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The Role of Maths, Science, and English/Welsh GCSE Attainment in Post-16 Subject Progression

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ABSTRACT: This study investigates the predictive value of subject-specific attainment in GCSE maths, science, and English/Welsh language on AS-level outcomes across six universally popular subjects. Logistic regression models estimate the independent effects of prior attainment and school-factors on AS-level success based on administrative data from 8010 pupils in state-maintained schools in Wales. GCSE science attainment was a consistently strong predictor of success across both STEM and humanities subjects, suggesting broader academic utility than typically acknowledged. These findings challenge prevailing policy- and school-level emphasis on maths and English as the priorities for post-16 readiness, subsequently calling for a reconsideration of how 'core' subjects are conceptualised and prioritised within educational policy, performance metrics, and school-level guidance. Additionally, the analysis revealed nuanced effects of school language medium and geography, with urban and English-medium schools generally associated with higher AS-level pass rates. Given the attrition between AS- and A-levels, the AS-level attainment focus provides critical insights into early post-16 educational progression not captured by an A-level focus. By focusing on Wales, a bilingual and rural context under-represented in UK education research, the study contributes novel insights into subject progression, highlighting the need for more subject-specific approaches to educational planning and intervention.

Keywords: Post-16 education, educational progression, attainment

1. INTRODUCTION

Educational attainment at age 18 marks a pivotal point in young people's trajectories, shaping access to higher education, employment opportunities, and long-term socioeconomic outcomes. In the UK, higher education is regarded as a substantial driver of social mobility across diverse socioeconomic groups (The Sutton Trust, 2021). Recent figures indicate that university graduates benefit from higher employment rates and higher median salaries than non-graduates (UK Government, 2024). However, the pathway to higher education begins much earlier.

In England and Wales, pupils progress through four Key Stages[1] (KS) of education, culminating in the General Certificate of Secondary Education (GCSE) examinations at KS4, typically taken at ages 15–16. In Wales, while education is only compulsory up to age 16, approximately 89% of pupils remain in education or training beyond this. This is approximately three percentage points lower than England where education or training remains compulsory until age 18 (Robson *et al.*, 2024). For those aspiring to university, A-levels are the predominant route, usually studied between ages 16 and 18 in either school-based sixth forms or further education colleges. Entry to A-level programmes generally requires at least five GCSEs at grades A*-C (equivalent to 9–5 in the reformed grading system in England).

Given the centrality of A-levels in shaping access to higher education and wider employment opportunities, the factors associated with pupils' A-level attainment have long been of interest to researchers, government, and schools (e.g., Rodeiro and Bell, 2007; Wyness *et al.*, 2023). This body of work has consistently identified prior attainment as a key predictor of educational outcomes, and a recent systematic review by Williams *et al.* (2022) highlights the robustness of this relationship across contexts. In studies of A-level attainment, prior attainment is most commonly operationalised using mean GCSE grade, which retains strong predictive power even after accounting for pupil- and school-level characteristics (Benton and Lin, 2011; Rodeiro and Bell, 2007).

However, this aggregate measure masks the role of consistent or unbalanced performance across subjects, and the unique importance of subject-specific performance. For instance, research in Norway found that 'generalist' pupils, who achieve uniformly across a range of subjects, have higher post-16 attainment and higher rates of progression to university compared to 'specialist' pupils with uneven attainment profiles (Sandsør, 2020). This could suggest that broad academic competence, rather than strength in isolated areas, may underpin sustained educational success and progression.

Existing research also suggests that A-level attainment in subjects with closely related GCSE precursors (e.g., maths, biology) is more accurately predicted than subjects without clear GCSE counterparts (e.g., psychology, law) (Williamson and Rodeiro, 2024; Wyness *et al.*, 2023). However, research into subject-specific progression remains largely confined to same-subject progression, or to the well-established benefits of strong prior attainment in maths and English. Despite science also being a core subject, how science attainment supports progression beyond science-specific A-levels is comparatively underexplored. This gap is notable given the mounting recognition of the ubiquitous value of science literacy for all career paths in a society increasingly shaped by scientific and technological advancements (Osborne and Allchin, 2024). Despite this, research and policy discourse most commonly prioritise maths and English as the foundations for educational progression and post-16 readiness (Benton

and Lin, 2011; Department for Education, 2021; Elliot Major and Parsons, 2022; Robinson, 2019).

This study directly addresses this gap by examining the distinctive contribution of GCSE science attainment to post-16 academic progression, not only in science subjects but across a wider range of disciplines. In doing so, it compares the relative influence of attainment in three core subjects: maths, science, and English/Welsh language, on pupils' subsequent educational progression. Such analyses provide important insights for schools and policymakers regarding prioritisation of subject-specific preparation at GCSE to maximise pupils' opportunities for success across diverse post-16 subject pathways.

Wales as a Valuable Research Context

Wales provides several unique contexts to address this research gap. For one, although A-level results are central to progression to higher education, A-levels comprise two components: the AS-level and the A2-level. The AS-level, typically completed after the first year of post-16 study, offers a valuable yet underutilised indicator of early post-16 progression. Pupils commonly study four AS-level subjects and discontinue one subject after the first year to complete three full A-level subjects after the second, A2-level year (Sutch *et al.*, 2015). Historically, even popular post-16 subjects such as History and English, lose 22% of pupils after AS-level, with Physics seeing the highest attrition at 33% (Department for Education, 2012). However, reports of subject-specific attrition rates at A-level are limited, not least because in 2016, England moved to a decoupled structure where both the AS- and A2-level are taken in the final year of 16–18 study. In contrast, Wales retains AS-level qualifications in the first year, providing a valuable opportunity to study this earlier stage of pupil progression in post-16 education, and provide a better understanding of early subject-specific progression that can inform interventions before pupils narrow their subject choices for A2-level.

Furthermore, despite the UK's devolved education systems, most empirical research on attainment and progression predictors draws exclusively on data from England. To date, no large-scale study of predictors of 16–18 attainment has been conducted in Wales. This omission is non-trivial, with Wales presenting a distinct geographical context with unique education challenges. Wales performs below both the OECD average and all other UK nations in PISA (Programme for International Student Assessment). Such shortfalls are not attributable to the higher levels of poverty in Wales, with disadvantaged pupils in England scoring either higher than or equal to all pupils in Wales (Sibieta, 2024). Furthermore, fewer 18-year-olds in Wales progress to higher education (30%) compared to England (37%) and Northern Ireland (38%) (Robson *et al.*, 2024).

