very soon. So where would we like to put likes helping others?

Bluebell: I think here

Interviewer: So [Bluebell] thinks least important

Olivia: no it's definitely not least important

Interviewer: you guys think it's important – we've got two saying least, two saying most so I'm going to put it there, and did you have another word you wanted to talk about [Olivia]?

Olivia: yes! [looks for word] likes computer games

Interviewer: do you think it's most or least important?

Olivia: it's the least because you don't have to like computer games to be able to do STEM

Interviewer: okay

Olivia: because if you do…

Bluebell: it could be important to some people

Bumble: technology, it's technology isn't it?

Olivia: yeah but that's games

Black Cat: yeah, but computer *games*

Bumble: there is some computer games where it's questions and you answer the questions

Olivia: yeah but I think it means like Mario and Luigi

Interviewer: well it means whatever you guys think it means – what were you going to say [Black Cat]?

Black Cat: it could also be quite important – well a bit important – because when you're young, you might have heard this game and you played it, but then when you're older, you might need to use some of that skills which you used. Like there's this game on the computer and you have to get around your paths – the level, but then you might have to get round the question and that could be your level.

Interviewer: okay

Black Cat: Or there might be a game where you have to answer questions, to get to the next level and then you might have to answer question in your work. So it could be a bit important

Interviewer: so sometimes it could be important, but mostly you think it's not important?

Bluebell: one of the questions could be, maybe a very important question – a thing you must know when you're older

Olivia: I don't think it's really important

Black Cat: actually, it's not that important

Interviewer: you think it's not that important? What do you think [Bumble]?

Bumble: not that important

Interviewer: Okay, so we're going to put that one there.

[Poppy takes photo]

Interviewer: so we're going to choose five words that describe ourselves, and then we're going to explain why we've chosen them. And then after that, there's another activity okay? So you can choose five words that you think describe yourself, and if there are any words that you need to share, then you can. Other people can use the same word okay?

Olivia: where's artistic?

Bluebell: I want artistic

Interviewer: you guys can share artistic

[chat about sharing words]

Bluebell: enjoy history, I kind of like that

Child: I can take risks

Bluebell: can work in a team – nope!

Olivia: have you found it [Bluebell]?

Bluebell: Enjoys sports, I like sport

Child: honest, I don't think that's really me

[children looking for artistic card]

Interviewer: okay, have we got our five words everyone?

[chat about how many words they have and which they are sharing]

Interviewer: okay, so who would like to start?

Olivia: me, but [Bluebell] has one of my words

Interviewer: we'll start with [Black Cat] because her hand went up first and then we'll come this way so you're second

Black Cat: [Bumble] has one of my words

Interviewer: [Bumble] can [Black Cat] borrow that word for now please? Please tell us about your words [Black Cat]

Black Cat: I enjoy reading because I learn new things which I haven't learned before, and then it also helps me with my learning at school. Because once I found this book which was about the Romans when we were doing our topic, and we were trying to find out some of the shield forces, or something like that. And I was looking it up in a book and then I found it

Interviewer: brilliant, okay – is that everything you want to say about that one?

Black Cat: yeah. And I enjoy science because once we did this really fun science lesson, where our parents came in and we had to pour all these liquids down this ramp and then we had to see which one was the fastest

Bluebell: sour cream took ten minutes!

Interviewer: that's not very runny is it? So that was an example of an exciting science lesson, and you enjoyed that one?

Black Cat: I also enjoy maths because it's quite challenging for me. And some of the ones like column method, I like that because I can do big numbers and it's a quick way for me to do my maths

Interviewer: so you like that maths challenges you, and that you can use specific methods?

Black Cat: yeah

Interviewer: okay

Black Cat: and I like being outdoors because

Olivia: her mum works at [local garden centre]

Black Cat: my mum does work at [local garden centre] and then I like being outdoors because in our garden, we have three baby kestrels – birds of prey – and then I

Bluebell: kestrels? What are they?

Black Cat: birds of prey. And then we always go down and visit them. And every year we have a group of them. And once when we were down there, we went down there in the evening and my brother went to go and check on them, but then the mummy and daddy kestrels were in there, and they were looking like this

Interviewer: they looked mad at him did they? Okay so you like being outdoors, and what was your last one?

Black Cat: likes to learn new things, because at home I do these questions with my brother sometimes, and then sometimes he teaches me new things. Like when I was in [Year 2], I wanted to learn how to do column because he did it, and then I wanted to learn, and then he taught me so it was really fun

Interviewer: okay, so you enjoy learning new things? Is it particularly when your brother teaches you?

Black Cat: also my mum because she teaches me how to recognise some plants from their fruits and stuff like that

Interviewer: fab! Is there any else you'd like to say?

Black Cat: no

Interviewer: no? thank you very much [Black Cat], [Olivia] would you like to tell us which words you chose?

Olivia: I need my words: artistic and creative

Bluebell: they're basically the same aren't they?

Olivia: no

Interviewer: we can talk about whether we think they're the same or not

Olivia: I think I'm reliable because if the teacher asks me to do something, I'd actually go and do it without her asking twice. So I think I'm quite reliable. I enjoy dancing because the people there feel a bit like my family, because they help me. And the four of us: me, [friend's names] – [class teacher] used to teach my friend

Interviewer: oh really?

Olivia: all of them feel like my sisters

Interviewer: okay

Olivia: and we always have sleepovers and playdates

Interviewer: that sounds fun

Olivia: near [place name] there's these basketball things called the cages and sometimes we go over there and play basketball

Interviewer: okay, so you enjoy dancing – you enjoy the community? The people at dancing?

Olivia: yeah. I think I'm creative because in my art, I don't just do one thing. Once we went outside and –

Child: that was yesterday

Olivia: yesterday and I was doing outside, and instead of doing one tree, I draw the gate and the house and a bit of the sky. So I didn't just do one thing

Interviewer: so you were creative with the things that you drew?

Olivia: I'm imaginative because my dreams at night are really creative, and my friends are quite imaginative [laughs]. My friend I, when we had a sleepover – when they all went to my house – she was sleeping and kicking, she was going "ahhh" because she was sat on a wall with Humpty Dumpty [laughs]

Interviewer: and how are *you* imaginative?

Olivia: I think that I have dreams like that as well

Interviewer: so you think your dreams are quite imaginative? Are you ever imaginative when you're awake?

Olivia: sometimes, but not all the time

Interviewer: okay

Olivia: I'm definitely artistic because I always do the small details with the art in the picture. So say I was drawing a tree, I'd do the little pieces of bark, and I'd mix colours to make that right colour

Interviewer: okay, brilliant – thank you very much. So J could you tell us about your words and why you chose them please?

Bluebell: I think I am artistic because I like art? And I like doing the detail on it…

Interviewer: what kind of art do you like doing?

Bluebell: [pause] I'm not sure, but I like drawing animals

Interviewer: okay

Bluebell: [pause] and… yeah

Interviewer: okay, fab

Bluebell: I kind of enjoy history

Interviewer: okay

Child: why?

Bluebell: …yeah

Bumble: I thought he said "I enjoy pastry"

[children laugh]

Olivia: that's what I thought you said!

Interviewer: but you said you enjoy *history*, what do you like about history [Bluebell]?

Bluebell: I don't know

Interviewer: okay

Bluebell: I just like it

Interviewer: okay

Bluebell: organised, because I don't like messy stuff

Interviewer: what kind of things do you organise?

Bluebell: [pause]

Child: plans maybe?

Bluebell: yeah, I make plans

Interviewer: you make plans? What kind of plans?

Bluebell: I don't know

[children are laughing, Poppy asks them to listen to Bluebell]

Interviewer: is that everything you wanted to say about organised?

Bluebell: I don't know, I just like organising *my* things, and I like organising art and how it looks. And I think creative's kind of like this

Interviewer: kind of like artistic? How come?

Bluebell: I don't know – because aren't you creative in your art?

Olivia: yeah

Bluebell: you could be creative in your art

Interviewer: do you think you're creative in your art?

[Bluebell uses non-verbal sign to indicate agreement]

Bluebell: I kind of enjoy sport because I like basketball and I have a basketball net at my house

Olivia: lucky!

Interviewer: brilliant, is that everything that you wanted to say about those?

Bluebell: yeah

Interviewer: lovely, thank you very much [Bluebell]. [Bumble], can you tell us your words and why you chose them please?

Bumble: I think I want to understand how things work, a lot because sometimes I read books and then I'm like "What does that mean?" and "how does that work? Which way does it go?" and "why does it do that?" and "how did it get here?" and "why is it here?"

Interviewer: and what kind of things do you think that about?

Bumble: Just questions really – what do you mean?

Interviewer: is there anything in particular that you want to understand how it works?

Bumble: things like machinery and technology

Interviewer: okay

Bumble: equipment. And then curious, I think I find this also interesting

Interviewer: ah so you think it links to wants to understand how things work? Okay, could you tell us more about curious?

Bumble: I think that's it

Interviewer: that's it, okay

Bumble: and I like being outdoors because I like playing with things outdoors

Interviewer: okay

Bluebell: making games up he normally does

Interviewer: do you make games outside?

Bumble: yeah

Interviewer: what kind of games?

Bumble: I don't know

Interviewer: you're not sure? Okay

Bumble: then I think I'm honest

[girls laugh, Poppy asks them to listen to Bumble]

Interviewer: why have you chosen honest [Bumble]?

Bumble: because I think I'm quite honest most of the time. I don't tell many lies really

Interviewer: that's only four words, did you have a fifth one?

Bumble: no

Interviewer: did you want a fifth one?

Bumble: no

Interviewer: okay, thank you very much for sharing that with us [Bumble]. We're going to do our final activity now

Black Cat: we've been here for an hour

Interviewer: I know! We've had lots to talk about haven't we? So for this last one, I've got some sheets for you to fill out. We'll go through the questions together

[chat about getting pens, pencils]

Interviewer: okay, shall we read through these questions together? So the first question, well at the top is the title of our project: STEM and archaeology, and the first question is have your thoughts or feelings about STEM changed during this project? So has the way that you think and feel about STEM changed since I started coming and speaking to you guys?

Bluebell: where do I write that?

Olivia: shall we write 'yes' or 'no' and then because

Interviewer: the 'because' can go in this section here

Bluebell: so we write our answer here

Child: can we do drawing?

Interviewer: yeah, write your answers for now, and we might have time for drawings. So if it's yes, if it's maybe, if it's no or a bit, can you also write why you think that? Or why it has or hasn't changed or has maybe changed a little bit

Black Cat: do we write it here?

Interviewer: you can write it wherever you want

Bluebell: I don't know how I can write about why

Interviewer: you're not sure why? Okay. So you've written yes, so how has it changed? What's different now?

Bluebell: I've learnt more

Interviewer: okay, learnt more what?

Bluebell: about STEM

Interviewer: okay, so you can write that down

[another child enters classroom]

Bumble: I'm not sure what to write about this

Interviewer: so why have you said 'no'? What was your reason for that?

Bumble: because I'm not sure what I've really – actually I've learnt how to build stuff

Interviewer: yeah?

Bumble: No, my thoughts and feelings haven't changed, but I'm not sure how to say why

Interviewer: okay, so when we started – what did you think or feel about STEM?

Bumble: just – it's just STEM

Interviewer: okay, and do you feel the same way now?

Bumble: yeah

Interviewer: so you could write 'no' and then your reason why is:

Bluebell: I have learnt about STEM

Interviewer: what have you learnt about STEM [Bluebell]?

Bluebell: I've learnt the meaning

Interviewer: yeah? Okay

Bluebell: science, technology, engineering and maths

Interviewer: okay, so [Bluebell] you feel like your thoughts have changed because you've learnt what it means? Okay fab. And while you're waiting for the others, you can draw a picture to go with it if you want to – you don't have to though. Okay [Bumble], you've done yours? You can also draw a picture if you want to. [Black Cat], you've said now you feel happy – do you feel happy…?

