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Exploring contexts for data materialisation in post-pandemic research activities with rural communities

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Abstract: Design methods are enabling new practices in exploratory and applied research for insights and innovation in policy settings contributing to rapid insights, meaningful interactions and evidence-based decision making. Insights into the ideas and experiences of people and communities affected by policy implementation enable policymakers to design systems and interventions that are both accessible and meaningful. This is particularly pertinent in areas such as rural connectivity, where rural digital policy is often implemented by civil servants living in urban areas with limited experiences or understanding of the unique challenges presented by the rural terrain to digital infrastructure. Drawing on proposals for the value of design in policy settings by Whicher (2020) the research presented here illustrates practical examples of “changing the nature of evidence” and “more meaningful public consultation” used in data materialisation experiences that was conducted as part of a government response to the unique challenges presented by rural communities. The researchers used methods based in design research, such as textile thinking, games design, and ethnographic approaches, presented here as case studies of methods designed to understand the everyday experiences of people living in poorly connected areas.

Keywords: rural digital policy; design research; tangible data interaction; data materialisation

1. Introduction

Picture the great British countryside. Imagine small villages nestled among the rolling hills, or lone farmsteads set against the backdrop of the wild moors.

Now imagine that there is no phone signal, no 4G, no GPRS. No helpline for when you need it, no guidance for when you have lost your way. While the rest of the country is developing smart city initiatives and remote working hubs, rural communities often struggle to access even the most basic digital services.

The activities described in this paper were used to support key aspects of the government-initiated delivery of superfast broadband across the nation. The Rural Gigabit Connectivity



Programme and the Call for Evidence for Very Hard to Reach Communities are both examples of initiatives aimed at improving broadband access for the UK's most digitally remote communities. By learning about the human experiences of digital infrastructure, policymakers have been able to gain insight into the ambitions and frustrations of rural broadband users, improve upon systems designed to provide infrastructure, and engage with stakeholders and potential beneficiaries.

2. Background

The Arts and Humanities Research Council Design Fellow's 'Challenge of the Future' report on use of design in the policy process (2020) proposed 6 factors for "Why design for Policy?". This includes the changing nature of evidence, growing interest in user-centred approaches, a focus on end-to-end policymaking, a drive for more meaningful public consultation, the need for rapid policy prototyping (particularly in the context of Covid-19 response) and the rise of futures thinking (such as speculative design). (Whicher, 2020).

To trial the use of design methods for learning about rural communities to support evaluation and consultation exercises the research presented here illustrates practical examples of the use of design in the areas of "changing the nature of evidence" and "more meaningful public consultation" and was conducted as part of a wider government response to the unique challenges presented by rural communities.

2.1 Rural gigabit connectivity programme

The research draws on a range of qualitative enquiries into people's attitudes and behaviours surrounding technology in a rural setting, and are discussed in this paper with the aim of contributing to the research question: how can data materialisation bridge the gap between design research methods and policy professionals to centre the user experience in policy development?

The two programmes will be briefly introduced in Table 1 and Table 2 for context. However, more detailed descriptions are available from Building Digital UK (HM Government, 2021).

Rural Gigabit Connectivity (RGC) is a programme that delivers gigabit connectivity to communities who are unlikely to take priority for commercial companies. Rural primary schools were part of the scheme to receive financial support to upgrade to gigabit capable connections. The research findings are used in the context of infrastructure demand stimulation programmes to evaluate the efficacy for delivery mechanisms to bring about benefits for communities reached by the schemes. Further details can be found in Appendix 1.

Table 1. Description of research to support the Rural Gigabit Connectivity evaluation

Objectives of programme : Identifying eligible rural primary schools and providing financial support upgrade to fibre broadband			
Research focus	Context	Methods	Outcomes
The research described here explores modes to evaluate the process by collecting evidence on efficacy and impacts.	The research focus was on exploring the impact of new broadband connection for primary schools.	It collected lived experiences of interactions with, and expectations of, high-speed internet. Focus was given to insights that suggest that access to broadband internet can improve access to public services and reduce the digital divide.	The research described here explores modes to evaluate the process by collecting evidence on efficacy and impacts.

2.2 Connecting very hard-to-reach premises

Improving Connectivity for Very Hard to Reach Premises is a policy programme that focuses on broadband provision in communities where the cost of delivering gigabit-capable broadband is prohibitive. Rural communities are more likely to have a sparser population spread across a wider geographic distance and more difficult terrain compared to urban areas. This presents challenges for establishing the infrastructure required for broadband provision. Information collected was analysed to present insight to policy makers designing interventions for broadband delivery. Further details of this research can be found in Appendix I.

Table 2. Description of research which is part of the Very Hard to Reach consultation

Objectives of survey consultation: Engagement exercise to gather feedback from rural SMEs about their connectivity concerns focusses on business needs.