Subsequently, Wales provides a valuable empirical setting to investigate underexamined predictors of post-16 educational progression. Findings have relevance to education systems elsewhere that contend with multilingualism, socioeconomic disadvantage, and multi-stage pathways to qualifications during the later years of secondary education.

Aim of This Study

This study uses administrative data to investigate subject progression, as evidenced by pupil attainment at AS-level. Specifically, it asks:

(1) What is the individual predictive value of GCSE maths, science, and English/Welsh language grades for AS-level attainment?
(2) What are the implications of the above for the current prioritisation of Maths and English proficiency for educational progression?
(3) How do pupil- and school-characteristics contextualise subject progression?

The study makes three contributions to the literature:

(1) It clarifies the relative importance of subject-specific GCSE attainment in shaping post-16 educational progression, informing subject selection and guiding schools on effective KS4 preparation.
(2) It highlights the often-overlooked role of GCSE science attainment as a predictor of success in a range of AS-level subjects.
(3) It provides the first large-scale analysis of AS-level attainment in Wales, a nation of bilingualism, devolution, and high poverty.

2. RESEARCH DESIGN

Cohort

This study focuses on the cohort of pupils who completed AS-levels in state-maintained schools (sixth forms) in Wales in 2017/18. This cohort was chosen as it is the most recent cohort whose compulsory education (up to age 18) was not affected by the Covid-19 pandemic, thus presenting the most 'typical' education trajectory to date.

Further education (FE) college data were not included because this required access to additional datasets that lay beyond the scope of the study. The results are therefore only applicable to school sixth form contexts. Nonetheless, in the context that approximately 70% of AS-level entries in Wales occur in school sixth forms and 30% in FE colleges (Estyn, 2018), the study reflects the largest share of AS-level provision in Wales.

Data

Data were drawn from two national databases in Wales, accessed via the Secure Anonymised Information Linkage (SAIL) databank (Ford *et al*., 2009). Data around pupils' prior attainment at age 16, as well as their AS-level attainment were drawn from the Wales Examinations Database (WED). To explore how pupil- and school-characteristics also moderate pupil progression, data on these factors were drawn from the Pupil Level Annual School Census (PLASC) which can be linked across years to track pupils throughout their education. Pupil and school characteristics explored in analyses included: sex, eligibility for free school meal (eFSM), special educational needs (SEN) provision, medium of education, KS4 science programme (explained in subsequent section), and geography. While these are not exhaustive of all possible contributors to AS-level attainment, they were selected based on evidence of their relevance to post-16 attainment and progression, gaps in prior research, and provided sufficient data to permit adequate sample sizes for robust quantitative analyses.

Outcome Variables

This study investigated predictors of attainment across six AS-level subjects: Biology, Chemistry, Physics, Maths, History, and English Literature. These subjects were chosen because they were the most popular subjects at AS-level in 2017/18[2] (Government, 2019), and presented breadth in subject epistemology.

For each subject, a binary outcome variable captured whether a pupil passed the subject with an A, B, or C grade (coded as 1), or obtained a D grade or below (coded as 0). This binary outcome was employed as it provided the most stable regression models. Using discrete grades through ordinal data, or an A grade cut-off instead of a C grade, introduced small cell sizes that threatened the stability of the models. Although a D grade does not constitute a formal fail, this cut-off aligns with research and school performance reporting practices (Government, 2019; Ofqual, 2024a). Only full grades rather than raw attainment scores (continuous measures) were available in the data.

Pupil Attainment

Pupils' GCSE attainment in maths, science, and English/Welsh language were recoded into three binary variables. An A/A* threshold was applied to these variables for both conceptual and methodological reasons. Conceptually, in terms of educational progression, approximately 92% of pupils in England with an A/A* in maths and English GCSE enter higher education (Babbini, 2024). Accordingly, A/A* grades at GCSE are frequently used as indicators of high educational accomplishment across research, school, and government

reports (e.g., Ofqual, 2024b). Methodologically, a binary variable reduced the risk of small cell counts that would accompany individual grade separation.

In Wales, pupils are expected to complete two maths GCSEs: maths and maths numeracy. Attainment in GCSE maths was therefore recoded into a binary variable whereby a 1 indicated the pupil achieved an A/A* grade in *either* maths or maths numeracy at GCSE.

In science, there are multiple programmes that pupils can follow that equate to either one, two, or three qualifications in science. Thus, if a pupil acquired an A/A* grade (or a Distinction for some programmes), in any of the possible GCSE programmes (or equivalent).[3] science programmes, they were assigned a value of 1 for GCSE science attainment

The Wales context meant that the pupil population included both Welsh and English first-language speakers, who studied at either Welsh-medium, English-medium, or bilingual schools. Given such differences, it was important to use a language qualification that was equitable across all pupils. In Welsh-medium and bilingual schools, pupils will study Welsh language as an equivalent to English language at English-medium schools. As such, if pupils achieved an A/A* grade in *either* English language or Welsh language at GCSE, they were assigned a value of 1 for GCSE English/Welsh attainment.

Pupil Characteristics

A variety of science programmes are offered at KS4 that amount to one, two, or three GCSE equivalents. Previous research has shown that pupils who do Triple Science (a GCSE in each biology, chemistry, and physics) have better progression in post-16 science (Gill, 2019; Bartlett in press). As this study examines the role of GCSE science in shaping post-16 educational progression across a range of subjects, it was important to distinguish between the quality of science attainment (measured by GCSE grades) and the quantity of science study (measured by programme type). Accordingly, a science programme binary variable indicated whether pupils completed Triple Science (coded as 1) or any other lesser-volume science programme (coded as 0).

Pupils' sex was accounted for using a binary variable with a value of 1 denoting female pupils and 0 denoting male pupils.

As is common across education research, eligibility for free school meals (eFSM)[4] was used as a proxy for socioeconomic status. Because pupils' eligibility can change over their school trajectory in line with changes in family circumstances or wider economic shifts (Gorard and Siddiqui, 2019), this measure was operationalised as a composite indicator. The PLASC dataset provides annual data on pupils' free school meal eligibility status, thus, by linking multiple PLASC datasets, it was possible track individual pupils from KS1 to KS5. These observations were collapsed into a binary composite variable where a value of 1 indicated a pupil had been eligible at any point between KS1-4, and 0 indicated they had never been eligible between KS1 and KS4.