Black Cat: about STEM

Interviewer: ah okay – why do you think that that's changed?

Black Cat: because at first I was nervous about it because I was thinking "are we gonna go to somewhere?" because I usually get really nervous when I go to trips or something like that

Interviewer: okay

Black Cat: because it's quite scary for me – I always get nervous when we go on a trip

Interviewer: yeah?

Black Cat: but then once we've done a few weeks, I was really happy and I started to like it

Interviewer: so is it STEM that you like, or is it these conversations that we have?

Black Cat: I like the conversations about which we have

Interviewer: so you like the conversations that we have about STEM

[noisy room next door]

Interviewer: so does the way you feel about STEM feel different now?

Black Cat: yeah, so when I first was in the conversation, I was thinking "what does STEM actually mean? I haven't really got a full explanation so I'm going to have a bit of work on it" like that

Interviewer: and how do you feel about STEM now?

Black Cat: I feel like it's things which I like doing: I like doing maths, I like doing science, I even sometimes like our computing lessons, so it's quite fun

Interviewer: okay brilliant. And so [Olivia] you've put "a bit more because all the lessons have been fun" – ah thank you! – "and you used to be nervous but now you"

Bluebell: confident!

Interviewer: – feel?

[pause while Olivia writes]

Interviewer: so you used to feel nervous as well, what did you feel nervous about [Olivia]?

Olivia: because like what [Black Cat] said, I never knew what STEM means, I used to be like "what does it mean, and what if she asks me?" and I was put on the spot because I didn't know?

Interviewer: okay

Olivia: then everybody started laughing, so I felt quite nervous. But now I actually know what it means, I feel quite happy

Interviewer: okay, brilliant thanks guys. Have we done everything we wanted for that one? Are you happy with your answers?

Children: yeah

Interviewer: awesome, so the second question is [Q2]. So is there anything about you, about your personality, anything you're really good at? Anything you really love? That you think would help you to use STEM in the future – and that could be STEM –

Bluebell: I like computers

Interviewer: okay, do you think that could help you with STEM in the future?

Bluebell: yeah because technology, so how could I write that?

Interviewer: okay, so write your answers for that. Are you okay [Bumble]?

Bumble: yeah

Interviewer: just thinking?

[pause in conversation while children work]

Bluebell: now I'm going to draw a computer!

Interviewer: so how do you think liking computers will help you [Bluebell]?

[pause]

Interviewer: can you think of an example maybe? It's okay if you can't... Do you want to share your answer with us [Bumble]?

Bumble: no

Interviewer: okay, go on [Black Cat] what have you got?

Black Cat: I like science and maths, and STEM's quite important to me because when I grow up I would like to be involved with STEM

Interviewer: ah okay, what would you like to do in STEM? Actually that's the next question, so I won't ask you just yet. So you like science and maths, and STEM is important to you? Okay. And you've said that your usage of computing will help – how will that help [Olivia]?

Olivia: I think it might help because it's one of the four letters, and I'm quite good at computing. And my mum knows a lot about computing because she used to have a job that she used to do computing with

Interviewer: okay

Olivia: so I think that might help

Interviewer: okay, fab. So are we ready for the third question now everyone?

Bluebell: yeah

Interviewer: okay, so if you turn it over? So the last question is [Q3]. So any of the maths or science or technology or engineering skills – do you think you'd like to use those in your job?

Bluebell: maybe

Interviewer: maybe, why maybe?

Bluebell: because I don't know what job I want to have when I'm older, and my job that I might want to have when I'm older *might* include STEM

Interviewer: okay, would you be able to write that down?

Child: I need to draw the back screen

Bumble: I don't know what to write for the explanation

Black Cat: you could do 'yes' because and then whatever

Interviewer: is there a particular part of STEM that you might want to use when you're older?

Bumble: [pause] maths

Interviewer: maths okay?

Black Cat: do you want to be a maths teacher [Bumble]? If you want to be maths?

Interviewer: you don't want to be a maths teacher? Do you know how you'd like to use maths?

Bumble: no

Interviewer: fair enough, you're not sure yet okay

[chat about where Olivia will draw her picture]

Interviewer: are you happy with your answer [Bumble]?

Bumble: yeah

Interviewer: do you want to talk about it a little bit more?

Bumble: no

Interviewer: okay brilliant, thank you for filling that out, is it alright if I take it? Thank you!

Olivia: what's our third job going to be?

Interviewer: this is our third activity. Go on [Black Cat]

Black Cat: I would like to maybe because I like to be an archaeologist, or a zoologist

Interviewer: an archaeologist or a zoologist? What kind of animals would you like to study if you were a zoologist?

Black Cat: I would like to study more about wild animals – because wild animals, I don't often see. I would like to do some which have already been – because I really like dinosaurs, so maybe do some about dinosaurs

Interviewer: ah so learn about dinosaurs? What's the word for someone who studies dinosaurs?

Child: archaeologist

Child: fossilizer?

Interviewer: it begins with a 'p' – it's a really long word

[pause]

Interviewer: shall I tell you? It's a palaeontologist

Black Cat: or maybe you might study a woolly mammoth

Interviewer: is everybody finished?

Black Cat: one of the programmes on tv is 'can we bring the woolly mammoth back to life?'

Interviewer: oh yeah?

Black Cat: and I sometimes watch it

Interviewer: interesting! Did you want to talk about your one at all [Bluebell]?

Bluebell: no

Interviewer: okay, are we all done? Has everyone told me everything they'd like to say?

Children: yes

[recording end]

49 Appendix 37: Additional word sort results

The following outlines participant responses to the word sort exercise across all three interviews. The results described here are those that were not included in Chapter 7.

49.1 Artistic

When discussing this card in their first interview, participants highlighted the application of artistic skill in the design process, where an individual might want to place their ideas or plans on paper:

> Pippin: *you could have a blueprint of what you're going to do. Like how far you were going to dig down*
> Stanley: *you can do a lot of stuff which* [is] *artistic, you can design an aeroplane, you can colour the wings*

> Bumble: *if you draw what you're going to make, if you lose it then you'll just forget what you were going to make*

> NJ: *if you're an engineer you might need to –*
> Cupcake: *draw stuff*

Pippin also raised the caveat that while blueprints might be important, '*artistic means painting, I'm not really sure that painting really goes with science or mathematics or something like that'*.

In their second interview this attribute was considered by participants from YP and BF. Stanley and Barry both spoke about how an artistic person may be able to '*draw really neatly*', '*learn lots of shapes*', and be able to draw a straight line without a ruler. Based on their previous assertion that artistic skill might be of importance when designing an aeroplane, it is possible that drawing neatly and understanding shapes and lines are artistic skills that Stanley and Barry feel would be of value when designing something. However, Barry and Stanley did agree that artistic skills were not essential to someone working in STEM:

> Interviewer: *why might someone in STEM need to be artistic? Do they need to be artistic?*
> Barry: *they don't have to, they could just*
> Stanley: *it's a good thing to do*
> Barry: *yeah*

Olivia and Black Cat thought that artistic skills might be useful to an archaeologist:

> **Olivia:** *you might need to draw the bones to sketch all the little details. Maybe you could draw it and then you could put it back and then you could research it?*
> **Interviewer:** *yep*?
> **Olivia:** *and see if that's the bone and then you could find out all about it?*
> **Black Cat:** *or could you scan the bone to find out which it is?*
> **Bluebell:** *and when/ where it's from*
> **Black Cat:** *and then you could draw it, and then you can label it. If somebody else needs that – if they have found that same bone, then you can tell them what it is to help them, if they're really stuck on it*

The concept of artistic talent being of use in archaeology and heritage was developed further in participants' third interview:

> **Buster:** *you might need to make sculptures of dinosaurs and bones, so then if you're sending something to a museum to display it, you might need to make a sculpture of it so then you can remember what it looks like*

> **Black Cat:** *if you were going to paint or draw this fossil, it might have different shades of colour. There might not be a really dark dark pencil, so you might need to buy something else. Like black paint, and let it dry and then you're going to have to get the detail, so you have to know how to do that as well*

Pupils from BF and SP also explored the idea that artistic talent might be useful in science and engineering:

> **Interviewer:** *can you be artistic when you're doing different things?*
> **Black Cat:** *yeah, in science*
> **Olivia:** *sometimes, but not all the time*
> **Interviewer:** *can you be artistic in science?*
> **Black Cat:** *or engineering*
> **Bluebell:** *you might need to draw a bone!*
> **Black Cat:** *in engineering, you might need it. So say you're gonna build an aqueduct, you're going to need to draw it*

NJ: *engineering – you need an architect to engineer, to see what you're gonna build*

Both Black Cat and NJ appeared to use concepts from their third workshop, where pupils took on roles of engineers and architects to build an aqueduct from recycled materials. Bumble and Bluebell also spoke about the importance of artistic skills when designing. They outlined the technical artistic knowledge a person might need and suggested how art and maths skills might overlap:

Bumble: *if you want to design something, you need to know what type of pencil you need to design something*
Bluebell: *in some cases, you get loads of different shades of pencils*
Bumble: *I think art actually links to maths because you need to know how long the thing you're drawing is*
Bluebell: *and the margin, you might need to do that really neat*

Cupcake and Olivia disagreed with these opinions, and felt that artistic skills were not necessary to someone working in a STEM field:

Cupcake: *in STEM, you don't always need to be artistic. It's not about drawing and stuff like that, it's about working hard and solving challenges and finding bones*

Olivia: *I think you don't really need to be artistic because you would have to be artistic if you were an artist, but STEM: you don't really need to worry about art because it's not one of the four things*

49.2 Can take risks

This card had a mixed response across the two groups that discussed it in depth in their initial interview. It was regarded in a negative way by the children at YP, who were concerned that some risky behaviour might be a danger to someone's life. Cupcake and Skull Trooper expressed similar concerns.

Barry: *'take risks' = no*

Interviewer: *you don't think you should take risks?*

Barry: *no because it will maybe go wrong*

Stanley: *like, you've never ever drove a – car –*

Barry: *– motorbike*

Stanley: *– yeah and then you do it and then, you're risking your life*

Cupcake: *if you do take a bad risk, you could die*

Skull Trooper: *or you could hurt yourself!*

These beliefs fit in with the general themes of harm reduction that participants had already expressed when discussing 'sensible' and teamwork. In contrast to these perceptions, NJ appeared to understand that taking risks is not always associated with dangerous situations, and can often lead to good outcomes.

NJ: *the reason why I think it's quite important is because taking risks – the whole part of life is taking risks, and if you take risks and it actually works out, you'll be really happy with yourself*

The understanding that risk taking might have both positive or negative outcomes was continued in participants' second interview session. Skull Trooper explored the different types of risk that a person could take, and spoke about the measures that someone might take to reduce risk of their actions, such as wearing protective clothing.