Research focus	Context	Methods	Outcomes
Qualitative research commissioned to add context to a wider online survey consultation issued by DCMS about needs of rural businesses	Research conducted with farmers operating a small or medium enterprise (SME) in a rural location	This research took an ethnographic approach and presented findings collected from walking interviews. During the interviews farmers described their experiences of poor broadband connection.	Qualitative research commissioned to add context to a wider online survey consultation issued by DCMS about needs of rural businesses

3. Methodology

3.1 Research context

The context of the research was necessarily shaped by the COVID-19 pandemic, the most significant impact of which were the restrictions placed on both researchers and participants around meeting face to face or travelling to meet people in different locations. Elements of the research design were therefore conducted digitally by necessity. Of these, perhaps the most significant is the impact on the design of the research itself (Tulley 2020). Relying on digital methods for any aspect of a research project has an impact on the people who can be reached and shapes the type of knowledge that can be produced as a result (Wahl-Jorgensen 2020). The response to this must of course be to work reflexively and acknowledge these pressures because by doing so, we are able to contextualise the data gathered whilst still finding enduring value in the experiences described by participants (Lupton 2021). It must be acknowledged that online spaces are not all-inclusive spaces, both in terms of who has access to these spaces, and how they experience being ‘online’ when they are there. These exclusions are more likely to occur in communities who are older, living in poverty, or do not have access to a reliable internet connection (Holmes and Burgess 2021), a factor which was significant in this research.

3.2 Design Research Approach

Design research at the UK Government enables deeper understanding of the needs of those impacted by policy direction. Insights into the ideas and experiences of people and communities affected by policy implementation enable policymakers to design and evaluate appropriate systems and interventions. This is particularly pertinent in areas such as rural connectivity, where policy is often developed by civil servants living in urban areas with limited experiences or understanding of the unique challenges presented by the rural terrain to digital

infrastructure. Employing design methods has enabled access to the lived experiences of rural-digital users and created space for those typically excluded from policy development to contribute to the vision for the future of rural life in the UK.

3.3 Design probes

Gaver et al, (1999), used physical objects as probes to support novel data collection which prompted ideation for design research. The information gathered through this process is a mode for garnering an impression about people and places that could be used for design rather than data for formal analysis. The authors of *Design: Cultural Probes* (1999) note the importance of presenting probes that offer an experience that is both appealing and accessible, for example ensuring that any materials could also act a bridge between researchers and participants who may not be familiar with research activities especially unusual modes of enquiry.

Use of surveys or diaries may also provide a platform for learning about people's experiences with technology. However, in this study the aim was to learn about what impacts technology would bring to the community therefore developing a sense of the people ("beneficiaries") involved in the intervention programme was key to establishing the types of future implications for specific communities. The design of artefacts described as case studies in this paper used the common theme of playfulness and intended to create a space of trust by demonstrating vulnerability and experimentation by using colourful and tongue in cheek illustrative experiences. In addition, for many who took part in the research there was an initial concern over a lack of "technical knowledge" about broadband functionality, the artefacts aimed to engage a non-technical audience by inviting emotive and experiential responses about interactions with high-speed internet.

3.4 Ethnographic walking interviews

Research into the use of digital technology by rural farmers was conducted by using ethnographic walking interviews. Farmers were invited to 'walk and talk' on their farmland, using the landscape as prompts to inspire reflection on the interactions of technology and daily farming life. It is an approach that is intensely interested in the way in which the world is perceived by the person experiencing it (Moran 2000). It draws on Edmund Husserl's concept of 'lifeworlds' to conceptualise the subjective experiences of a research participant, something which is made accessible through ethnographic methods (Naidoo 2021). It is not without its constraints however, and it is important to acknowledge that researchers are limited by restrictions of time and budget, as well as the boundaries of their own experiences and understandings. Recently, further limitations have been imposed by the ongoing COVID-19 pandemic, which has necessitated restrictions on the ability of researchers to travel to meet participants and immerse themselves in those worlds. The ethnographic walking interviews conducted were carried out against this backdrop, and the notion of conducting interviews in an outdoor space was partially in response to the need to act within the guidelines of social distancing and ventilated spaces.

These constrictions may present a challenge to the concept of an ‘immersive’ methodology, as they place a limit on the extent to which the researcher can absorb themselves in these lifeworlds. To immerse oneself is often connected with the notion of being completely involved or completely covered so to restrict that access brings into question the immersive nature of the research itself. In this context, however, ethnographic research can become something limitless, an idea that is directly at odds with the practicalities of research design and implementation. In the context of the research presented here, these constraints are thought of as boundaries that can give shape to this apparently limitless information. As the act of data gathering is delineated by these boundaries, so is the interpretation of the results and we would encourage those engaging in our research to approach both the research and our understanding of immersive research methods within these boundaries.

3.3 Tangible data interaction

The methods described in this paper draw on both ethnographic approaches to learn from rural communities and from tools and practices in design research to consider systems for collecting and communicating data. The approach is positioned in the subsect design research that looks at interactions using physical materials to enable deeper engagement with different kinds of data. Tangible interaction with complex information and concepts has been shown to prompt dialogue and questioning and to support the development of new ideas (Lockton et al. 2017, Hogan and Hornecker 2016, Hogan et al. 2018). Lean (2020) has shown that material choice of data artefacts can enable critical thinking and that designers exploring new contexts for data practice using materials offer understandings of data feminism (Ignacio and Klein 2020). The term data materialisation is used to differentiate the process from that of data visualisation and aims to communicate the idea that rather than a representation of data, materialisation concerns the whole experience of that data engaged with by the viewer, in the material world. The case studies in this paper offer examples of applied feminist research as data materialisation considering the context, tools, and objectives of the research activities and through use of physical materials and tangible interactions push the boundaries of typical government data visualisation. This enables alternative forms of knowledge and understanding which uses the body through walking, playing, making, and handwriting to enter the policy making cycle.