The same approach was used for SEN status,[5] where 1 indicated the pupil had been identified as having SEN sometime during their KS1-4 pathway and 0 indicated they had never been identified as having SEN.

Although the binary measures of eFSM and SEN status are simplistic, they were deemed sufficient in the context that the focus of this study was on prior subject attainment as predictors of subject progression. Ethnicity was carefully considered for inclusion, but was ultimately excluded as it risked producing unreliable or potentially misleading estimates.[6]

School Characteristics

As outlined previously, Wales presents a distinct educational context shaped by bilingualism and regional variation in school provision. Pupils may attend Welsh-medium, English-medium, or bilingual schools, and has implications for educational delivery and outcomes. Existing literature, while indicative of a relationship between language medium and pupils' educational outcomes, report different directions of associations. While some report positive associations between Welsh-medium schools and educational outcomes, others report negative associations (Classick *et al.*, 2020; Johnes, 2020; Jones *et al.*, 2020). Research also typically relies on general performance metrics rather than subject-specific outcomes. Exploring the role of school language medium in the context of subject-specific AS-level attainment enables a more nuanced analysis of the role of language medium in shaping post-16 educational progression.

The focus of this analysis was the language medium of the school attended during KS4. Subsequently, pupils were coded as '1' if they attended a Welsh-medium school[7] at KS4, and '0' if they attended an English-medium school.

Given the documented importance of regional context and the high levels of rurality in Wales, geographical location was also included as a predictor. Previous research has linked rurality and limited access to educational resources with disparities in progression (Sibieta *et al.*, 2024). Pupils were categorised according to the local authority of the school attended during KS4. Using the Rural Urban Classification system (Office for National Statistics, 2025), schools were classified as either urban (coded as '1') or rural (coded as '0').

A summary table of all variables is provided in Appendix 1.

Statistical Analysis

Data analyses involved six binary logistic regression models to estimate the odds ratios and predicted probabilities of pupils obtaining an A-C grade (A* grades are not used at AS-level) in AS-levels in (1) maths, (2) biology, (3) chemistry, (4) history, (5) English literature, and (6) physics. Logistic regression models are used widely in social science research for predictive modelling, and more specifically, identifying factors that best differentiate groups (Poston *et al.*, 2023). The suitability of using

regression models for predictions is reinforced by the temporal ordering of the data. All predictors were measured prior to AS-level attainment outcomes, supporting the interpretation of these variables as potential predictors rather than consequences.

Preliminary checks indicated that the school-level intraclass correlations for the outcome variables were small (0.03–0.10), suggesting minimal clustering. Under such circumstances, it was decided not to use multilevel models as this would provide little gain and may have introduced unnecessary complexity. Furthermore, since the major school-level characteristics relevant to the study (language medium, geography) were entered as fixed predictors, much of the systematic between-school variation was directly modelled.

To evaluate the effects of each predictor, odds ratios were calculated to measure the magnitude and direction (positive or negative) of an association between a predictor variable and an outcome variable. In this case, the relative odds of achieving an A-C grade at AS-level for pupils with a given characteristic (coded as 1) compared to those without this characteristic (coded as 0), whilst holding all other model variables constant. An odds ratio of 1 indicated no difference between the groups, a value greater than 1 indicated pupils with that characteristic had greater odds of achieving an A-C grade. A value less than 1 indicated pupils with that characteristic had reduced odds of achieving an A-C grade than the reference group. Additionally, predicted probabilities were reported, providing an intuitive measure of the likelihood of achieving A-C grades in a given subject for specific combinations of predictor variables. Given that this study uses population data and therefore did not involve sampling, odds ratios (effect sizes) are prioritised over significance values. In this context, odds ratios provide a more meaningful indication of the magnitude and direction of associations. Nevertheless, significance values are reported for completeness and comparability with prior research with inferential thresholds. These values should be interpreted descriptively rather than as formal inference tests.

Interaction effects across variables were tested based on evidence from existing literature. For example, even among high-attaining pupils, those from disadvantaged backgrounds are less likely to sustain strong outcomes at AS- and A-level than peers from more advantaged backgrounds (Sammons *et al.*, 2018). Some research also indicates that males are more negatively affected by socio-economic disadvantages than females (Friedman-Sokuler and Justman, 2020).

To ensure robustness of regression models, the analytic sample only included pupils in the 2017/18 AS-level cohort who completed an AS-level in at least one of the six subjects of study, and for whom data on all nine predictor variables were available. While exclusion of individuals with missing data risks the introduction of bias, comparison with official Welsh Government statistics (Government, 2025) indicated that the analytic sample remained comparable to the population. Sensitivity and specificity checks (proportion of true positives

and true negatives) exceeded 70%, which confirmed the reliability and robustness of the model.

All statistical analyses were conducted using Stata software (version 19). In compliance with SAIL databank data disclosure standards, and to protect anonymity, all numbers reported in this study have been rounded to the nearest multiple of five.

3. RESULTS

A total of 8010 pupils pursued AS levels in 2017/18 in a state-maintained school in Wales, had achieved at least one GCSE qualification in each maths, science, and English or Welsh language, and had data available on the six demographic areas of interest.

In terms of the most popular subjects at AS-level, results confirmed figures presented in Government (2019) reports. Maths, biology, history, chemistry, English literature, and physics were the six most popular AS-subjects in that academic year, chosen by 25%, 23%, 20%, 19%, 15% and 14% of pupils respectively. The demographic details for each subject cohort are provided in Appendix 2. Table 1 summarises the proportion of pupils who achieved an A-C grade in the AS exams for each of the six subjects. The first row details the overall percentage of A-C grades (pass) for each subject cohort, and the following rows provide the proportion of pass grades pertaining to each demographic group.

Table 1 shows that overall, more than half of pupils passed each of the six AS-level subjects, with pass rates ranging from 75% in AS-History to 51% in AS-Biology.