Skull Trooper: if you take a risk, it could be a risk that leads to you in a lot of pain

Interviewer: *oh okay*

Skull Trooper: *and if you don't take the risk, it's better. And you'll help other people if you don't take serious risks*

Interviewer: *okay so you don't think that you should take serious risks. What kind of risks are okay to take? Are there any risks that are okay to take?*

Skull Trooper: *Trying out new things? If it's electrical, and it's a really powerful electrical, you should have some rubber gloves on*

Interviewer: *oh okay, so if you get electrocuted?*

Skull Trooper: *yeah because rubber gloves don't get electrocuted because rubber stops it*

Barry and Stanley also spoke about risk taking in terms of how dangerous something might be, or its potential to hurt others. They agreed that it wouldn't be appropriate for Ali to take risks that would lead to a patient's death:

> Barry: *so if she does a risk, there's more chance the patient's going to die*
> Stanley: *if you're doing it to somebody's parent – if you kill them, if they die – you won't feel good for the people*

In addition to medical careers, Stanley suggested that risk taking wouldn't be appropriate in his father's job:

> Stanley: *my dad can't* [take risks] *because he's an engineer does the wings – he designs them*
> Barry: *and if he does something wrong*
> Stanley: *if he puts too much weight up on one and one's up here*
> Barry: *so he can't take risks*

Previous discussion about the dangers of poorly designed planes touched on the fact that they might cause many people to die. It is clear that Stanley and Barry are aware that some risks have very serious consequences, and do not believe that these risks ought to be taken. In contrast to this, Barry felt that risk taking is acceptable in non-dangerous contexts:

> Interviewer: *is there anyone else that we know that it* ***is*** *okay for them to take risks?*
> Barry: *my mum because if –*
> Stanley: *science?*
> Barry: *yeah, science – she can take risks, but sometimes*
> Stanley: *not with like really – medicines*
> Barry: *no, not with like dangerous – but with – if you do an explosion, you can take a risk*
> Interviewer: *okay? Sometimes taking a risk might be a good thing?*
> Barry: *yeah*
> Interviewer: *why might it be a good thing?*
> Barry: *in a careful thing – you've got more chance of doing it right*
> Stanley: *sometimes you might say – to make an explosion you need a bottle of coke*
> Stanley: *one mento, and it says to you to put one mento in and instead you might put ten mentos in! Then it will go up!*
> Barry: *that's fine – I would say that's fine*

In their final interview, Barry and Pippin held differing opinions on the importance of this card for a person working in a STEM field. Barry expressed the concern that taking risks with a low chance of paying off would lead to failure of a project. However, unlike in the previous session, he did not appear to consider how the level of risk may vary between contexts. Pippin, on the other hand, believed that the potential payoff from risk taking would make it an important part of a STEM practitioner's job.

> Barry: *I think it could be least: can take risks. Because it might be 10% chance it will work, and that's not a percent to make this project work*
> Pippin: *I think it's actually important*
> Barry: *how?*
> Pippin: *because if you take a risk and try something out, it might work really well so you never know until you try*

49.3 Careful

Discussion prompted by this card in initial interviews placed an emphasis on getting things right and staying safe. Participants highlighted the importance of not making mistakes by being careful:

Pippin: *do everything right*

Cupcake: *you have to get it correct*
Blossom: *it will just end up going wrong*

Skull Trooper also mentioned the need to be careful if using something '*dangerous, like hot stuff*'. Discussion also touched on the idea of learning to be more careful following a mistake or mishap: Molly stated that '*after you've learnt from your mistakes, you're gonna be careful*'. Due to the similarity in responses to this and the 'sensible' card, it was not included in any further interviews.

49.4 Comes up with lots of new ideas

This card was present in the first interview only, and the majority of participants' suggestions focused on the importance of avoiding repetition or correcting previous mistakes. Bluebell and Bumble emphasised the importance of new ideas to prevent yourself from '*just making the same thing over and over*' and '[getting] *really annoyed*' when things don't work. Bluebell also suggested that '*the new idea might be* [a] *quicker* [way] *to do something'.* Jelly linked this card back to archaeology by stating that archaeologists need to come up with new ideas about where to excavate if they fail to find any archaeology at a site.

49.5 Competitive

Initial conversations about this word were framed around the idea that being competitive is unnecessary, and that it might impact teamwork. SP participants believed that competitiveness was not important to complete a task, as demonstrated by Blossom and Cupcake:

> Blossom: *you don't really need to be competitive, you can do it as fast or as slow as you want*
> Cupcake: *it really doesn't matter*

Other participants highlighted that being overly competitive might affect someone's ability to work well with others, or bring harm to themselves and those around them.

> Buster: *if you're competitive then that means that you can't work in a group*

> Apple: *if you get* too *competitive you can start to be mean and bring down other people's work*
> Jelly: *if you get too competitive, you might upset someone and it can bring their emotions down, and you could bring their work levels down as well*
> Interviewer: *ah okay, so you need to be careful when you're being competitive?*
> Jelly: *yeah. Last year on sports day, I got really competitive. I went round a corner really fast and I ended up sliding and twisting my ankle because I got too competitive*

These groups had previously made clear the value that they place on teamwork, and so it makes sense that they viewed anything that might disrupt this unfavourably. Black Cat and Olivia also felt that being competitive could lead to unpleasant behaviour:

> Black Cat: *if you do that and you win and you boast then –*
> Olivia: *- that's not very nice*

Cleo countered some of these ideas, by stating that '*you can't just be lazy*', she felt that being competitive might be beneficial in motivating someone to complete an objective or goal.

Following this, her group agreed that being competitive could be of value, as long as it was done in a careful and sensitive manner.

In their second interview, participants continued to examine ways that being competitive might be harmful. Skull Trooper outlined a scenario in which being competitive might be harmful to other people. In this scenario, he pitted a '*competitive*' person against someone who is '*just positive*'. This indicates that Skull Trooper considered competitiveness to be in opposition to positivity, and he exploreed how a person may leave a job if the environment is too competitive:

> **Skull Trooper:** *if you're competitive then – say if there's a manager, and then two people who work, one competitive person and one just positive. And then the competitive person is just being mean to the positive. It's a new business so they don't have much people and it's only them two, then the competitive* [person] *is really competitive, then the positive one might leave the job*

Cupcake felt that someone doesn't *'really need to be competitive with* [their] *work – you just try to find out as much as you can'*, and spoke about how being competitive may actually hinder the work you are trying to do:

> **Cupcake:** *if you're competitive, you may want to do more than the other person, so you may rush what you're doing – and you're meant to take your time and try and do it slowly so you're not rushing down all the research and you do it all wrong*

However, there was some consideration of how competitiveness might be applied in a constructive way. Stanley, Barry and Jelly all spoke about how competitiveness might be advantageous or necessary.

> **Stanley:** *you always have to be competitive in life*
> **Interviewer:** *what's important about being competitive?*
> **Stanley:** *because you can get far. If you're not competitive you're like "ah I'm not going to win"*
> **Barry:** *like Ronaldo*
> **Stanley:** "*I don't really care about this, I'm just going to have a go"*
> **Barry:** *and see what happens*

> **Stanley:** *and see what happens then when you've finished everybody thinks that you're good – you don't recognise how good you are*
> **Interviewer:** *so why is being competitive important in STEM?*
> **Barry:** *so you can show you're good*
> **Stanley:** *so you can show that you're competitive*
> **Barry:** *and trusted*
> **Stanley:** *you* want *to do it*
> **Interviewer:** *right okay – so have you got anyone in particular who needs to be competitive on here?*
> **Stanley:** *sport*
> **Interviewer:** *if you work in sport you might need to be competitive?*
> **Barry:** *like Ronaldo*

Jelly felt that being competitive is important for his friend's father, who is a business owner:

> **Jelly:** *he's very competitive with other companies*

Black Cat and Olivia suggested that being competitive may lead to a person showing off about their skills:

> **Black Cat:** *if somebody else from another place came over, and then they said "I can do this and you can't" you might want to say something that they wouldn't be able to do*
> **Olivia:** *So say if somebody said "I can do this and you can't" then you would say to get them impressed "actually yes I can", but you might not be able to yet*

These statements appear to be neutral, as neither Black Cat or Olivia pass any judgement on the hypothetical person in these scenarios. Instead, they may simply be commenting on the behaviours that might accompany competitiveness. While various advantages and pitfalls of competitiveness were covered in the second interview conversations, comparison of these factors did not occur within individual groups. Instead of recognising that being competitive can be both positive and negative, each group's discussion explored only one dimension of the personality trait. An exception to this was BF, where Bluebell suggested that competitiveness might be important, although his interaction with this word appears stilted, and indicates a lack of confidence in this opinion:

Interviewer: *Do you think that might be important if you work in STEM?*

Bluebell: *maybe* [pause]

Interviewer: *why do you think it might be important?*

Bluebell: [pause] *just so you get it right and maybe* [pause]

The same themes also featured in participants' final interview, with some pupils perceiving competitiveness as a specifically negative thing, and others exploring its application in appropriate contexts. Videogame Guy and Cleo spoke about how competitiveness might lead to poor time management:

Videogame Guy: *if you were competitive, then you would like getting to lots of competitions and that would just be a waste of time*

Cleo: *if you're competitive you might not focus on your work, and there might be a deadline and* [instead] *you're focusing on beating someone… So competitive would not be helpful and it can lead to some problems*

Buster, Skull Trooper and Molly also outlined how being competitive might negatively impact the people around you:

Buster: *if you were competitive then, you would be starting arguments, and it wouldn't be listening to other people's options*

Skull Trooper: *if you're competitive, you're kind of bossing everyone around and no one wants to be bossed around… you might think you're being just a normal person, but then other people are getting really sad that they're being bossed around*

Molly: *if you're competitive, like "Who can find the most bones?" [and] someone doesn't find as much bones, and then you're really mean to them, that could bring your job apart*

However, some participants did outline constructive applications of competitiveness. Stanley observed that it might be appropriate in a sporting context: *'that goes with sport, like "I'm gonna win this game"'*. Pippin revealed that she believes herself to be '*very competitive*' in response to this card, and spoke more about her perceived competitiveness during the self-assessment word sort task. Videogame Guy acknowledged that being competitive might be useful in some situations:

> Videogame Guy: *a race to 'who can fix the most computers in two hours' would be an okay competition*

49.6 Determined

This card was perceived in a generally positive way amongst the NB, BF and BG groups in their initial interview. 'Not giving up' was a central theme of the discussion surrounding this skill, and most children felt that there was value in persevering with a task.

> Buster: *if you're not determined then that means you'll just give up, but if you're determined then you'll try it again*
> Videogame Guy: *like if you're doing science and you're determined to do the experiment*
>
> Cleo: *if something goes wrong, you have to try again. If not, you're basically giving up and not being resilient*
>
> Black Cat: *important because then you want to find out more things and you don't give up*

In their second interview, Videogame Guy, Olivia and Black Cat all spoke about how determination might help a person to complete a goal.

> Videogame Guy: *I just think they need to be ready. Say they were going to do something, say they were going to do a task, which was kind of hard. They would need to be ready to do that task, especially if it was hard*
>
> Interviewer: *why might it be important to be determined in STEM?*
> Olivia: *so you can get past your task*
> Interviewer: *okay*
> Olivia: *and I think* [my cousin] *is quite determined to get past her exams*
> Interviewer: *ah okay. So is that her science exams?*
> Olivia: [indicates yes]
> Interviewer: *does anyone else need to be determined? Is that important for anybody else?*

Black Cat: *maybe Chloe?*

Interviewer: *yeah?*

Black Cat: *because she want to be determined to build this thing? Maybe if it's not the right time to, she doesn't have many of the right things*

Olivia: *like materials*

Black Cat: *but then she got them and then she can build it*

Only the pupils of BF chose to speak about this card in their final interview.