In traditional policy development, the ROAMEF cycle (Rationale, Objectives, Appraisal, Monitoring, Evaluation, Feedback) as described in the Green Book (2020) is used for evaluation and appraisal. The research activities in this paper are connected to Evaluation and Appraisal by offering insights on benefits realisation and public response to policy proposals through consultation. We explored the impacts and potential use cases for data materialisation to evoke deeper connections with policy makers by enabling a broader understanding of the needs of rural communities who are otherwise unreachable other than through traditional big data collection methods such as surveys.

The tangible data interactions and data materialisations described in this paper were intended as embodied experiences, which evoke reaction and dialogue in their audience rather than a cognitive exchange or true understanding of the data. In various formats including a board game and physical postcards the artefacts were designed as prompts to initiate discussion and enable deeper engagement with the research context which was rural communities. This was necessary as the audience, or customer of the data is physically and socially removed from the context. Lean (2021) acknowledged the challenges of presenting novel formats for data interaction and suggested actions such as explaining the methods or helping stakeholders to feel included in the process as a means of successfully engaging people with new data experiences. This aspect is expanded in this paper throughout the case studies and discussion.

Positioned as discovery research, this research initially aimed to uncover typical use cases for rural broadband users. The findings were used to develop design recommendations for intervention programmes including suggestions for mechanisms to improve awareness of available funding, appropriate language, and iconography to present information of the benefits of fibre broadband that is relatable to the target group and to support policy makers to challenge assumptions during the design of future interventions for technology roll out in rural communities. As the results of the research described are directly related to government policy the purpose of this paper is to present and critique methods that design researchers may draw on to approach research challenges in similar contexts rather than present specific findings and data.

4. Case Studies

The following 3 case studies present a tool for data collection, a tool that is data collection and data display, and a tool for data sharing. Drawing on the descriptions used by Lean (2021) the data materialisation examples are designed to connect with people's experiences, capture and document experiences, enhance an experience and to act "as" an experience in policy settings. The case study artefacts contribute to understanding of the value of design in policy in the specific areas of "changing the nature of evidence" and "more meaningful public consultation".

4.1 Case study 1 : Connectivity postcards (changing the nature of evidence)

A key challenge for investigating the direct impacts of infrastructure upgrades for rural schools on the RGC is access. Teachers are busy and the schools are physically hard to get to. Teachers work specific hours used for face-to-face time with children and colleagues. Observing the schedules of teachers and considering additional workload due to the pandemic as well as the everyday dynamics of small, busy rural schools it was clear that formal interviews would not be appropriate.

We designed a set of postcards and invited teachers and school staff to keep these on their desks and to jot down comments that came to mind during their working day related to digital connectivity. On the front of the cards, there were sections to fill out with illustrations of human figures depicting joy and frustration, on the back, there was a question “How has connectivity impacted your working week?” The cards were “A5” sized so that they deliberately stood out as a reminder for the participants but also for the recipients of the card to have a tangible output to hold. The cards which were designed to gather anonymous data used deliberately playful imagery. Cards were delivered to schools and each card had a stamp on it and the address for the researcher.

The postcards enabled insights which are reflective rather than reactive (that might be the case in an interview for example) to learn about the positive and negative ways that connectivity impacts the working week – using the teachers’ own words, in their own time. This resulted in insights about the impacts of a new internet connection from work lives at school. The findings, ranged from gratitude for the funding to improve connectivity to contextual information about the use of the connection to a complaint that enhanced broadband connectivity had created extra workload due to an increased digital presence and perceived “availability” by pupils and staff.

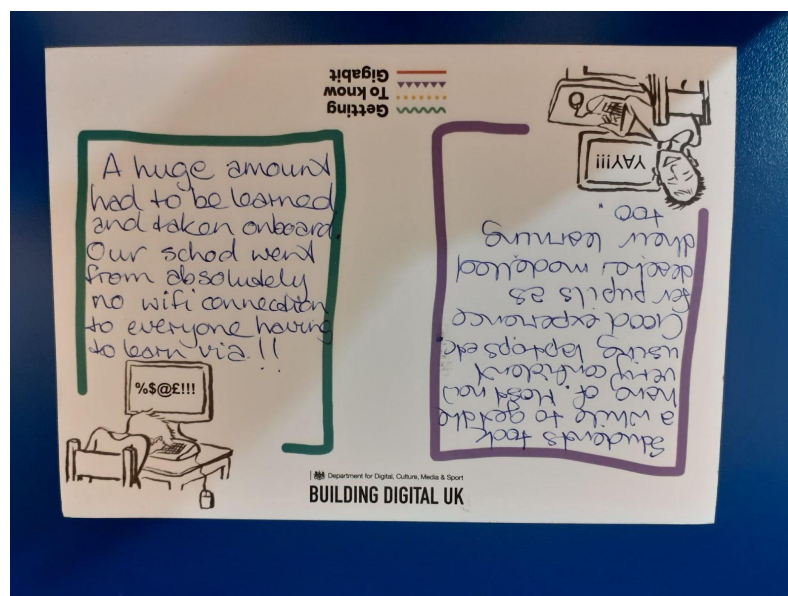


Figure 1. Completed postcard from a newly gigabit- connected school

“Yay! All 30 children logged into google classroom in super quick time!”