Prior attainment at GCSE appeared to have a role in AS-level outcomes. Among pupils who achieved a B grade or lower in GCSE maths, only 6% passed AS-Physics and 5% passed AS-Maths. Similarly, 10–12% of pupils with B grades or lower in GCSE science passed AS-Biology, AS-Chemistry, and AS-Physics. Pass rates for AS-Maths among low GCSE science achievers were slightly better at 19%. High attainment in English/Welsh language also appeared beneficial, particularly for AS-English Literature and AS-History. Specifically, 92% of pupils with A/A* grades passed AS-English literature compared to 49% of their lower attaining peers.

Clear patterns were also evident across pupil characteristics. For all six AS-level subjects, pass rates differed by at least 10 percentage points between eFSM pupils and non-eFSM pupils, with the greatest difference observed in AS-Maths. This same difference was seen in AS-Maths for pupils with and without SEN. However, for the other five AS subjects, the difference between SEN pupils and their peers was seemingly less marked than the difference between eFSM and non-eFSM pupils. The role of language medium varied across AS-level subjects, with little difference in pass rates for AS-Maths and AS-English

Table 1. Proportions of biology, chemistry, Physics, maths, history, and english literature AS cohorts who passed, by demographics

	AS-Biology	AS-Chemistry	AS-Physics	AS-Maths	AS-History	AS-English Literature
Total Passed	**925 (51%)**	**850 (56%)**	**625 (54%)**	**1,160 (58%)**	**1,170 (75%)**	**815 (67%)**
A/A* grade in GCSE Maths	825 (69%)	815 (65%)	615 (63%)	1,150 (64%)	520 (90%)	305 (91%)
≤B grade in GCSE Maths	100 (16%)	35 (13%)	10 (6%)	10 (5%)	645 (65%)	510 (57%)
A/A* grade in GCSE Science	860 (69%)	820 (66%)	595 (66%)	1,055 (74%)	505 (94%)	315 (95%)
≤B grade in GCSE Science	65 (12%)	30 (11%)	25 (10%)	105 (19%)	660 (64%)	500 (56%)
A/A* grade in GCSE English/Welsh	650 (71%)	600 (73%)	385 (75%)	740 (77%)	625 (90%)	470 (92%)
≤B grade in GCSE English/Welsh	280 (31%)	250 (36%)	240 (37%)	420 (40%)	545 (62%)	345 (49%)
eFSM (at some point)	60 (35%)	60 (46%)	40 (42%)	80 (41%)	105 (64%)	100 (53%)
Never eFSM	865 (52%)	795 (57%)	585 (55%)	1,080 (60%)	1,065 (76%)	715 (69%)
SEN (at some point)	90 (41%)	80 (50%)	65 (45%)	105 (41%)	165 (65%)	105 (55%)
Never SEN	835 (52%)	775 (57%)	560 (55%)	1,055 (60%)	1,005 (76%)	710 (69%)
Welsh Medium Education (at KS4)	155 (53%)	135 (51%)	130 (59%)	200 (60%)	210 (78%)	145 (66%)
English Medium Education (at KS4)	770 (50%)	715 (57%)	495 (53%)	960 (58%)	960 (74%)	670 (67%)
Female	575 (52%)	425 (55%)	180 (57%)	550 (64%)	680 (77%)	625 (68%)
Male	350 (50%)	425 (57%)	445 (53%)	610 (53%)	485 (70%)	190 (64%)
Triple Science	650 (56%)	655 (60%)	455 (59%)	745 (65%)	400 (82%)	280 (80%)
Other Science Programme	275 (42%)	195 (46%)	170 (43%)	415 (49%)	770 (71%)	530 (61%)
Urban Geography	665 (52%)	635 (56%)	440 (53%)	835 (57%)	815 (75%)	585 (68%)
Rural Geography	260 (49%)	215 (56%)	185 (56%)	325 (60%)	355 (72%)	230 (65%)

Literature. However, pupils from English-medium schools appeared to perform better in AS-Chemistry (57% versus 51%), while those from Welsh-medium schools had higher pass rates in AS-Biology (53% versus 50%), AS-Physics (59% versus 53%), and AS-History (78% versus 74%).

Differences by sex were apparent across some AS-subjects, with females achieving higher pass rates than males in all but AS-Chemistry, where males were slightly advantaged (57% versus 55% pass). The largest gap was for AS-Maths, where females outperformed males by 11% points (64% versus 53%).

Participation in Triple Science at KS4 appeared to benefit all six AS subjects, not just the sciences, with such pupils obtaining pass rates of 11–19% points greater than pupils on other science programmes at KS4. The greatest difference was for passing AS-English Literature, with 80% of Triple Science pupils passing compared to 61% of other science programme pupils.

Finally, geographic patterns appeared modest and subject-specific: pupils who attended urban schools in KS4 had a higher pass rate in AS-Biology, AS-History, and AS-English Literature, while pupils from rural schools had higher pass rates in AS-Physics and AS-Maths.

Modelling A-C Grades Across AS-Level Subjects

To explore the isolated effects of these individual variables, multivariate binary logistic regression analyses were employed. Null models (without predictor variables) demonstrated that for all AS-level subjects bar Biology, pupils were more likely to achieve an A-C grade (pass) than a D grade or lower. Next, full regression models that incorporated all nine predictor variables were administered to see what impact prior attainment at GCSE had on AS attainment. The odds ratios (OR) for each predictor variable across the six AS-level subjects are provided in Table 2.

The Role of Prior Attainment

As evident from Table 2, prior attainment in GCSE maths, science, and English/ Welsh language emerged as strong positive predictors of AS-level pass rates across all six AS subjects. However, the strength of associations varied across subjects.

GCSE maths positively predicted AS-level attainment in all six subjects and was the strongest predictor of success in AS-Maths (OR = 13.87) and AS-Physics (OR = 12.41). These results are suggestive that pupils aiming to study AS-Physics may benefit from prioritising their GCSE maths performance in order to increase their chances of passing AS-Physics. In contrast, of the three core GCSE subjects, maths was the weakest contributor to attainment in AS-History (OR = 1.84) and AS-English Literature (OR = 1.74).