Olivia: *you need to be able to do it over and over again to be a scientist, you can't just do it once and then not do it anymore. Because that's basically not trying, so you need to be a bit inquisitive or –*

Black Cat: *resilient*

Olivia: *and also you need to do it over and over again because maybe if you done it first time and you got it wrong and you don't try again, but actually if you did try again, you might have got it right*

Bluebell: *there could be loads of different ways, and you only choose one way*

Interviewer: *okay, Bluebell – so there's lots of different ways, and you can choose –?*

Bluebell: *any way, and if that one doesn't work then you can choose another way, until it's the right one*

Olivia: *and the more difficult it is, I think it's better because you can try harder when it's more difficult. When it's easy you can just do it straight away – it's just because I like the more challenging because it makes me actually think*

Interviewer: *okay, so you like something to be challenging? You like to be challenged to be determined? Okay… were you going to say something Black Cat?*

Black Cat: *if we don't keep on trying it might be something important – a teacher might have said that we have such and such time left to do it, but then you really panic, but you shouldn't panic because then you might not get it done. So you should – if you first did it and it didn't go right, you should use your left over time maybe to do the rest*

49.7 Discusses ideas with others

This card was not discussed extensively, and was only mentioned by three of the groups in their first interview: BG, BF and SP. Black Cat felt that this was similar to 'shares information with others' and drew attention to the fact that the interview itself was a form of idea sharing and discussion. NJ suggested that it might be important to discuss ideas with others when helping them with research: '*you might need to help them look in the history, and do science, do maths*'.

Due to the limited interaction that this card stimulated, it did not feature in any further interviews.

49.8 Encourages others

This card was also subject to very limited discussion, and Olivia was the only participant who discussed it in any detail. She stated that she was unsure of her reasoning, but felt that encouraging others might be important in helping them achieve something they initially did not want to do. Because of this, she felt it was *'maybe a bit important, but not really important'* to someone working in a STEM career. This card was only present in participants first interview.

49.9 Enjoys building things

Perceptions of this card differed amongst groups in their first interview: BG and SP felt that it was quite important, YP regarded it in a generally positive way but did not assign a level of importance, and NB and BF thought that it was not particularly important to someone working in STEM. NB participants did not outline their rationale for this.

> Blossom: *I've got enjoys building things*
> NJ: *that's a good one*
> Interviewer: *oh okay, what do you think about that one?*
> Cupcake: *that's kind of like creative I guess*
> Interviewer: *So what do we think about enjoys building things?*
> NJ: *that's quite important… because engineering and maths*

> Interviewer: *Okay, what makes you put it on number one?*
> Pasta: *because you could enjoy building more buildings?*

> Stanley: *you can build things, aeroplanes, you could build cars, you could build motorbikes, you could build bikes and stuff like that*

Bumble's opinion changed as he spoke about this card:

> Bumble: *that's kind of important… actually, I think that should go on four because I think that you don't really do building*

In their second interview, Cleo and Olivia both highlighted the importance of this card to Chloe:

> **Cleo:** *I think for Chloe – she needs to enjoy building things, because she designs things… but she has to enjoy building things at the same time*
>
> **Olivia:** *because Chloe – she designs things in our built environment*
> **Interviewer:** *okay, so what might she build?*
> **Olivia:** *she might build* [pause] *she might build a thing to help to stop the environment from flooding, like what happens*

Olivia's comment may be linked to the Climate Change workshop. In that workshop there had been extensive discussion of how sea level change can cause areas to flood, including images and a video of the process and results. Only participants in the BG group chose to discuss this card in their third interview. They felt that this card would be important in engineering, but less so in other areas of STEM.

> **Videogame Guy:** *engineering – that's like building*
> **Interviewer:** *okay, so enjoys building things – you think might be important if you're an engineer?*
> **Videogame Guy:** *yeah, even if it's – it could be a house that could be good, it could be a Lego house that would still be good. Because it's practice*
> **Buster:** *you don't have to enjoy building things, because if you were working in medicine or maths, then you wouldn't be building things – but engineering* would *be*

49.10 Enjoys reading

In their first interview, participants spoke about this card in terms of its impact on your ability to follow instructions, or conduct research. Stanley felt that enjoying reading might be important to someone when following a set of written instructions. In response, Barry pointed out that someone doesn't have to 'enjoy' reading in order to follow instructions. However, Barry did also highlight that '*you can learn from books*', indicating that a person who enjoyed reading might be able to gain new knowledge as they read. Videogame Guy also highlighted this point: '*you could read things to learn about stuff*', and NJ suggested that you might '*look in a dictionary for things*'. Bumble noted that reading fiction might give a person ideas, and that they *'can get things out of the things that you read, like a made up story, you can design what it sounds like'*.

This card was covered briefly by Videogame Guy in the second interview session, who reemphasised the importance of reading skills skill in research, but the enjoyment of reading was not crucial to this:

> Videogame Guy: *you might read to get information? To help you with things, but you don't necessarily need to* enjoy *it*.

In their final interview, participants continued to consider how reading might be useful in terms of finding information or learning new facts from books.

> Videogame Guy: *if you were in science then you might need some information in order to do what you want to do, and you could find it in a book*
>
> Olivia: *if there's a book that you read to go and find facts, you have to kind of enjoy books*

The distinction between enjoyment and ability is also raised by Bluebell and Videogame Guy in their groups:

> Bluebell: *you don't have to enjoy it, you've just got to know how to do it*
>
> Videogame Guy: *reading* could *help you to do the job, but you don't need to enjoy doing that do you?*

49.11 Enjoys history

This card stimulated discussion about the range of jobs that might come under the umbrella of STEM in participants' initial interview. Archaeology and zooarchaeology was mentioned by two school groups, as references as to why a STEM practitioner might need to enjoy history:

> Cupcake: *you don't need history*
> NJ: *you sort of do because… if you're going to look at the bones*
>
> Black Cat: *if there are animals which are extinct, they're in history?*
> Bumble: *you must enjoy history because that's the stuff you dig up*

Bumble also reflected that enjoying history might only be important to those who use historical content in their work: '*I think four if they're people who use no history…I think number one if they're people who dig up the bones'*. Even after he has acknowledged that not all STEM practitioners are concerned with history, Bumble still does not believe that enjoying history is completely irrelevant to them.

In the second interview, discussion surrounding this card touched upon the idea of STEM practitioners who work with historical artefacts. Zooarchaeologists were mentioned by the YP group: Stanley suggested that '*you have to know how old the bone is'*. Buster believed that '*it's good to enjoy history because if you're working with historical artefacts then you have to be able to know what year and what time it's from*', but was unsure of any specific STEM job that might require this skill. Black Cat spoke about how Johanna (a conservator) might need to enjoy history, as her job requires her to do *'things with history from the past'*.

In their final interview, participants continued to think about the ways in which a STEM practitioner might interact with history across the whole spectrum of STEM. NJ suggested that this would be most important for archaeologists '*because if you're an archaeologist, you need to be able to look at the bones, and the bones are history'*. Stanley also suggested that enjoying history might be important to help someone contextualise an object that they had found. NJ thought that people outside of archaeology might also need to have an appreciation of history, which they could use to inspire their designs. He suggested that someone developing a new phone design might study '*the creators of the first phones*' to gather ideas for their work.

However, some participants highlighted that enjoying history might not be crucial to all areas of STEM:

> **Barry:** *you wouldn't really find history stuff in most STEM*
> **Pippin:** *not every single part is history*

49.12 Likes learning languages

In the initial interview, this card was linked to travel that might be undertaken as part of a person's job; it was thought to be important by the children who recognised this. Black Cat and Bluebell both thought that it is important to learn the language of countries that you visit:

> Black Cat: *because if you go to another country, and you don't know their language, then that's a problem because if you have a question to ask about what you're doing then you might need to speak the language*
> Bluebell: *it's kind of important to know it, if you go to a country with another language*

Some participants linked their thoughts to 'likes visiting other countries' card, noting that people who like to travel a lot, might also need to enjoy learning new languages.

> Skull Trooper: *if you're going to travel, you're going to need to know different languages*

> Black Cat: *if you like visiting other countries, then you need to know their language*

Pepperoni and Cleo suggested other ways in which someone might need to enjoy learning languages for their job; to use equipment programmed in another language, and to be able to read historical inscriptions. Pepperoni mentioned zooarchaeology, suggesting that '*maybe when they scan a bone'* the computer '*might be from another country'* and '*talk in different languages*'. Cleo agreed with Pepperoni and developed the idea further:

> Cleo: *maybe if you're an archaeologist and you've found something – let's say in Latin, you might be able to read it*

This card continued to be linked with 'likes visiting other countries' in the second interview, specifically by outlining the importance of understanding the language of the country that you're visiting. They felt that being able to communicate with the people in countries you visit as part of your job would be of importance to Scott and Chloe in particular.

Buster: *I think it's important to learn new languages because if you're going to a foreign country, then you have to know the language*
Interviewer: *ah okay, so who might like to learn languages then?*
Buster: *Chloe and Scott*

Black Cat: *Scott because he might need to learn*
Bluebell: *he might go to different places and he might want to talk to somebody*

This card was touched upon briefly by the BF group when they discussed 'likes visiting other countries' in their third interview. They felt that learning the language of a country in which you intend to work is important, in order to be able to communicate effectively with the people you will work with.

Black Cat: *you're going to have to know how to communicate*
Bluebell: *they might know where that bone is, and you don't understand their language or what they're saying*

Buster in the BG group, outlined a similar rationale for the importance of understanding languages when visiting new places:

Buster: *if you're going to a different country, and the people who you're visiting have no idea what you're saying if you're speaking in English, then you would have to learn that language to be able to communicate with that person*

49.13 Likes to learn new things

All five groups discussed this card in their first interview, and the major discussion theme was the concept of self-development. Black Cat felt that someone who likes to learn new things will '*get somewhere*', and Pepperoni stated that *'if you learn new things, you will get cleverer and cleverer at science, and then soon you'll know nearly everything about science'*. This card was spoken about by three groups in their second interview: NB, SP and YP. The children at NB valued learning new things extremely highly, and spoke about their own experience of learning new things:

Jelly: *I learn new things every day*
Pepperoni: *yeah, every second I learn new things*

Stanley and Barry spoke about how their respective parents might learn new things in their STEM jobs. Stanley suggested that his father could learn how to make different types of plane wing, and Barry outlined how his mother might learn new experiments to do with her class. Buster felt that wanting to learn new things would link with wanting to understand how things work, and that finding out how things work would constitute learning something new. Skull Trooper also thought that someone might learn new things by listening to other people's opinions.

The children who spoke about this card in their third interview, all suggested that learning new things would improve a person's intelligence, brain capacity, and career prospects. Blossom stated that '*every time you learn something, you get smarter and smarter'*, and Cleo felt that learning new things '*makes your brain bigger'*. Cleo's comment about improving brain capacity appears to have been made partly in jest, though it still highlights her perception that learning is 'improving' your brain. Cleo also believed that '*to get further in life you need to learn new things and it would be boring if you just knew everything'*, this sentiment was echoed by Jelly, who stated that *'if you never learnt anything, you'd just be dumb as a brick'*. Cleo highlights how learning new things might include learning from mistakes, which would be beneficial to a person's STEM career:

> **Cleo:** *it would help* [your] *career in STEM*
> **Interviewer:** *how would it help you?*
> **Cleo:** *so if you learn new things, you become smarter. And if you made a mistake and you learn from it, it would help you move on*

49.14 Likes to try new things

This card was only discussed at length by BF group in their first interview. This may be due to the card's similarity with 'likes to learn new things'. Bumble and Black Cat's conversation focused on using this to prevent failure at the same thing multiple times:

> **Bumble**: *because if you just do one thing, it might not work. And then you do it again and again and get more frustrated and then you might stop doing it*
> **Interviewer**: *so it's important to – do you mean trying different approaches?*
> **Bumble**: *yeah*
> **Black Cat**: *like different methods and strategies*

‘Likes to try new things’ was not present in the second and third interviews.

49.15 Likes visiting other countries

The focus of the conversation surrounding this card in the first interview, was on acquiring knowledge from new places. Apple suggested that a person might want to visit another country to ‘*see what they’re doing and how they’re actually building it’*. Cleo spoke about the possibility of a STEM practitioner attending an international conference: ‘*if you had a conference in a different country you would have to go’*. Skull Trooper linked his thoughts about visiting other countries to zooarchaeology: ‘*what if your country had no bones? So there’s basically no point of working’*. He suggests that a person might wish to visit other countries, in order to work with resources that are not available in their own.