This information was used to demonstrate the direct impacts of the connectivity and enabled dialogue on assumptions about use and barriers to benefits realisation for schools. The tangible data was also used to prompt discussion with teachers. Rather than drawing on survey data, user researchers trialed using the physical postcard to initiate questions. For example, during a phone conversation with a class teacher who was very positive about their connection and use in school I drew upon the postcard anecdote about workload and

through this opened a discussion on additional training needs, peer to peer learning, and confidence with digital in the classroom.

The use of postcards as a tool for data collection with teachers was motivated by researchers at Sheffield Institute for Education who were inspired by Lupi and Posavec's Dear Data project where the two designers developed visual systems to record and share insights through data (2016). In the Postcards from Literacy Classrooms project teachers independently developed visual systems for logging various aspects of their experiences. The teachers were part of a cross-school peer group and taken through exercises with a data visualisation expert to develop their logging style. In our study we asked for written-textual responses, this allowed us rapid insights as teachers did not have to learn new approaches, this was appropriate given the remote context where teachers were already taking on the challenge of developing new skills. One of the headteachers who engaged with the study expressed that he felt we could have created digital— rather than physical artefacts for data collection. However, others including office staff and headteachers elsewhere commented that since staff were not all particularly “tech-savvy” the postcards would be accessible. Drawing from this feedback, in “Getting to Know Gigabit”— described in the following section we offered data collection artefacts that enabled both digital and physical input.

The postcards facilitated the opportunity for data collection with remote research participants which did not rely on a) technology such as phone or internet access b) specific skills such as confidence with data visualisation or digital skills c) taking up time or interrupting everyday activities—participants chose for themselves when to take part.

The outcomes- physical paper with handwritten messages, real stamps and postmarks provided the research teams with a tangible interaction with an otherwise very faraway person. This object enables a connection with those who are impacted by the programme and has been used as evidence for the benefits of improved access to broadband in schools but additionally to foster empathy across the organisation to motivate and boost morale. The postcards in a digital form (a photograph) have been used in presentations, as assets to promote research and policy outputs on social media channels. Researchers on the Postcards from Literacy Classrooms presented an online exhibition of the postcards which was part of a research methods festival and workshop (2020). Displaying the research in an online format created the opportunity to motivate other researchers to access the context and the research team to ask questions and learn more through the workshop format.

4.2 Case study 2 : Getting to know gigabit workbook (changing the nature of evidence)

Getting to Know Gigabit captured the experiences and awareness of connectivity through the experiences of rural school children. This is important for evaluating the efficacy of the policy intervention and understanding additional needs for rural communities connecting to high-speed internet.

The research activities facilitated dialogue on and enabled access to insights based on the lived experiences of the research participants. The outcomes of this study provided evidence on:

- Current connectivity needs for rural education settings
- Future uses of gigabit-capable technology
- Situated knowledge on the potential impacts of improved connectivity

This evidence is particularly valuable as it acts as thick data to present a true picture of the challenges and struggles of really benefiting from upgraded connections. For example, what level of upskilling is involved, what additional technology and funding may be required to achieve the impacts assumed by policy makers designing interventions to deliver broadband. The thick data here compliments traditional survey data on the scale of improvement across rural primary schools on the delivery programmes.





The design challenge in this case was to find a way to engage children and their teachers to consider current and future scenarios that may be impacted by a technology solution. A key concern here was taking care not to glamourise the broadband potential but to create scenarios where school pupils could draw on their own everyday experience to imagine how connectivity could impact it. Creative activities provided the opportunity for research participants to have time to engage and reflect on the topic of connectivity relative to their own local environments, as opposed to on-the-spot interviews. We collaborated with a creative designer and a group of rural educators to design a 4-part activity series using an illustrated “workbook” to engage with and listen to primary school pupils and to gather data on their experiences with broadband.

Design

These research activities were designed in collaboration with an independent creative designer and rural educators. The outcomes are stories that show how schools and pupils are interacting with issues around the internet and the broadband upgrade using their own words (described in Appendix 1, Table 2). The design took a playful approach using a booklet containing tasks and questions to learn about experiences and activities supported by the internet connection, now and in the future.

Due to lockdown travel restrictions, BDUK researchers were not able to travel therefore we asked pupils to take on the roles described in Table 3 to help us to “get to know gigabit”. A character was designed for each activity and used to illustrate research materials which included: information sheet for teachers and guardians, a booklet, stickers, and a certificate of completion. Four sections covered experience, function, future thinking, and communication on the topic of connectivity.