Table 2. Odds ratios of predictor variables in passing biology, chemistry, physics, maths, history, and english literature as

	AS-Biology	AS-Chemistry	AS-Physics	AS-Maths	AS-History	AS-English Literature
N	1,820	1,520	1,160	2,005	1,570	1,220
	Odds Ratios					
GCSE Maths Attainment	4.73**	5.53**	12.41**	13.87**	1.84*	1.74*
GCSE Science Attainment	7.09**	8.17**	8.64**	6.39**	4.03**	4.30**
GCSE English/ Welsh Attainment	2.95**	3.77**	3.43**	2.37**	2.73**	6.51**
FSM	1.00	1.01	0.80	0.84	0.82	0.81
SEN	1.61*	1.32	1.20	0.92	0.90	1.04
Sex	0.80	0.50**	0.57*	0.97	1.12	1.04
KS4 Science Pathway	0.95	0.91	1.10	0.97	1.01	1.22
Medium	1.05	0.63*	1.08	0.80	1.11	0.75
Geography	1.24	1.23	1.08	1.02	1.19	1.20

Note: $**p < 0.001$, $*p < 0.05$

GCSE science attainment was the biggest predictor of success in AS-Biology, AS-Chemistry, and AS-History. Specifically, pupils with an A/A* grade in GCSE science had 7.09 times higher odds of achieving an A-C grade in AS-Biology than their lower attaining peers. For AS-Chemistry, these odds were 8.17 times higher, and for AS-History, 4.03 times higher. The results for AS-History are particularly notable, as it would be reasonable to assume that GCSE attainment in English/Welsh language would be more valuable than science, given the comparable essay-based structure of these qualifications.

Furthermore, not only was GCSE science the largest predictor of AS-History success, it was also a substantially better predictor than GCSE maths at predicting success in AS-level English Literature (4.30 versus 1.74 ORs). Such results are indicative of limitations of focusing exclusively on maths and English as priority subjects for educational progression.

In terms of GCSE attainment in English/Welsh language, this was the strongest predictor of success in AS-level English Literature (OR = 6.51). However, across all AS-level subjects, pupils with A/A* grades in GCSE English/Welsh Language had between 2.37- and 6.51-times greater odds of achieving A-C grades in each AS-level subject than their peers with lower grades at GCSE.

Interaction effects between each prior attainment measure and free school meal eligibility, and sex were explored, but no interactions were identified.

The role of different GCSE attainment profiles in maths, science, and English/Welsh in their contributions to predicting AS-level attainment are further illustrated in Table 3. This summarises the predicted probabilities of achieving A-C grades in each AS-level subject according to all possible GCSE attainment permutations, whilst controlling for the six pupil and school factors.

Across all six AS-level subjects, pupils who achieved A/A* grades in all three GCSE subjects (permutation 8, Table 3) consistently had the highest predicted probabilities of success. While this is perhaps not surprising, a crucial insight is the role of GCSE dual-subject combinations.

The most favourable dual-pairings for each AS-level subject are highlighted by the bordered cells in Table 3. Here, it is evident that high attainment in GCSE maths and English/Welsh were not the two strongest predictors for success in any of the six AS-level subjects. For AS-levels in Biology, Chemistry, Physics and Maths, high attainment in both GCSE maths and GCSE science (permutation 7, Table 3) yielded the highest predicted probabilities of an A-C grade at AS-level. Given Maths' longstanding status as the most popular AS-level subject (Joint Council for Qualifications, 2025), this insight is particularly relevant for guiding pupils' preparation for post-16 progression.

In contrast, for the humanities and art subjects, AS-History and AS-English Literature, the most favourable dual combination was high attainment in both GCSE science and GCSE English/Welsh language (permutation 4, Table 3). These combinations yielded predicted pass probabilities of 94% and 96%, respectively, compared to 87% and 90% associated with the maths and English/Welsh pairing (permutation 6, Table 3). Also more powerful than permutation 6 for attainment in AS-History and AS-English Literature was permutation 7. That is, GCSE maths and science had a stronger association with passing these AS-subjects than GCSE maths and English/Welsh. Crucially, this demonstrates the advantage of science proficiency beyond STEM subjects.

The Role of a Higher Volume GCSE Science Programme

Including a variable for KS4 science programme allowed the analyses to distinguish between the influence of attainment in science and the volume of science studied by pupils. Once prior attainment was accounted for, taking Triple Science at GCSE had little independent association with the likelihood of achieving an A-C grade in any of the AS-level sciences, AS-Maths, or AS-History. Although this contrasts with the descriptive differences reported in Table 1, these differences are likely explained by underlying attainment, as pupils who take Triple Science tend to be higher achieving overall (Archer *et al.*, 2017). No interaction effects were observed between GCSE science programme and GCSE science attainment, further indicating that the apparent advantages of Triple Science are moderated when prior attainment is controlled. Taken together, these findings suggest that, for educational progression, the

Table 3. Predicted probabilities for passing biology, chemistry, physics, maths, history and english literature as-level

GCSE Grade permutations			Predicted probability of pupils achieving A-C grades at AS level					
Maths	Science	English/Welsh	Biology	Chemistry	Physics	Maths	History	English Literature
1	≤B	≤B	≤B	5%**	3%**	1%*	2%*	57%***	45%***
2	≤B	≤B	A/A*	13%***	9%***	4%*	5%*	78%***	84%***
3	≤B	A/A*	≤B	26%***	18%***	10%***	12%*	84%***	78%***
4	≤B	A/A*	A/A*	50%***	44%***	27%***	24%***	94%***	96%***
5	A/A*	≤B	≤B	19%***	13%***	14%***	22%***	71%***	59%***
6	A/A*	≤B	A/A*	40%***	35%***	35%***	41%***	87%***	90%***
7	A/A*	A/A*	≤B	61%***	53%***	57%***	65%***	91%***	86%***
8	A/A*	A/A*	A/A*	82%***	80%***	82%***	81%***	96%***	98%***

** $p<0.001$, * $p<0.05$

quality of science attainment (GCSE grade) is more consequential than the quantity of science studied.

The Role of Pupil Characteristics

The odds ratios in Table 2 are indicative that pupil characteristics of sex, eFSM status, and SEN status do indeed have moderating effects on AS-level attainment.

For AS-level Physics, History, Maths, and English Literature, eFSM pupils were less likely than their non-eFSM peers to obtain an A-C grade, with ORs ranging from 0.80 to 0.84. For AS-Physics, previous evidence from the same cohort demonstrated that eFSM was not a predictor of pupils choosing Physics at AS-level (Bartlett in press). While this is encouraging, if those pupils are then less likely to pass than their non-eligible peers, it is important that sufficient support is put in place to close this gap and maintain eFSM pupils' progression in Physics.