In their second interview, Olivia, NJ and Buster spoke about specific examples of STEM practitioners who might like visiting other countries, using the STEM profiles they were given for the session. They all highlighted that Scott travels to Japan for part of his job, and NJ suggested that ‘*you might have to visit other countries to see different old buildings’* in reference to Johanna’s conservation work. Buster added that Chloe might also need to like visiting other countries, as she has worked as a civil engineer in both Peru and Uganda. In the final interview, the main theme of discussion surrounding this card was the concept that someone might visit a new country in order to learn something new.

> **Interviewer:** *why might someone who works in STEM be going to a different place?*
> **Buster:** *to find other dinosaur bones, or different kind of bones that are from animals, or information from other people*
>
> **Black Cat:** *maybe if you’ve got half of an animal but there’s one bone missing, there might be only that bone in [another] country*
>
> **Olivia:** [if] *there was just one small bone missing, you could go all around the world trying to find that bone*
>
> **Skull Trooper:** [if you] *know everything about the old stuff in Wales… now you might want to visit other countries*
>
> **NJ:** *you’ll end up learning history if you go to another country*

Participants also suggested that visiting other countries might make up a part of someone's job:

> **Stanley:** *some people in their jobs, they go to other countries*
> **Barry:** *yeah, maybe to build stuff*
> **Pippin:** *yeah like biologists*
> **Stanley:** *and my dad because my dad designs aeroplanes and he goes to Toulouse, Norwich… once he went to South Africa, even China*
>
> **Bluebell:** *there might be jobs in other countries where you visit*
>
> **Olivia:** *you need to like other countries to go and work there*

49.16 Gets all the answers right

This was regarded in a very negative way by the children who chose to discuss it in their first interview. The concept of learning from mistakes was drawn upon very strongly, with many participants emphasising the importance of trying again:

> **Buster**: *you don't need to get all of the answers right, if you get an answer wrong then you can have another go*
>
> **Black Cat**: *it's like learning from your mistakes, if you don't get them all right… it doesn't matter*
>
> **Cupcake:** *you might* want *to get all the answers right, you might as well just try and then if you make a mistake, you learn from it*
> **NJ:** *I think it's important to try your best, and then see what happens*
>
> **Molly:** *it's okay to be wrong somethings, not every time though*

While Molly's comment was made in response to the 'practical' card, her words are more appropriately discussed here: she appeared to understand that being wrong is part of a learning process, but appreciated that *never* getting answers right can also be a barrier to achievement. Finally, Apple's thoughts were framed by the belief that it is necessary for a person to be challenged in order to retain their interest:

Apple: *I think this is a* bad *thing because if you get all the answers right, it's just going to be really easy… and things that are really easy are a bit boring*

Participants continued to perceive 'gets all the answers right' in a negative light, and appear to believe that it is not important to a person working in a STEM field. Much of their discussion was in opposition to the content of the card, and centred around the idea of learning from mistakes and 'trying again'.

Buster: *if you do get some answers wrong, then you can try the test again*
Videogame Guy: *if at first you don't succeed, try try again!*

Stanley: *you can do a couple of mistakes and then go back and do it better*

It was even suggested by Black Cat that making mistakes might be good for personal development: '*if you've made the mistake – like at school – then that's good because you learn from that'*. However, Black Cat recognised that some mistakes might not be beneficial, citing Ali as an example: *'if she made a medicine, she needs to try and get it right*'. Olivia was an exception to this, drawing upon her understanding of an older cousin studying biomedical science at university. Olivia pointed out that getting answers right might be desirable in a degree context '*because if you get it wrong, you might not be able to do the job that you want to do'*.

Opinion on this card in the third interview was almost entirely unanimous, and once again emphasised that getting answers wrong might be regarded as a learning opportunity.

Buster: *if you don't get an answer right then it doesn't matter, you can learn from your mistakes*

Black Cat: *you don't always have to get* [things] *right because you could learn from it – you might do it again… and again until you can do it*
Bumble: *I think it's not important because then you know how to make it better the next time… next time, maybe you'll have a better idea than you did the first time*

Jelly: *getting all of the answers right isn't learning*

Jelly, Cleo and Apple considered what life would be like for someone who did get all answers right. They appeared to believe that this would have a negative impact:

> Jelly: *one day you're gonna get bored of getting all the answers right, sometimes you need to think more*
> Cleo: *in school if you knew all of the answers, you'd just be bored and think it's a waste of time*
> Apple: *if someone came up to you and gave you a really hard question, you could just say the answer and it wouldn't be very fun*

Overall, participants had realistic expectations of performance when answering questions:

> Videogame Guy: *you just need to get some* [answers] *right. Not necessarily first time, but* some

> Bluebell: *you might have learnt it every day, but when it comes to a test and you've got to do that sum, you get it wrong*

> Cupcake: *it's not about being the best and getting all the stuff right, it's about trying your hardest*

> Skull Trooper: *you just got the answers wrong by accident or something*
> NJ: *I sort of think the same*
> Interviewer: *yeah? So if you get an answer wrong by accident - ?*
> Skull Trooper: *it isn't really much of a deal*

49.17 Hardworking

This was considered to be important across all groups in their first interview. There was very little disagreement amongst participants about the placement of this card, therefore discussion of it was limited. In this interview, the importance of being hardworking was discussed in general terms, rather than how it might specifically relate to somebody working in STEM. Barry drew a link between being hardworking and earning potential:

> Barry: *you have to be hard working… you work hard and you get more money*

However, Pasta stated that this card was not important:

Pasta: *that's going on number five*
Interviewer: You don't think it's important to be hardworking? How come?
Pasta: *because you don't have to be hardworking*

In their second interview, participants spoke about the 'hardworking' attribute in relation to specific individuals, and more generally within STEM.

Interviewer*: okay Jelly which words did you think might be important for somebody who works in STEM?*
Jelly: *I'm doing this for my friend – he's a grown up but I can never remember his name. He's* [classmate's] *dad*
Interviewer: *okay, what does he do in STEM?*
Jelly: *he owns his own company, he uses a computer to design a car... he's very hardworking. Extremely hard working*

Interviewer: *What does everyone else think about hardworking?*
Skull Trooper: *I think it's good, because if Rhodri does some bad – not good work on the computer, it might still work a little and then it might be even worse?*

Stanley: *so you always need to put lots of effort into something. Say if you're engineering a plane, you won't be like "okay another plane to work on okay I'll do exactly the same" - but it might a different plane, so you need to think hard*
Barry: *okay, "so I make the same size but then I'll put different things on it"*
Interviewer: *okay, and you need to work hard to do that?*
Stanley: *if you always work for one company... you have to try your* best *for that company*
Interviewer: *okay*
Stanley: *so say if you work* [as an aeronautical engineer] *you're like... "it's boring, but I'll just do the wing" and he designs is and it all goes wrong when the plane takes off*
Interviewer: *ah right so you need to be hardworking to make sure it works properly?*
Barry: *yeah*

More general comments about being hardworking in a STEM career were made by Buster, Black Cat and Bluebell:

Buster: *I think hardworking because if you're in STEM then you have to be able to do things that sometimes you can't do*
Interviewer: *okay*
Buster: *and if you can't do it yet, then you have to try again*
Interviewer: *okay, so you have to work hard to try again?*
Buster: *yeah*
Interviewer: *where would you like that card to go?*
Buster: *I think they all need to be hardworking*

Black Cat: *if we only have one person on the task, then it's not*
Bluebell: *not very good*
Black Cat: *very quick, and then you want to get most of it done and we're all doing something*
Bluebell: *probably all of them might need to do hard work*

Hardworking was not discussed by any group in their final interview.

49.18 Inventive

In their first interview, all participants who discussed 'inventive' made reference to the creation of 'new' things:

NJ: *you could be able to get something old and then make it into something new*

Stanley: *you have to be inventive to design an aeroplane and do everything - make a motor, which goes into the aeroplane. And you could invent new stuff, like new science stuff, you could invent*

Jelly: *if you're being an engineer in a university, you might need to be inventive to be able to create new things like* [pause] *a person needs to be creative to make a chocolate bar*

SP, BG and BF chose to speak about this card in their second interview. NJ and Bluebell both related 'inventive' to the work of Scott from the STEM practitioner profiles who works as a technologist, though only NJ expanded upon his reasoning:

> **NJ:** *if you have a job like Scott, you need to be able to invent and fix and make things better*

Buster and Black Cat both suggested that Chloe would find this skill useful, with Buster making specific reference to Chloe's work as an engineer:

> **Buster:** *I think inventive goes with Chloe because she's an engineer*
> **Interviewer:** *ah okay, so what kind of things is she inventing?*
> **Buster:** *she's seeing the hygiene of the water in Peru and Uganda*
> **Interviewer:** *okay, and how is she being inventive? What's she doing to be inventive?*
> **Buster:** *she is* [pause] *making new designs and building* [pause] *things in the environment*

Videogame Guy's contribution to the discussion of this word centred around the glossary definition of inventive ('comes up with new ideas to solve puzzles, or design new things'). He suggested that solving puzzles might be useful to someone in mathematics:

> **Videogame Guy:** *because the mathematics part*
> **Interviewer:** *yeah?*
> **Videogame Guy:** *it says comes up with new ideas to solve puzzles*
> **Interviewer:** *yeah?*
> **Videogame Guy:** *you might need to do that*

This card was not selected by participants for discussion in the final interview.

49.19 Learns from their mistakes

This card was discussed by each group in the first interview, and was felt to be of some to high importance by all participants. The main focus of the discussion surrounding this card at BG was the issue of safety: '*if you make a mistake in science, you'd know not to do it again because it could be dangerous*'. Molly linked the concept to archaeology, by stating that '*if you dug a little bit too far…next time you know not to do it*'. Black Cat discussed this card in terms of resilience, and reflected on how learning from mistakes would help prevent someone from '*giving up*'.

Jelly's perspective of learning from mistakes is one where a person can '*learn from that mistake and move o*n'. He also suggested that people who don't make mistakes are '*perfect'*, but that these people are at a disadvantage because '*if you don't make any mistakes in life, you won't be able to learn as much*'. While '*perfect'* could be used as an aspirational term, it is clear that Jelly believed that there is more value in making mistakes as part of the learning process. This card was not present in the second or third interviews.

49.20 Listens to other people's opinions

A common theme when discussing this card in their first interview was the importance of using other people's opinions to widen your own range of options.

> **Black Cat:** I *think that it's good because then you have lots of options of what it could be and then you might have a good chance of getting the answer*

> **Apple:** *you can listen to other people's opinions, which is a good thing because it gives you more ideas, but sometimes you've got to have your own ideas as well*

Many children also mentioned that once a person has listened to other people's opinions, then they may still proceed with their original plan if they think it's the best course:

> **Buster:** *you can listen to other people's opinions, but if you think that something's a really good idea then you don't* need *to*

> **Bumble**: *if you have something really strong in your mind that you think will work, and you test it out with a piece of paper or something, and maybe something did work and you had that in your mind a* lot*, maybe you should listen to what* you *think*

The concept of improving your own work by hearing a range of ideas was picked up again in participants' second interview. NJ and Videogame Guy both identified a link between listening to opinions and teamwork.

Pepperoni: *if you don't listen to other opinions, you won't get any ideas*

Cupcake: *you can learn other people's ideas and what they decided to do*

NJ: [Scott] *can hear people's ideas to improve the technology to work with everyone*

Videogame Guy: *listening to other people's opinions – that could help you, so they would be helping you and technically that's working as a team*

Stanley, Barry and Bluebell identified specific people that they thought ought to listen to others' opinions in their jobs. Stanley and Barry spoke about the different ways listening to opinions might be important in a medical setting, and also touched upon the theme of working in a team.