Table 3. Getting to Know Gigabit characters and roles

Role	Themes explored
<p>Researcher</p> 	<p>Internet use and functionality (either at home or school) and rural areas.</p> <p>Pupils explored what the internet is used for in their community, tried out the speed test, thought about how they feel when there is no internet.</p>
<p>Engineer</p> 	<p>Understanding and awareness of the internet and how it works.</p> <p>Pupils researched how the internet works and the people and steps involved in bringing connectivity to their area.</p>
<p>Designer</p> 	<p>Future consideration for how broadband could be used in the school/ local community.</p> <p>Pupils explored how the internet could be used creatively and developed future technology ideas that would improve their local area</p>
<p>Communicator</p> 	<p>How information learnt on this project can be used and shared with other school pupils, within the education sector and beyond.</p> <p>Pupils investigated ways to communicate how their broadband upgrade would benefit their school experiences such as using poetry.</p>

Teachers and pupils brought in their own style, for example, some pupils wrote directly into a printed copy of the booklet whereas others created PowerPoint presentations, some teachers used a whole day to explore the topic together, others carried it out over a few weeks. The findings are words, drawings, ideas from rural pupils about their experiences using the internet.

“My internet worked well today- there wasn’t anything I couldn't do. When it doesn’t work, I get a book! I’m a bit annoyed when this happens”

Of particular interest are the pupil's own words about the frustrations and experiences of poor internet that should be impacted by upgrades and insights that are relevant to the rural-digital citizen experience.

“We need the internet for buying cows and animals and notifying cow numbers”

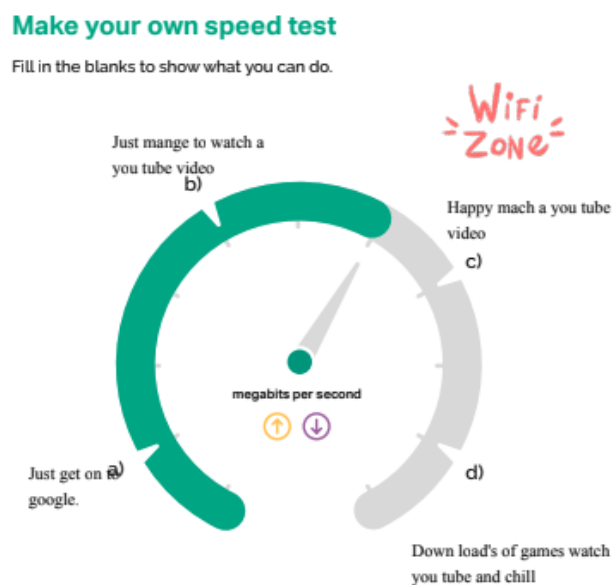


Figure 2. Screenshot of pupil’s response in the workbook activity ‘Make your own Speed Test Dial’ to explain the use of broadband speeds without using numbers

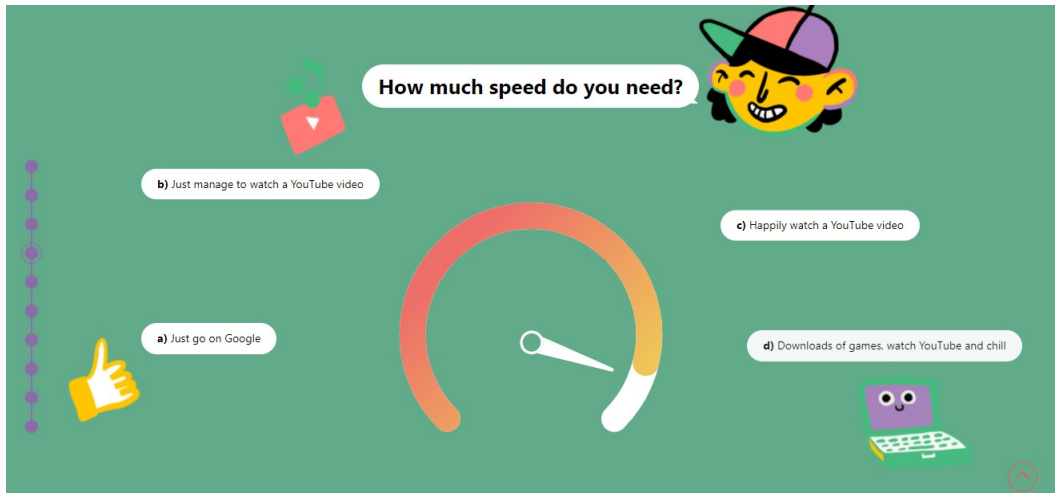


Figure 3. Screenshot of digital interaction prototype developed using pupil responses

Enabling opportunities for immersive research in the classroom setting presented constraints due to covid travel restrictions but additionally due to the time and scheduling of class activities. The workbook activities were delivered by class teachers as both “class topic” projects and to complement aspects of the computing curriculum.

Reflections on the tool as a data collection method

- Key learnings were around accessibility- offering a paper and a digital option, supporting teachers who may not be particularly engaged with digital technology to feel in delivering a project based around broadband and enabling teachers ownership of delivery for example when and how to incorporate the local area and knowledge.
- A challenge for the researchers lay in collating the data from the workbooks. Physical workbooks had to be photographed or scanned, the digital versions were saved as PDFs.
- A future iteration of a workbook in this style could be presented as an online form that incorporates the design experience. As the activities encouraged hand drawing, and model making a future version could incorporate a tool for digital drawing or options to upload hand-drawn imagery.
- Teachers who took part fed back that a set of short films would be helpful to support teachers at each stage.