Interestingly, pupils with SEN status had greater odds of passing all three science subjects than their non-SEN peers, though to varying degrees of magnitude (OR = 1.20–1.61). Such results appear to be at odds with the descriptive statistics summarised in Table 1 where a smaller proportion of SEN pupils passed the AS-level science subjects compared to their non-SEN peers.

Table 3 also highlights differences in AS-level attainment according to sex. Once all other predictor variables are accounted for, male pupils displayed higher odds of achieving favourable grades in all three sciences, though again to different degrees of magnitude (AS-Biology OR = 0.80; AS-Chemistry OR = 0.50; AS-Physics OR = 0.57).

The Role of School Characteristics

Given the unique context of Wales among the UK nations as one of bilingualism and high rurality, how these factors contribute to pupils' educational progression was important to account for in statistical modelling.

How school language medium contributes to educational progression appeared to vary across subjects. From Table 2 it is apparent that pupils attending Welsh-medium schools for KS4 had marginally higher odds of achieving an A-C grade in AS-Physics (OR = 1.08), and AS-History (OR = 1.11). By contrast, their odds of achieving favourable grades were notably lower than their English-medium educated peers for AS-Chemistry (OR = 0.63), AS-Maths (OR = 0.80), and AS-English Literature (OR = 0.75).

In terms of geography, pupils educated in urban schools for GCSE had higher odds of passing all six AS-subjects compared to their rural-educated peers, with the most pronounced advantages observed in AS-Biology (OR = 1.24), AS-Chemistry (OR = 1.23), and AS-English Literature (OR = 1.20).

4. DISCUSSION

Traditionally, maths and English have been prioritised as the key prerequisites for post-16 readiness (Department for Education, 2021; Robinson, 2019). However, the finding that GCSE maths and English/Welsh were not the two strongest predictors of success for any of the AS subjects challenges this convention. Instead, GCSE science attainment consistently presented as one of the top two most powerful predictors across the six most popular AS-subjects, including non-STEM disciplines. This finding extends existing research on the value of science for later STEM achievement (e.g., Gill and Bell, 2013) by illustrating a broader cross-disciplinary influence of scientific literacy. Such results invite a reconsideration of how 'core' subjects are conceptualised within policy frameworks and guidance. Positioning maths and English as universal gatekeepers may risk obscuring the wider academic utility of science, potentially undermining how pupils prioritise GCSE subjects in line with their intended post-16 subject pathways.

Findings also contribute to the literature in terms of the individual predictive value of maths and English/Welsh in shaping post-16 progression. Much prior work has examined the combined role of such subjects (e.g., Ross *et al.*, 2025), yet few have disentangled their independent contributions. Here, English/Welsh attainment emerged as a positive predictor across all AS-level subjects, including the sciences, complementing research suggesting that while English/Welsh may not uniformly influence choice in science (Bartlett in press), it exerts a meaningful influence on subsequent achievement. This has important implications for supporting long-term STEM participation, particularly given the linguistic demands of scientific reasoning and assessment, which may be underacknowledged.

A further notable insight concerns the distinction between the quantity and the quality of prior science study. Although Triple Science has been seen to predict uptake of science subjects at AS-level (Bartlett in press), the present analysis shows no corresponding improvement in AS-level performance once prior attainment is controlled for. This suggests that grades, rather than breadth of exposure, are more consequential for post-16 progression.

In terms of how pupil characteristics moderate subject-specific progression, the finding that pupils with SEN had higher odds of passing AS-level sciences than their non-SEN peers warrants careful interpretation. Although this contrasts with national attainment patterns, it resonates with prior evidence indicating that certain SEN subgroups, particularly those with an autism spectrum disorder, are substantially more likely to progress into STEM degrees than peers with other disabilities and the wider pupil population (Wei *et al.*, 2013). A plausible explanation could be a selection effect: pupils with SEN who progress into AS-level sciences may be atypical in terms of motivation, support, or science-related capital (Archer *et al.*, 2015) and are not captured within administrative datasets.

After adjusting for confounders, it is also evident that males had higher odds of passing AS-level Biology, Chemistry, and Physics. This runs counter to headline descriptive metrics suggesting female outperformance (e.g., Smith and White, 2025), but aligns closely with analyses incorporating value-added measures (UK Government, 2025). These findings underscore the need for caution when interpreting raw attainment statistics and suggest that gendered patterns in STEM achievement may be more dependent on underlying attainment profiles than is acknowledged in some policy discourse.

The role of school characteristics is complex. The comparatively large effect sizes favouring English-medium educated pupils in AS-Chemistry, AS-Maths, and AS-English Literature raises concern about potential systemic challenges within Welsh-medium provision. Such disparities may be linked to teacher recruitment challenges disproportionately affecting Welsh-medium schools (Ghosh and Worth, 2022), but further research is required to establish causal pathways.

Similarly, the consistently lower odds of success for pupils educated in rural schools add to a growing literature around the structural pressures facing rural provision in Wales. While earlier research has focused primarily on access and institution choice (Sibieta, 2024), the present findings suggest that the challenges extend to attainment itself, potentially reflecting differences in teacher availability (Evans and Mendez Acosta, 2023), curriculum offer, absenteeism patterns, or broader socioeconomic contexts. These results highlight the need for sustained attention to rural educational equity and suggest that targeted support may be necessary to mitigate structural disadvantages.

Several limitations of the study should be acknowledged. The analysis focused on pupils completing AS-levels in school-based sixth forms, thereby excluding learners in further education (FE) colleges, an omission that constrains the generalisability of findings. Although less than a third of FE learners pursue AS-levels (Robson *et al.*, 2024), this population is generally of lower socioeconomic status (Huxley and Davies, 2024), and as such, their inclusion in future work would yield a more comprehensive picture of progression across post-16 pathways. The dichotomised operationalisation of FSM and SEN status was necessarily coarse to allow sufficient cell sizes. However, in future research, use of multiple cohorts or mixed methods studies would enable these factors, and additional factors such as ethnicity, to be explored in more detail. Relatedly, the use of administrative data, while extensive, limits exploration of non-cognitive and contextual factors such as pupil motivation, parental support, and teaching quality. Addressing these dimensions through mixed-methods or longitudinal designs would deepen understanding of the mechanisms linking GCSE attainment to later outcomes. Finally, the predictive associations observed cannot be interpreted causally, and unobserved confounding, particularly in relation to pupil background or teacher characteristics, may influence results.