Stanley: *like a doctor you -*
Barry: *listen what they're going to do*
Stanley: *listen to what the person thinks and what he really wants you to do well with him*
Interviewer: *so this person here, she's a doctor isn't she? Who does she need to listen to?*
Stanley: *she needs to listen to other doctor's opinions*
Barry: *yeah*
Stanley: *because then she*
Barry: *can make something bigger*
Stanley: *she and* [another doctor] *can work together*

Bluebell: *so* [pause] *maybe him because*
Interviewer: *Rhodri yeah? Why might it be important for Rhodri?*
Bluebell: *maybe because he might say "it's broken", but some other person might say "it's not broken"?*
Interviewer: *oh so he might need to listen to their opinion?*
Bluebell: *maybe he'll check because they might be right or they might be wrong*

The concept how of listening to other opinions might impact teamwork was examined again in the final interview, with participants from YP linking this card to project collaboration:

> Molly: *well, if you're working in a group then if you're not listening to anyone else, then you won't know what to do*
> Interviewer: *okay, and why might that be important if you work in STEM? So if you're a scientist or a mathematician or a technologist?*
> Molly: *because you usually have to work together, not apart. If you had to find bones, like you do, or stuff in the ground, well you'd have to work as a team to pick an area*
> Interviewer: *what we're you going to say about that one Pippin?*
> Pippin: *well this is for other people's opinions, so say you're about to do a science experiment, you have to listen to other people to try and find out how you can probably make it. Like how it might work. So there's one thing gone wrong*
> Interviewer: *yeah*?
> Pippin: *you have to make sure that everyone knows that that's happened and you have to work together to* [pause] *fix it. But you have to listen to other people and try and make a way to do it*

NJ suggested that listening to others opinions may be of value in cases where you need someone's help:

> NJ: *if you* [pause] *do maths, you might get a wrong calculation but then someone else might help you get it right*

49.21 Practical

Discussion of this card was limited, across all three interviews. Where is was discussed, it appears to be frequently misunderstood or misinterpreted. In her first interview, Molly suggested that being practical might be important '*so you get it right and not wrong'*, although she later admitted that she was still unsure of the definition, putting her suggestion into question. Apple also appeared to have misunderstood what was meant by 'practical' in this context:

Apple: *if you're not practical at all, that means no one's going to like you because you're not funny*
Interviewer: *okay*
Apple: *but if you're a little bit practical, some people are going to like you because you are a little bit funny*
Interviewer: *ah like a practical joker?*
Apple: *yeah*

None of the participants elected to speak about 'practical' in their second interview, and only the NB group discussed it in the third. Due to Apple's previous interpretation of 'practical' as being related to a 'practical joker', in the third interview, the interviewer was careful to explain the difference between a person with practical skills and a person who might be described as a 'practical joker'. Jelly was the only child who spoke about this card, relating practicality to efficiency:

Jelly: *I think you need to be very practical in science because you need to be very focused, hardworking, and you don't really want to dilly-dally*

49.22 Reflective

Discussion about this attribute was limited in the first interview; Buster was the only child who spoke about it. She described it in terms of learning from past mistakes.

Buster: *if you've done a mistake in the past, then you can reflect on that and say what went well, and next time you could do something better*

Buster's perception of 'reflective' in her second interview was consistent with what she had said before. She outlined how reflecting on work might inform future approaches to similar tasks, and Videogame Guy mentioned how they are encouraged to undertake reflective practice in their lessons.

Buster: *I think it's important to be reflective because if you got something wrong, in the past and you want to try again on it, then you have to be reflective*
Videogame Guy: *we do it in class*
Interviewer: *oh do you?*
Videogame Guy: *after our work because we do the 'what went well?' and 'even better if'*

Black Cat and Olivia chose to speak about this card in their third interview. They both regarded it as a positive thing, which would enable a person to improve their work. While Black Cat discussed how reflection might improve future work, Olivia explored the dynamic nature of reflection and explained how it might be used to adapt work in the present.

> Black Cat: *if you have – like what we just did with the aqueducts – if we built something, like out of technology and then it doesn't go as we planned, then we talk as a team what we could do better next time to make it again*
> Interviewer: *okay, does anyone else have anything to add to that?*
> Olivia: *yeah – so say you built something wrong, you could reflect to that and see what you could do differently. And then give your ideas to the other people in your team. So say Black Cat was in my team, and we were building the aqueducts and we accidentally missed something, and I reflected back quickly, I could give her my opinions what we could do differently*

49.23 Reliable

Buster was the only participant who discussed this in the first interview. She felt that reliability was very important to a person working in STEM:

> Buster: *if someone says to look after the bones, then if you stayed then that means you're reliable, but if you went and* [did] *something else, then that's not being reliable*

In the second interview, some of themes that had been discussed for honesty were picked up again in relation to reliability, by Black Cat, Bluebell and Buster.

> Black Cat: *so like somebody is relying on somebody to if the phone rings, they get the phone. Or rely on them to fix the computer or something else?*
> Bluebell: [Rhodri] *could say "I promise to fix the computer"*
> Black Cat: *or maybe Ali – this person relies on her to give her the right medicine and get them back to how they're meant to be*
> Bluebell: *somebody might make a medicine for her, and she might trust that it's the right medicine for them*
> Interviewer: ah so as well as *being* reliable, she needs to be able to rely on other people to give her
> Child: *because they're trusting*

Buster: *if you're on your own and someone leaves you to go and do something else, you have to be – you can't make it all messy when they're gone*

Buster also suggested that reliability might be an important skill for Johanna (a conservator), but did not explain her rationale:

Interviewer: *are there any people in particular who need to be reliable here?*
Buster: *maybe Johanna?*
Interviewer: *Johanna? Why does Johanna need to be reliable?*
Buster: *because* [pause] *she has to* [pause] *I'm not sure but I just think it would be – she has to be reliable*

Pepperoni and Cleo spoke about how an archaeologist might need to be reliable:

Pepperoni: *so you need to be reliable to be an –*
Cleo: *archaeologist*
Pepperoni: *there you go – so you need to be reliable if someone needs you – with all the bones and you have to be sensible and reliable with all of them*

Cupcake thought that reliability might be important for all people who work in STEM, as team members will rely on each other for help in their research:

Cupcake: *I think it should go maybe in the middle* [of the STEM career mind map] *because with reliable, you can rely on somebody – maybe in your team, who you're helping, they want to rely on you to help them with their research*

In the final interview, Jelly outlined how the importance of reliability might vary across STEM, though peers in NB group disagreed with him:

Jelly: *I think if you were a scientist, you'd mostly work alone because you'd be examining DNA, but in other cases, like in maths, engineering and all of them, you'd have to be reliable*
Interviewer: *okay*
Jelly: *so I would put it in most* [important] *for certain jobs*
Cleo: *I think it should be for all jobs, because if you're studying DNA, some people have to do some parts because you can't do all of it yourself*

Pepperoni: *yeah*
Cleo: *and you need to work as a team*
Interviewer: *okay*
Cleo: *and you could be working with different parts of STEM to create something like a project*
Apple: *I feel like since I said DNA in my one, everyone's started saying DNA*

Buster and Pepperoni discussed reliability in terms of the potential negative impact of a person who is not reliable:

Pepperoni: *if someone leaves you with something and you're not reliable, if you're in a team in STEM, you could get your team fired or something for not doing it*

Buster: *I think that you have to be reliable, because if you were left on your own to do a job then you have to* [pause] *be sensible and not mess things up*
Interviewer: *okay*
Buster: *But if you do mess something up, but by accident, then you can say what happened*

49.24 Shares information with others

This card also had limited interaction, but was deemed of some to high importance by BG, BF and SP. Black Cat suggested that sharing information with others would be important when helping someone understand something: '*if they don't get it, you can help them*'. This card was present in the first interview only.

49.25 Wants to understand how things work

Participants gave a range of examples when speaking about this card in their first interview; understanding equipment, understanding human biology and solving problems.

Buster: *if you're working with a machine, then you have to know how to work it*

Black Cat: *if you don't get it, then you could try and see how you could solve it and then you're trying to understand it*
Bumble: *you need to know how things work, but I don't think it's actually that important*
Black Cat: *I think it's very important*

Bumble: *you need to be able to do a few things… you need to know how to do things or you can't really –*
Bluebell: *do anything*
Bumble: *like a laptop*

Cleo: *it means the same thing as curious*
Jelly: *yeah but say if you were studying how bodies work, how things work, how your brain works, how your heart works, how your body works and all your body functions*
Interviewer: *okay, so you guys think number one? Why did you think number one?*
Pepperoni: *because it's really important Because if you don't know how things work, you might not learn, when you grow up, you might not know stuff. You might not know how stuff works and you might make it really wrong. When you do a mistake the first time, you might do it a second time, and you need to understand how to do it right*

Cupcake believed that wanting to understand how things work differed in importance between disciplines:

Cupcake: *it's not important in some science, but then it is important in others*

The children who talked about this card in their second interview, did so with reference to a specific STEM profession:

Videogame Guy: *I think the technologists would need to do that because – [they] would want to understand how the technology works, like how when you press a key on a computer, something happens or how when you press something on an iPad, something happens*

Stanley: *How a beekeeper keeps all the bees in the hives? How the bees make it work, how they turn the nectar into honey? How do the people get the bees to them and in the hives to make honey for the people?*

Black Cat: *maybe Ali, she might want to know how that medicine works and what it can do*
Olivia: [Scott] *might want to learn a bit more about technology*

Participants continued their consideration of specific STEM careers when discussing this card in their final interview. In Cleo's opinion wanting to understand how things work was essential for those working in STEM and she illustrated this point with examples from each STEM branch; Jelly explored how his own desire to understand how things work fuels his personal interest in STEM. Videogame Guy and Molly both suggested that this card might be particularly important for people working with technology. Videogame Guy's rationale for this appeared to stem from his perception that technology is complex, whereas Molly was concerned about individual pursuit of new knowledge.

> Cleo: *one of the key points if you're working in STEM is wants to understand how things work. Because for science you need to understand how the human body works; technology, you need to understand the technology itself; for the engineering you need to understand the points of the type of engineering you're doing. And for maths you need to understand how to do equations*
> Jelly: *I think it's very important because I want to know how the periodic table works, what the periodic table is, what the periodic table can be used for – what the things in the periodic table can make, what the things in the periodic table are. I'm obsessed with the periodic table now*
>
> Videogame Guy: *technology, it's very complicated to know how it works. So if you want to understand how it works, that would be good*
>
> Molly: *Say you're a technologist and you don't know how one thing works and you don't really want to learn about it because you don't enjoy learning, you're not really going to find anything out are you?*

Skull Trooper and NJ both believed that wanting to understand how things work was important, particularly if '*you're new to STEM'*, or are learning about a new part of STEM:

> Skull Trooper: *I think it's that because if you're new to STEM, you need to know what things to do in STEM. Because if you don't know, you might want to ask someone to help you*
> Blossom: *what if you already know how things work?*
> NJ: *but then new STEM? How that works?*

Blackjack was the only participant who did not believe this trait to be of high importance. This may be due to the way in which she interprets the meaning of the card. She spoke about this card as if the person in question has already learned how everything works, rather than them having a curiosity about the processes behind things.

> **Blackjack:** *you don't need to know how every single thing works because then your job would be a bit boring and it would be a bit confusing, knowing how every single thing works*

50 Appendix 38: Examples of archaeological content on the reformed Welsh curriculum

The following outlines ‘descriptions of learning’ for Progression Step 2 (age 8) by ‘statements of what matters’ from the reformed Welsh curriculum as they relate to examples of archaeological practice.