The data collected in the workbooks as words and drawings, through class discussion and as future technology design ideas forms an original portfolio depicting ideas and experiences from a snapshot in time during a global pandemic when access to the internet in the UK was not a given. The outputs were analysed using a benefits framework to understand how connectivity will impact communities with particular focus on “Reducing the Digital Divide” and

“Improving Public Sector Services”. The results of this activity have been incorporated into a prototype interactive webpage (a snapshot is shown in figure 4) designed to enable viewers to “visit” a rural school by scrolling to learn about rural pupils’ experiences and ideas. The intended audience is the rural public, future gigabit users and educators interested in the benefits of gigabit and in methods for engaging pupils in critical thinking about the internet. Public Engagement researcher Allmann (2021) has emphasised the need for critical thinking about technology to be part of the school curriculum. Allmann has suggested that equipping younger generations to critique technology that ethics in the design of future consumer technology space may be considered.

For the policy evaluation and benefits realisation context, a next step is publishing the activity guides for educators as an open-source download. This will enable colleagues to monitor the pupil’s inputs and ideas themselves as research data and secondly engage educators who take part to provide continuous insights based on interactions with connectivity and opportunities enabled by broadband access.

4.3 Case study 3 : Snakes and ladders board game (more meaningful public consultation)

Researchers who immerse themselves in the lifeworlds of their participants are given privileged access to a small amount of time and space in those worlds and are challenged with capturing as many aspects of that world as they can. A two-hour farm visit can provide an array of data points all of which can be drawn together and synthesised for the purposes of policy development. However, the challenge for the researcher is to re-present that world and highlight the nuances and fine details that are privileged in ethnographic research. The idea to approach this by using a board game came out of a series of conversations around bringing research findings to life and making them meaningful. It is an approach advocated by Macklin et al (2009) who argue that not only can data provide an interesting context for game-playing, but that the process of playing itself is one of learning and engagement, meaning that the presentation of data through board games can provide new opportunities to engage stakeholders with research findings.

Snakes and ladders was chosen as a medium because the idea of being projected forward or backward by something largely out of your control seemed like an accurate representation of the experiences described by research participants. The game play starts as the farmer is waking up and the player must make their way through the day towards bedtime whilst negotiating the challenges and opportunities their broadband connection offers them. Good internet connection will lead you up ladders and take you further ahead, but when it fails, you find yourself falling behind. Unlike traditional representations of the game, each snake or ladder in this version is accompanied by a short scenario, such as being able to get online to attend a business webinar, that explains exactly why they are encountering a snake or a ladder. All these scenarios are based on data points from the research, giving the player access to real-life scenarios that they may not have thought about as being significant. The player makes their way through the day to the final square and in doing so, encounters a

wide range of data points that give them the opportunity to reflect on the lives of rural farmers with poor broadband connections.

The use of scenarios is not new to design research- scenario and personas are used as part of the design process to consider user needs for example living conditions to devise appropriate solutions. Rather than a static point in time as provided by use of scenarios of personas in design, the scenario depictions used on the game board enable access to a particular frustration or successes that are part of an everyday activity creating a dynamic illustration of the living part of a lived experience research for those unfamiliar with the specific context.