5. CONCLUSION

This study offers substantial new insights into the determinants of early post-16 academic success, demonstrating that GCSE science attainment is a robust and cross-disciplinary predictor of achievement across a diverse range of AS-level subjects. In doing so, it provides evidence to challenge long-standing assumptions about the primacy of English/Welsh and mathematics as the core foundation for post-16 readiness. The findings welcome a consideration of a broader conceptualisation of 'core' skills. Specifically, one which recognises the role of scientific literacy in supporting general academic progression, may better reflect the realities of pupil trajectories and provide a more balanced basis for guidance and policy. The study also demonstrates that pursuing a higher-volume science programme (Triple Science) has negligible additional impact once attainment is accounted for, suggesting that the *quality* of science learning, rather than the *quantity* of exposure, is more consequential for subsequent educational progression.

The significance of this work extends beyond the Welsh context. As many education systems grapple with questions of curriculum design, subject hierarchies, and equitable post-16 provision, these findings highlight the need to revisit assumptions about prior attainment and its relationship to progression, as well as the quantity of teaching as demonstrated by the role of Triple Science. Findings also demonstrate the value of subject-specific modelling over broad descriptive analyses when designing targeted interventions.

Future research should build upon these findings by including FE learners, tracking cohorts beyond AS-level into subsequent educational and occupational outcomes, and employing mixed-methods approaches to capture motivational, cultural, and pedagogical influences that are not observable in administrative data. Pooling multiple cohorts would also enable more fine-grained analyses of predictors and outcomes, for example using an A-grade threshold at AS-level or ordinal outcome measures. Together, these approaches would support a more comprehensive and equitable understanding of educational progression.

decisions in Wales. The ADR Wales programme of work is aligned to the priority themes as identified in the Welsh Government's Programme for Government. ADR Wales is part of the Economic and Social Research Council (part of UK Research and Innovation) funded ADR UK (grant ES/W012227/1). The author would like to acknowledge all the data providers who make anonymised data available for research, and in the context of this study, to schools and teachers. It is the author's responsibility alone for interpreting information supplied by SAIL. The author would like to thank the reviewers for their valuable feedback on this manuscript.

7 DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

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9 DATA AVAILABILITY STATEMENT

This study uses administrative data accessed via the Secure Anonymised Information Linkage (SAIL) Databank at Swansea University. The author is not the owner of this data.

10 ETHICS STATEMENT

This study utilises anonymised, de-identified data held within the Secure Anonymised Information Linkage (SAIL) Databank at Swansea University. All research proposals involving SAIL data, including this study, must receive a favourable opinion from the independent Information Governance Review Panel (IGRP), which includes members representing regulatory bodies, professionals, and the public. Only upon this approval is remote access to data via the secure SAIL Gateway granted.

11 NOTES

[1.] In line with the new curriculum in Wales, Key Stages are being phased out. However, qualifications by the age of 16 will remain critical for pupils' prospectives for further study and future career pathways.

[2.] While Social Studies was reported as one of the most popular subjects, this is a composite indicator, comprising multiple individual subjects and so is not included in this study.

3.   While not all of the possible science programmes that pupils can pursue are GCSE qualifications, the term GCSE is applied here for consistency and readability in the context of maths and English/Welsh language qualifications.

4.   Eligibility for free school meals is determined by local authorities and is based on whether pupils' parents or guardians receive particular low-income benefits.

5.   In Wales, the SEN system was replaced with an ALN system (additional learning needs) in 2021. However, the SEN terminology is used in this paper to reflect the period of the data.

6.   Wales has relatively low ethnic diversity with approximately 94% of the population identifying as White in the 2021 Census. This distribution was reflected in the administrative school data, where ethnicity could only be operationalised as a highly aggregated binary variable of 'white' and 'non-white'. Even at this level of aggregation, small cell sizes and levels of missing data were present, which reduced statistical power and led to instability in preliminary model specifications.

7.   The category Welsh-medium school also included bilingual schools. Given the very few number of bilingual schools, this is common practice in Welsh Government reports, e.g.: https://www.gov.wales/schools-census-results-january-<unciteclass= 'unciteRefText'>2024</uncite > −html.

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APPENDIX 1

Variable	Description	Format
AS-Biology Grade	Whether a pupil acquired an A, B, or C grade in AS-level Biology	0 – did not gain an A-C grade 1 – gained an A-C grade
AS-Chemistry Grade	Whether a pupil acquired an A, B, or C grade in AS-level Chemistry	0 – did not gain an A-C grade 1 – gained an A-C grade
AS-Physics Grade	Whether a pupil acquired an A, B, or C grade in AS-level Physics	0 – did not gain an A-C grade 1 – gained an A-C grade
AS-Maths Grade	Whether a pupil acquired an A, B, or C grade in AS-level Maths	0 – did not gain an A-C grade 1 – gained an A-C grade
AS-History Grade	Whether a pupil acquired an A, B, or C grade in AS-level History	0 – did not gain an A-C grade 1 – gained an A-C grade
AS-English Literature Grade	Whether a pupil acquired an A, B, or C grade in AS-level English Literature	0 – did not gain an A-C grade 1 – gained an A-C grade
GCSE attainment in maths	Whether a pupil got an A/A* grade in a maths KS4 qualification	0 – B grade or lower 1 – A/A*
GCSE attainment in science	Whether a pupil got an A/A* grade in a science KS4 qualification	0 – B grade or lower 1 – A/A*

(*Continued*)

Variable	Description	Format
GCSE attainment in English/Welsh Language	Whether a pupil got an A/A* grade in English/Welsh language KS4 qualification	0 – B grade or lower 1 – A/A*
Sex	The sex of the pupil	0 – Male 1 – Female
FSM eligibility	Whether a pupil was eligible for free school meals at any point from Key Stage 1 to 4.	0 – Not eligible 1 – Eligible
SEN	Whether a pupil was identified as having special educational needs at any point from Key Stage 1 to 4.	0 – Not SEN 1 – SEN
GCSE science programme	Whether a pupil completed a KS4 qualification in each biology, chemistry, and physics	0 – Other programme 1 – Triple science
Language medium of education	Whether a pupil attended a Welsh-medium or English-medium school during KS4	0 – English-medium 1 – Welsh-medium
Geography	Whether a pupil attended a school in a rural or urban local authority in KS4	0 – Rural 1 - Urban

APPENDIX 2

The table below summarises the proportion of pupils who chose each of the six subjects at AS-level, along with demographic details for each subject cohort. It presents both the overall AS cohort demographics and that of the individual subject cohorts. Percentages were calculated using the relevant cohort as the denominator; for example, 270 AS chemistry pupils had a B grade or lower in KS4 maths, representing 18% of that cohort.