Science and Technology Area of Learning

<table>
<tr><th>Area of Learning</th><th>Statements of what matters for Progression Step 2</th><th>Excavation and other field-work</th><th>Archaeological investigation: data collection, analysis, interpretation</th><th>Experimental archaeology (e.g. craft, construction, cooking)</th></tr>
<tr><td rowspan="5">Science and technology</td><td>Being curious and searching for answers is essential to understanding and predicting phenomena</td><td colspan="2">I can ask questions and use my experience to suggest simple methods of inquiry
I can recognise patterns from my observations and investigations and can communicate my findings</td><td></td></tr>
<tr><td>The world around us is full of things which depend on each other for survival</td><td></td><td colspan="2">I can use my knowledge and understanding to predict effects as part of my scientific exploration</td></tr>
<tr><td>Forces and energy provide a foundation for understanding our universe</td><td></td><td>I can explore relationships between living things, their habitats and their life cycles</td><td></td></tr>
<tr><td>Design thinking and engineering offer technical and creative ways to meet society’s needs and wants</td><td></td><td></td><td>I can produce designs to communicate my ideas in response to particular contexts
I can make design decisions, using my knowledge of materials and existing products, and suggest design improvements</td></tr>
<tr><td>Matter and the way it behaves defines our universe and shapes our lives</td><td>I can safely use a range of tools, materials and equipment to construct for a variety of reasons</td><td></td><td>I can safely use a range of tools, materials and equipment to construct for a variety of reasons
I have experienced using basic prototyping techniques to improve outcomes</td></tr>
</table>

Area of Learning	Statements of what matters for Progression Step 2	Excavation and other field-work	Archaeological investigation: data collection, analysis, interpretation	Experimental archaeology (e.g. craft, construction, cooking)
Science and technology	Matter and the way it behaves defines our universe and shapes our lives (continued)	I can identify things in the environment which may be harmful and can act to reduce the risks to myself and others		I can identify things in the environment which may be harmful and can act to reduce the risks to myself and others I can explore and describe the properties of materials and justify their uses

Mathematics and Numeracy Area of Learning

Area of Learning	Statements of what matters for Progression Step 2	Excavation and other field-work	Archaeological investigation: data collection, analysis, interpretation	Experimental archaeology (e.g. craft, construction, cooking)
Mathematics and numeracy	The number system is used to represent and compare relationships between numbers and quantities		I can read, write and interpret larger numbers, up to at least 1000, using digits and words I can understand that the value of a number can be determined by the position of the digits I have engaged in practical tasks to estimate and round numbers to the nearest 10 and 100 I am beginning to understand that unit fractions represent equal parts of a whole and are a way of describing quantities and relationships. I have experienced fractions in practical situations, using a variety of representations	

<table>
<tr><th>Area of Learning</th><th>Statements of what matters for Progression Step 2</th><th>Excavation and other field-work</th><th>Archaeological investigation: data collection, analysis, interpretation</th><th>Experimental archaeology (e.g. craft, construction, cooking)</th></tr>
<tr><td rowspan="10">Mathematics and numeracy</td><td>The number system is used to represent and compare relationships between numbers and quantities (continued)</td><td></td><td>I have explored equivalent fractions and understand equivalent fraction relationships

I have explored additive relationships, using a range of representations. I can add and subtract whole numbers, using a variety of written and mental methods</td><td></td></tr>
<tr><td rowspan="4">Geometry focuses on relationships involving shape, space and position, and measurement focuses on quantifying phenomena in the physical world</td><td colspan="2">I have explored and used different ways of showing the passing of time, including calendars, timelines, simple timetables and schedules</td><td></td></tr>
<tr><td colspan="3">I have explored measuring, using counting, measuring equipment and calculating, and I can choose the most appropriate method to measure</td></tr>
<tr><td colspan="3">I can use a variety of measuring devices from different starting points</td></tr>
<tr><td>I can describe and quantify the position of objects in relation to other objects</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Statistics represent data, probability models chance, and both support informed inferences and decisions</td><td colspan="2">I can collect and organise data to ask and answer questions in relevant situations</td><td rowspan="4"></td></tr>
<tr><td></td><td>I can sort and classify using more than one criterion, including the use of Venn diagrams and Carroll diagrams</td></tr>
<tr><td colspan="2">I am beginning to record and represent data in a variety of ways, including the use of tally charts, frequency tables and block graphs, when appropriate axes and scales are provided</td></tr>
<tr><td rowspan="2"></td><td>I am beginning to interpret and analyse simple graphs, charts and data</td></tr>
<tr><td colspan="2">I can explain my findings and I am beginning to evaluate how well my method worked</td></tr>
</table>

Health and Wellbeing Area of Learning

<table>
<tr><th>Area of Learning</th><th>Statements of what matters for Progression Step 2</th><th>Excavation and other field-work</th><th>Archaeological investigation: data collection, analysis, interpretation</th><th>Experimental archaeology (e.g. craft, construction, cooking)</th></tr>
<tr><td rowspan="8">Health and wellbeing</td><td>Developing physical health and well-being has lifelong benefits</td><td>I can use and improve basic movement skills in familiar and unfamiliar situations. I can respond to prompts in imaginative and creative ways. I have the confidence and motivation to persevere when faced with physical challenges</td><td></td><td>I can use and improve basic movement skills in familiar and unfamiliar situations. I can respond to prompts in imaginative and creative ways. I have the confidence and motivation to persevere when faced with physical challenges</td></tr>
<tr><td rowspan="2">How we process and respond to our experiences affects our mental health and well-being</td><td></td><td colspan="2">I can, with support, focus attention on my perceptions and thoughts</td></tr>
<tr><td colspan="3">I can reflect on my experiences</td></tr>
<tr><td rowspan="3">Our decision making impacts the quality of our lives and the lives of others</td><td colspan="3">I can make decisions based on what I know</td></tr>
<tr><td colspan="3">I can take part in group decisions and I understand why some decisions need to be made as a group</td></tr>
<tr><td>I can identify and assess risks</td><td></td><td>I can identify and assess risks</td></tr>
<tr><td>Healthy relationships are fundamental to our well-being</td><td></td><td></td><td>I can make friends and try to resolve disagreements, seeking support when needed</td></tr>
</table>

Humanities Area of Learning

Area of Learning	Statements of what matters for Progression Step 2	Excavation and other field-work	Archaeological investigation: data collection, analysis, interpretation	Experimental archaeology (e.g. craft, construction, cooking)
Humanities	Enquiry, exploration and investigation inspire curiosity about the world, its past, present and future	I have been curious and made suggestions for possible enquiries and have asked and responded to a range of questions during an enquiry		
		I have experienced a range of stimuli, and had opportunities to participate in enquiries, both collaboratively and with growing independence		
		I can collect and record information and data from given sources. I can then sort and group my findings using different criteria		
			I can recognise the difference between facts and beliefs	
		I can present what I have discovered in a variety of ways and draw simple conclusions		
	Events and human experiences are complex and are perceived, interpreted and represented in different ways		I can recognise and explain that my opinions and the opinions of others have value	
			I can recognise that opinions may change over time	
			I am beginning to recognise other people's feelings and viewpoints about familiar events or experiences	
	Our natural world is diverse and dynamic, influenced by processes and human actions	I can describe how people and the natural world may impact on each other		
		I can describe how places, spaces, environments and landscapes are important to different people and for different reasons		
		I can recognise the distinct physical features of places, environments and landscapes in my locality and in Wales, as well as in the wider world		
		I can describe how and where some places and environments are similar and others are different		
		I can recognise the distinctive features of places, environments and landforms, and how these may change		
	Human societies are complex and diverse and shaped by human actions and beliefs	I can sequence events and I am beginning to understand that the past can be divided into periods of time		
		I can recognise similarities and differences between people's lives, both in the past and present		

Area of Learning	Statements of what matters for Progression Step 2	Excavation and other field-work	Archaeological investigation: data collection, analysis, interpretation	Experimental archaeology (e.g. craft, construction, cooking)
Humanities	Human societies are complex and diverse and shaped by human actions and beliefs (continued)	I can identify aspects of life in my community that have changed over time		
		I have explored some causes and effects of events and changes in my community over time		
		I can explore my identity and compare it with those of others, recognising that society is made up of diverse groups, beliefs and viewpoints		
		I have explored and am aware of diversity in communities		
	Informed, self-aware citizens engage with the challenges and opportunities that face humanity, and are able to take considered, ethical action			I can take care of resources and not waste them, and I am conscious of the importance of creating a sustainable future

Languages, Literacy and Communication Area of Learning

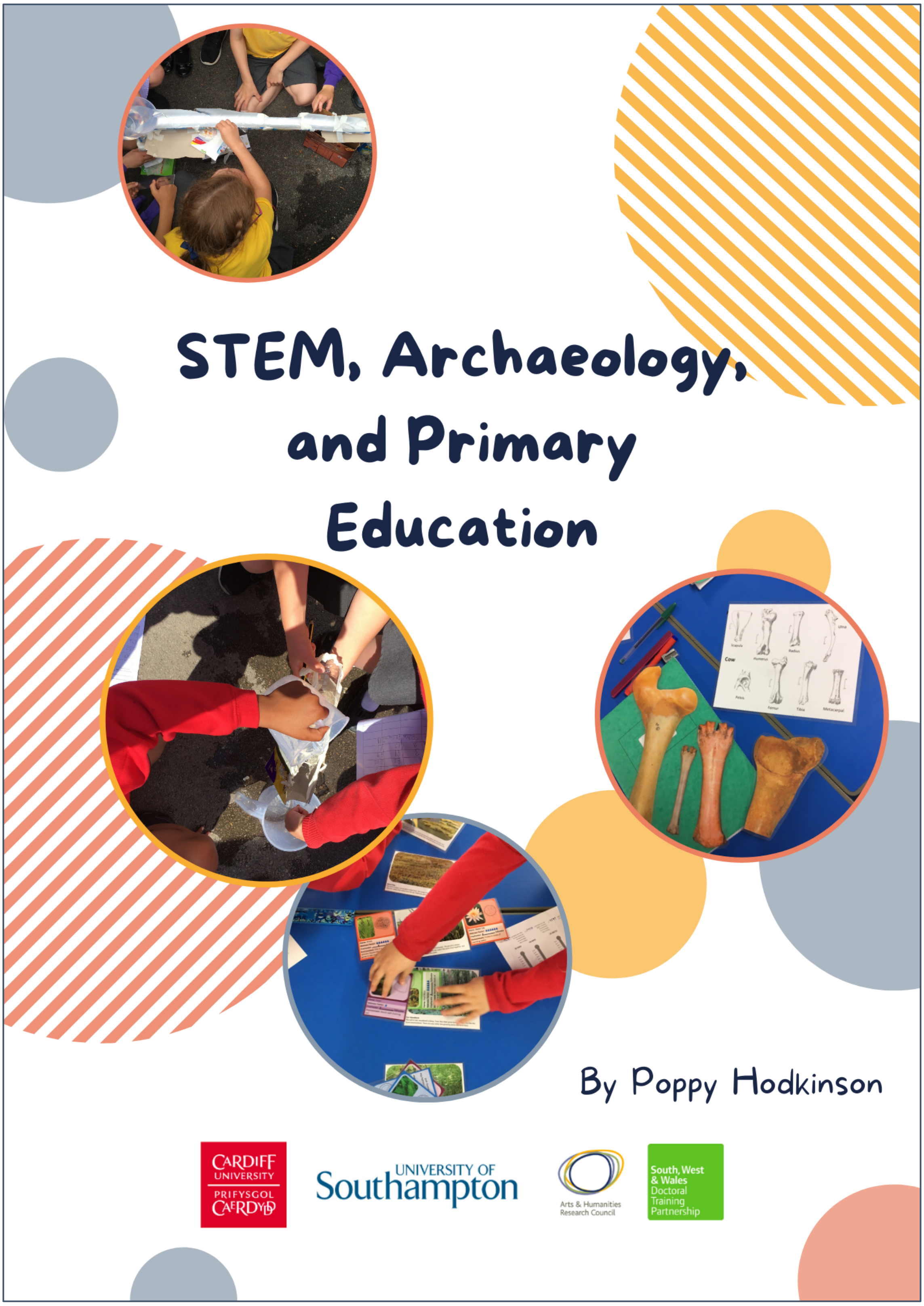
<table>
<tr><th>Area of Learning</th><th>Statements of what matters for Progression Step 2</th><th>Excavation and other field-work</th><th>Archaeological investigation: data collection, analysis, interpretation</th><th>Experimental archaeology (e.g. craft, construction, cooking)</th></tr>
<tr><td rowspan="17">Languages, literacy and communication</td><td rowspan="8">Understanding languages is key to understanding the world around us</td><td colspan="2">I can listen to, understand and later recall what I have heard</td><td></td></tr>
<tr><td colspan="2">I can understand information about a variety of topics, identifying main points</td><td></td></tr>
<tr><td colspan="3">I can understand and respond to a range of questions and multi-step instructions in a variety of familiar and unfamiliar contexts</td></tr>
<tr><td></td><td colspan="2">I can recognise the features of different types of texts and use appropriate language to talk about them</td></tr>
<tr><td></td><td>I can find and use information from different materials that I read</td><td></td></tr>
<tr><td></td><td colspan="2">I can infer meaning from text and images</td></tr>
<tr><td colspan="3">I can respond to what I hear, read and see, asking questions and showing my understanding</td></tr>
<tr><td colspan="2">I can develop my vocabulary through listening and reading and use these new words in a variety of contexts</td><td></td></tr>
<tr><td rowspan="9">Expressing ourselves through languages is key to communication</td><td colspan="2">I can speak clearly, varying expression and gestures to communicate my ideas</td><td></td></tr>
<tr><td></td><td>I can use single and multi-clause sentences, making choices to meet the intended audience and purpose</td><td></td></tr>
<tr><td colspan="3">I can communicate using an increasingly varied and precise vocabulary</td></tr>
<tr><td></td><td>I can use single and multi-clause sentences</td><td></td></tr>
<tr><td></td><td colspan="2">I can review my work and am beginning to use a range of familiar strategies and tools to improve my speaking and writing</td></tr>
<tr><td colspan="3">I can explain where and why I have made any changes or corrections</td></tr>
<tr><td colspan="3">I can adopt a range of roles and manage my contributions appropriately</td></tr>
<tr><td colspan="3">I can ask and answer questions and exchange ideas and information</td></tr>
<tr><td colspan="2">I can write legibly</td><td></td></tr>
</table>