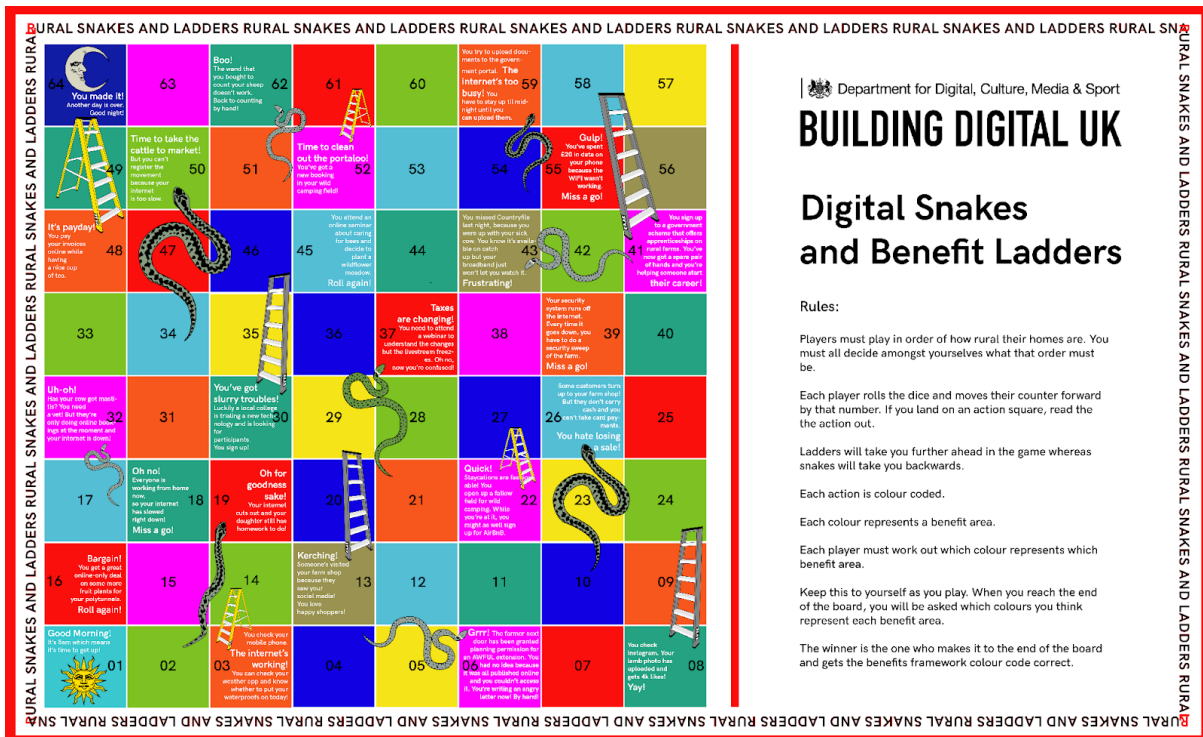


Figure 4. Snakes and Ladders Board Game

5. Discussion

5.1 Reflections on case studies

In the activities described here, design objects extend beyond the constraints of public consultation by enabling citizens to offer a deeper contribution to research that impacts their community. It has also been used to create connections by mapping the landscape to understanding findings and patterns, getting closer to the public as service users and research participants, and finding new ways to engage stakeholders with research findings. The novel artefacts described in this paper enabled policy professionals to engage with rural voices in a way that encouraged critical and creative thinking about the systems that connect rural communities. For example, a group of policy professionals were invited to play snakes and ladders in a virtual forum, which led to a deeper and more nuanced discussion of the issues

faced by farming communities and feedback on this session suggested that it is a novel and engaging approach to presenting research.

5.2 Framing research as a design problem

The design problems lay firstly in reaching the communities themselves and secondly in establishing needs that could be addressed as part of the policy intervention. Positioned as discovery research, this research initially aimed to uncover typical cases for rural broadband users. The findings were used to develop design recommendations for intervention programmes including suggestions for mechanisms to improve awareness of available funding, appropriate language, and clear iconography. Communicating the benefits of broadband upgrade has tended to draw on phrases such as “lightning speed” thus developing user-friendly terminology with real-world examples is a desired outcome.

Presenting physical artefacts, for example, the postcards offered space to consider the physicality of the internet connection we researched, both in the specific materials that host the connection (fibre-optic) and the physicality (feeling) of the experiences afforded by the immaterial digital data exchange. To use an example from the walking interviews, learning about the sadness and frustration of a farming community member that could not attend an online funeral service due to connectivity issues gives weight to the real impacts afforded by the immaterial rural broadband policy space. Observing the physicality (feeling) of the workbooks with children’s drawings, spelling errors, folded edges, and the postcards (handwriting, stamps) gave our qualitative data real human touch and created an exchange experience for the researchers during a moment where embodied research activities felt largely out of reach due to COVID-19 restrictions. We acknowledged that digital data may be more easily shared and downloaded but through the data materialisation practices we explored modes to present the messy aspects of the everyday lives of the communities we engaged. Lived experiences are not stopping as points in time to be researched so the layering of objects, data, and people as a portfolio in this paper reflects this real-life world we explored.

Presenting novel research products has been received by stakeholders both as something new and uncomfortable. In academic art-school settings it is common to see physical artefacts in studios and ad hoc exhibitions but in the policy environment, this is unusual and new. Practicing data materialisation in the policy delivery environment presented real-life constraints both in dealing with “real” people and being part of public service and considering how to present research activities that may be perceived as ‘novel’. In the context of policy and broadband delivery we took certain risks with the research activities but found that exploring in this way uncovered discoveries that were unexpected or previously unseen thus may be considered as part of future policy evaluation and delivery agendas.

This work has also placed an emphasis on the importance of using qualitative research methods to study the impact of digital infrastructures, an emphasis which borrows heavily from Science and Technology Studies (STS). By using embodied research methods to investigate

digital matters, we establish space for the lived experiences of people as they navigate technological artefacts and thus have access to new avenues of inquiry that put human interaction at the forefront. This is important because it resists assumptions, where they exist, that specialist knowledge of ICT systems is needed to assess their wider impact and evaluate their centrality to contemporary society.

The objective of the research was to gather evidence that informs policy makers about benefits of technology and to inform strategists about the efficacy of novel mechanisms for delivery. Regarding the use cases for gigabit, the methods employed enabled access to and sharing of insights that challenge assumptions by illustrating real world scenarios and everyday (mundane) rural life. For example, the findings show that rather than farmers' main focus being on using gigabit technology to upgrade business processes (as assumed by policy makers) the connectivity was often somewhat more valuable in the personal/domestic space as seen in the example of the missed funeral and accessing online resources for homeschooling during lockdown.

5.3 Practical recommendations for designing data materialisation experiences in policy settings

Developing innovative activities for learning about lived experiences is only useful if all the stakeholders can interact and benefit from the findings. Creating awareness of creative methods for engaging citizens and supporting policy colleagues to use novel formats is a key role for policy designers (Whicher, 2020). Engaging with data in alternative formats enables new relationships and connections to be revealed. It may not be feasible for all policy makers to travel to remote settings to learn about those impacted. Data materialisation practices that offer engagement with people and places and their stories that enable the possibility of including user experience in policy development. Here the approach goes beyond data physicalisation or visualisation practices by creating the opportunity for emotive interactions with individual experiences. The following are reflections on making an impact using data materialisation as part of user experience research contributing to policy design and delivery-

- As designers working with different communities, we often find ourselves as the go-between, facilitating understanding between internal colleagues and the external research communities. It is important to find what works for sharing insights, for example taking policy colleagues through ethnographic films to identify for themselves the value of listening to real people impacted by policies.
- Find opportunities to share research findings and outputs that make it meaningful in the places the stakeholders will be. Activities may include running workshops, popping up in policy team huddles and creating infographics to tell stories.