From Table 1, it is apparent that within the full AS cohort, 39% of pupils had A/A* grades in GCSE maths. By comparison, such pupils were overrepresented in AS-Biology (66%), AS-Chemistry (82%), AS-Physics (84%), and AS-Maths (89%), comparably represented in AS-History (37%), and underrepresented in AS-English Literature (27%).

Pupils with A/A* grades in GCSE science made up 35% of the full AS cohort, and by comparison, were overrepresented in AS-Biology (69%), AS-Chemistry (82%), AS-Physics (78%), and AS-Maths (72%) cohorts. Their representation in AS-History (34%) was comparable to the full AS cohort, however they were underrepresented in AS-English Literature (27%).

Pupils with A/A* grades in English/Welsh Language GCSE represented 31% of the full AS cohort, however they were overrepresented in all six AS-level subjects, with representation ranging from 42–54%.

Representation of pupils in the full AS, biology, chemistry, physics, maths, history, and English literature AS cohorts.

	AS cohort	AS-Biology	AS-Chemistry	AS-Physics	AS-Maths	AS-History	AS-English Literature
Total pupils	**8,010 (100%)**	**1,820 (23%)**	**1,520 (19%)**	**1,160 (14%)**	**2,005 (25%)**	**1,570 (20%)**	**1,220 (15%)**
A/A* grade in GCSE Maths	3,135 (39%)	1,195 (66%)	1,250 (82%)	980 (84%)	1,785 (89%)	575 (37%)	335 (27%)
≤B in GCSE Maths	4,875 (61%)	625 (34%)	270 (18%)	175 (15%)	215 (11%)	995 (63%)	890 (73%)
A/A* grade in GCSE Science	2,780 (35%)	1,255 (69%)	1,240 (82%)	900 (78%)	1,435 (72%)	535 (34%)	330 (27%)
≤B in GCSE Science	5,230 (65%)	565 (31%)	280 (18%)	260 (22%)	565 (28%)	1,035 (66%)	890 (73%)
A/A* grade in GCSE English/Welsh	2,475 (31%)	915 (50%)	825 (54%)	515 (44%)	965 (48%)	695 (44%)	510 (42%)
≤B in GCSE English/Welsh	5,535 (69%)	905 (50%)	695 (46%)	645 (56%)	1,040 (52%)	875 (56%)	710 (58%)
eFSM (at some point)	1,085 (14%)	170 (9%)	130 (9%)	95 (8%)	195 (10%)	165 (11%)	190 (16%)
Never eFSM	6,925 (86%)	1,650 (91%)	1,390 (91%)	1,065 (92%)	1,810 (90%)	1,405 (89%)	1,035 (85%)
SEN (at some point)	1,395 (17%)	220 (12%)	160 (11%)	145 (13%)	155 (8%)	255 (16%)	190 (16%)
Never SEN	6,615 (83%)	1,600 (88%)	1,355 (89%)	1,015 (88%)	1,745 (87%)	1,315 (84%)	1,030 (84%)
Welsh Medium Education (at KS4)	1,420 (18%)	295 (16%)	265 (17%)	220 (19%)	335 (17%)	270 (17%)	220 (18%)
English Medium Education (at KS4)	6,590 (82%)	1,525 (84%)	1,255 (83%)	940 (81%)	1,655 (83%)	1,300 (83%)	1,000 (82%)

Female	4,435 (55%)	1,115 (61%)	770 (51%)	315 (27%)	855 (43%)	880 (56%)	925 (76%)
Male	3,575 (45%)	705 (39%)	745 (49%)	845 (73%)	1,145 (57%)	690 (44%)	295 (24%)
Triple Science	2,810 (35%)	1,165 (64%)	1,100 (72%)	765 (66%)	1,150 (57%)	490 (31%)	350 (29%)
Other Science Programme	5,200 (65%)	655 (36%)	420 (28%)	395 (34%)	855 (43%)	1,080 (69%)	870 (71%)
Urban Geography	5,705 (71%)	1,290 (71%)	1,130 (74%)	825 (71%)	1,460 (73%)	1,080 (69%)	865 (71%)
Rural Geography	2,305 (29%)	530 (29%)	385 (25%)	330 (28%)	545 (27%)	490 (31%)	355 (29%)

In terms of socioeconomic background, eFSM pupils were underrepresented across all AS subjects apart from AS-English Literature where they were slightly over-represented compared to the full AS cohort (16% versus 14%). For pupils with SEN status, while underrepresented in the three science AS-levels and AS-maths, they were equally represented in AS-History and AS-English Literature compared to the full AS cohort.

The proportions of Welsh- and English-medium pupils across the individual AS-level subjects were comparable to their representation in the full AS cohort, so too were pupils who studied in rural and urban areas, except for a small overrepre-sentation of urban pupils studying AS-Chemistry (74% versus 71% in full AS cohort).

The greatest variation in the socio-demographic characteristics of pupils taking AS-subjects was sex. An important context to this is females' overrepresentation in the full AS cohort (55% versus 45% males). Compared to the full AS cohort, females were overrepresented in AS-Biology (61%) and AS-English Literature (76%). They were most underrepresented in AS-Physics (27%), but also AS-Maths (43%). Representation in AS-Chemistry and AS-History was more balanced by (51% and 56% females respectively).

Pupils who pursued Triple Science at GCSE were overrepresented in AS-Biology, AS-Chemistry, AS-Physics and AS-Maths and underrepresented in the humanities and art subjects, AS-History and AS-English Literature.

These results give an overview of the characteristics of the six AS-level subject cohorts.

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