Area of Learning	Statements of what matters for Progression Step 2	Excavation and other field-work	Archaeological investigation: data collection, analysis, interpretation	Experimental archaeology (e.g. craft, construction, cooking)
Languages, literacy and communication	Expressing ourselves through languages is key to communication (continued)		I can attempt to spell more difficult words plausibly using a range of strategies	
			I can use familiar punctuation	
		I can explain information and share ideas, opinions and feelings using relevant vocabulary		
			I can talk to plan writing and write for different purposes and audiences	
			I can organise my writing into a logical sequence	
			I can write using an increasingly imaginative, varied and precise vocabulary	
	Literature fires imagination and inspires creativity		I can retell stories creatively	
			I can use my imagination to respond to and adapt literature to create my own work	
			I can use my imagination to create my own literature	
				I am beginning to show empathy with characters in literature

Expressive Arts Area of Learning

<table>
<tr><th>Area of Learning</th><th>Statements of what matters for Progression Step 2</th><th>Excavation and other field-work</th><th>Archaeological investigation: data collection, analysis, interpretation</th><th>Experimental archaeology (e.g. craft, construction, cooking)</th></tr>
<tr><td rowspan="5">Expressive arts</td><td rowspan="3">Exploring the expressive arts is essential to developing artistic skills and knowledge and it enables learners to become creative and curious individuals</td><td rowspan="3"></td><td></td><td>I can explore and experiment with and then select appropriate creative techniques, practices, materials, processes, resources, tools and technologies</td></tr>
<tr><td colspan="2">I can explore how and why creative work is made by asking questions and developing my own answers</td></tr>
<tr><td colspan="2">I can explore and describe how artists and creative work communicate mood, feelings and ideas</td></tr>
<tr><td>Responding and reflective both as artist and audience is a fundamental part of learning in the expressive arts</td><td></td><td></td><td>I can give and accept feedback as both artist and audience
I can compare my own creative work to creative work by other people and from other places and times
I can consider, with guidance, how moods, emotions and ideas are communicated both in my own creative work and in the creative work of others</td></tr>
<tr><td>Creating combines skills and knowledge, drawing on the senses inspiration and imagination</td><td></td><td></td><td>I can communicate ideas, feelings and memories for an audience and for purposes and outcomes in my creative work
I am beginning to apply techniques in my creative work with guidance and direction
I can create my own designs and work collaboratively with others to develop creative ideas
I can perform, produce, design, exhibit and share my creative work in a variety of ways for different audiences, inspired by a range of stimuli and experiences
I am beginning to demonstrate resilience and flexibility in approaching creative challenges
I can use creative materials safely and with some control under supervision</td></tr>
</table>

51 Appendix 39: Thesis findings presented to project participants



In 2018/19 your class took part in a research project. The project studied school children's feelings about STEM, and whether archaeology could make a difference to them.

What is STEM?

STEM is an 'acronym'. This means that each letter in the word STEM, stands for another word.

Science
Technology
Engineering
Mathematics

STEM is a big part of modern life. It's used in food production, healthcare, entertainment, transport, and many other things.

Lots of jobs in the UK use STEM, but not many people choose to study STEM after the age of 16. This means that there are lots of jobs, but no one to do them!

STEM skills and knowledge can also help you make decisions about your own life. You might decide which medical treatments to take, the kind of transport you should use, or what food to eat.

Is there anything important in your life that uses STEM?

Project contributors:

5 schools

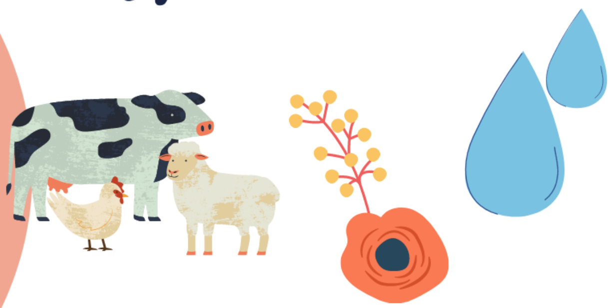
9 classes

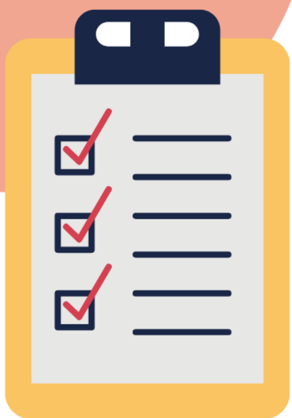
233 pupils

20 pupils interviewed

Together we did:

3 archaeology sessions





6 questionnaires

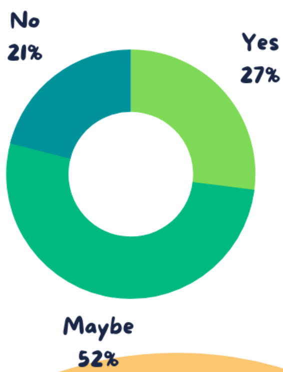
3 interviews

From the questionnaires, we discovered...

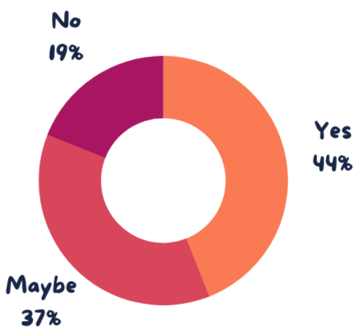
Lots of you like maths and science lessons

I like science lessons: 82%

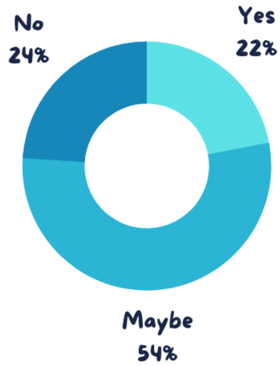
I like maths lessons: 70%



Some of you thought STEM is an important part of your life



Some of you wanted to learn more about STEM in the future

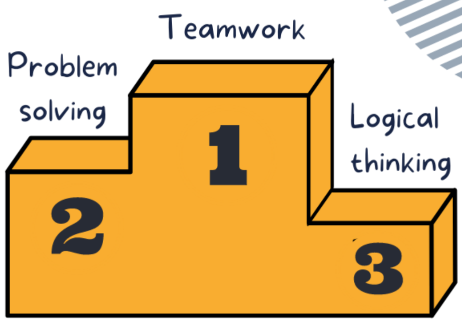


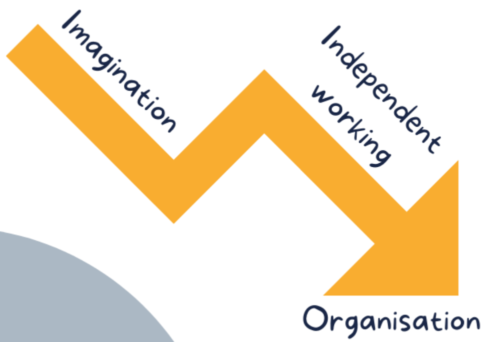
Some of you wanted a job that uses STEM when you are older

But most of you were undecided. You've still got lots of time to decide what you'd like to do in the future!

From the questionnaires, we discovered...

These were the 'top three' skills you thought a person working in STEM would need. They were <u>also</u> the top three skills you said you used in each workshop!





These were the skills you thought were <u>least</u> important to a person working in STEM.

You thought that 'curiosity' was less important for someone working in STEM <u>but</u> felt that you used it often in the workshops.

Does this change your opinion on whether curiosity is important in STEM?

In the interviews, we discovered...

You thought people who work in STEM are...

determined

honest

creative

curious

reliable

hardworking

... and that they

like helping others

listen to other people's opinions

enjoy maths

like to learn new things

can use computers

can work in a team

enjoy science

enjoy building things

Do any of these words describe you?

This is how you described yourselves in the interviews:

enjoys dancing	hardworking	artistic	enjoys maths
can use computers	enjoys sport	enjoys reading	likes helping others
enjoys science	creative	likes being outdoors	likes computer games

These were your aspirations:

Sports presenter	Fashion designer	Something with computers	Author and Illustrator	
Vet	YouTuber	Dancer	Nurse	Baker
Footballer	Archaeologist	Hairdresser	House designer	
Scientist	Something with maths	Robotic engineer	Zoologist	

Some of you thought your aspirations didn't 'count' as STEM.

Actually all of these jobs use STEM!

Can you think of ways these jobs use STEM?

Overall I learned that a lot of you are interested in STEM

BUT...

... other researchers have proved that many young people who like STEM become less interested as they get older.

To change this young people could think about how the things they like, and are good at, are relevant in STEM.

Not everyone has to like STEM, but there is STEM in most of the things we like!

STEM isn't just about getting answers right or being the smartest. People in STEM can be: creative, reflective, problem solvers, good team players, and so much more!

What are you interested in?

What are you good at?

How could that help you have a future in STEM?

A big thank you to all of the pupils and staff who contributed to this project. I couldn't have done it without you!

Diolch yn fawr