- Be an advocate for thinking differently about data- how does reframing it as tangible help to use it to tell stories? Experimental encounters and display can result in meaningful discussion based on real-life experience.

The paper has offered practical examples for “Why Design in Policy” (Whicher, 2020) that may be used to support proposals for embedding practice based design methods into the policy process. We hope that the descriptions of artefacts and activities in this paper provide inspiration for design researchers exploring ways to engage with everyday lives of groups found harder to access due to distance and time for example, due to travel restrictions, digital access and busy schedules and bringing this information to policymakers. The examples in this paper will also be relevant to the field of data visualisation and aims to inform practitioners of novel contexts and applications for experimenting with materialities and modalities for data experience that is part of user experience design research.

6. Conclusion

This paper has used three examples of novel formats for tangible data interaction-artefacts which draw on ethnographic design research methods to engage people at different stages of policy development. The positioning of this work as part of a key policy agenda is itself a novel context for experimental practice. Due to the nature of the research both in time (post covid-19 pandemic) and place (rural settings) the approaches for data collection and dissemination were necessarily exploratory– to identify appropriate means to engage internal stakeholders (policymakers and government analysts) and external subjects (people in rural communities) with the research.

The case studies are presented as documentation of research activities firstly to enable discussion on the challenges of carrying out remote research and to motivate other researchers to consider physical artefacts in methodologies for carrying out research as part of policy design. The data physicalisation and data materialisation tools and their outputs are qualitative expressions of experience that creates opportunities for engaging with ethnographic insights to foster a sense of empathy– with those who are living with poor connectivity and a new form of understanding – using a board game to consider the day-to-day aspects of farm life. Through this work we emphasise the importance, not of a “complete” and formatted dataset such as that found on a digital spreadsheet but formats that recall the messy, tangible interactions found in researching everyday life that call for physical experiences of data that may be remembered, held, and felt as a means to meaningfully interact with research.

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Appendix 1

Table 1. *Connectivity Postcards (Changing the nature of evidence)*

Participants	Context	Methods	Outcomes
7 Rural Primary Schools that are recipients of funds from the Rural Gigabit Connectivity Programme	Learning from school staff about the experience of upgrading broadband	Staff provided with stamped, addressed postcards and were asked to respond in their own words about how broadband connection had affected their working week	Gratitude for the funding that had provided the broadband connection Contextual information about how broadband was being used Frustration that being online was being seen to increase workload

Table 2. *Getting to Know Gigabit Workbook (Changing the nature of evidence)*

Participants	Context	Methods	Outcomes
50 pupils across 4 rural Primary Schools that are recipients of funds from the Rural Gigabit Connectivity Programme	The research focused on how improved broadband connectivity would affect the way pupils thought about their school and local area	A workbook (digital or paper version) was used to prompt classroom discussion and creative responses (e.g., poetry, drawing, design ideas) about how rural life is impacted by access to high-speed internet	Insights about pupil experience that contribute to an understanding of the types of benefits for public sector services that may be afforded by access to better internet. Experiences are documented through written language recorded words and visuals created by the pupils Of particular interest are pupil's own words about the frustrations and experiences of poor internet that should be impacted by upgrades and insights that are directly relevant to the rural-digital citizen experience.

Table 3. *Rural Snakes and Ladders (More Meaningful public consultation)*

Participants	Context	Methods	Outcomes
5 Farmers	The research was commissioned to provide qualitative insight into the impact poor broadband connection had on small and medium enterprises in rural areas in the UK. Farms were chosen as a context to explore this because of the multiple complexities faced by farming communities	Ethnographic walking methods were used to engage with farmers to gain insight into the impact poor broadband had on their ability to run their business. Farmers were invited to ‘walk and talk,’ using their surroundings as a prompt to talk about the multiple ways in which their connectivity had an impact on their lives. 5 farmers took part in the research, all living in rural areas without superfast broadband connection. Interviews lasted 60 - 90 minutes and were conducted in both English and Welsh. Interviews were recorded and transcribed by the interviewer. Results from a narrative analysis were then used to create a version of ‘Snakes and Ladders’ that presented some of the key findings	<p>Slow broadband connectivity was found to have a noted impact on the ability of farmers to conduct their business. Participants reported feeling frustrated and constricted at not being able to easily conduct essential tasks associated with the running of the farm, such as registering the movement of livestock.</p> <p>All of the farms visited were diversifying their business models to include activities such as holiday accommodation or farm shops and reported that their ability to do this was significantly restricted by their broadband connectivity.</p> <p>Furthermore, poor digital connection was having a wider impact on their lives outside of their businesses, and farmers reported frustrations in accessing digitised public / health services, staying in touch with family and friends, online schooling and pursuing their own personal interests and hobbies.</p>