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Research Matters

Issue 42 / November 2026



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Citation

Articles in this publication should be cited using the following example for article 1: Majewska, D., & Ireland, J. (2026). Learning theories unpacked: A discussion of the findings from three Research Division studies. *Research Matters: A Cambridge University Press & Assessment publication, 42,* 9–19. https://doi.org/10.17863/CAM.134279

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Research Matters 42 DOI: https://doi.org/10.17863/CAM.134284

All details are correct at the time of publication in November 2026.

Contents

4 **Foreword:** Jane Mann

5 **Editorial:** Victoria Crisp

6 **In This Issue:** Victoria Crisp

9 **Learning theories unpacked: A discussion of the findings from three Research Division studies:** Dominika Majewska and Jo Ireland

20 **"Post-traumatic growth" in education: How crises can spark positive change:** Filio Constantinou

39 **Gaps in foundation mathematics understanding among 16-year-olds in England:** Alejandra Miranda

65 **Progression and earnings of students who leave post-16 education with low grades in their A Level qualifications:** Carmen L. Vidal Rodeiro and Tim Gill

84 **Data literacy: Exploring secondary school teachers' perspectives and skills:** Annie Vincent, Nicky Rushton and Chris Jellis

108 **Research News:** Jackie White

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Foreword

Jane Mann

A thread you will find running through this issue of *Research Matters* is that of gaps – the gap between learning theories and classroom practice, between the capture of assessment data and its subsequent use by teachers, the gaps in mathematical understanding that mean roughly one-third of GCSE students in the UK need to resit, and the gaps that emerge over time between students who leave school with lower A Level grades, and their higher-scoring peers.

Research is excellent at finding such gaps, but the harder question, and one that our researchers are always working through, alongside colleagues across our wider organisation, is how to bridge those gaps, turning evidence into solutions that a teacher can use in the classroom, a curriculum designer can build into their materials, or a policymaker can act on with confidence.

This issue also reminds us that necessity, in this case caused by COVID-19 disruption, really can be the mother of invention, as evidenced by Filio Constantinou's research into the positive impacts of the COVID-19 crisis on education. Through a lens not often used on the pandemic's impact on education, we can better understand "post-traumatic growth" in this context, and learn how this can contribute to the global dialogue on the future(s) of education.

Taken together, these five articles interrogate where gaps lie, and then point out what closing them, or using them, might look like. We hope this issue leaves you with a sharper sense of where evidence is needed, as well as some ideas for translating that evidence into practice.

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Editorial

Victoria Crisp

Welcome to the November 2026 issue of *Research Matters*. We begin this issue by considering theoretical ideas about how people learn, and how such ideas are used to inform educational design. Dominika Majewska and Jo Ireland reflect on three studies relating to learning theories and their use in developing curricula and other educational materials. They note challenges, such as the large number of theories and their abstract nature, and emphasise the need for practical guidance when applying theories to real-life contexts.

While much has been written about the effects of the COVID-19 pandemic on education, less research has considered whether such crises may be able to prompt some positive changes in educational contexts. In our second article, Filio Constantinou uses interviews with teachers conducted during the COVID-19 pandemic to explore ways in which a crisis may result in "post-traumatic growth". The positive effects that were identified relate to emotions and attitudes, behaviours, interpersonal relationships and how education might be reimagined.

Students' mathematics understanding and skills can be particularly important to their future opportunities. Therefore, in England, those who do not achieve a standard pass (grade 4) in GCSE Mathematics are required to retake their exams. In her article, Alejandra Miranda uses item-level data from GCSE Mathematics exams to explore which topics and skills tend to be more challenging and whether there are particular topics and skills for which grade 4 students perform disproportionately better than grade 3 students. Findings may have implications for supporting students.

A Levels are key qualifications for higher education entry and for employment opportunities. In our fourth article, Carmen Vidal Rodeiro and Tim Gill explore whether students who achieve grades D or below in their A Levels have different progression outcomes and earnings to students who achieve higher grades, using a database that links their educational backgrounds (including exam results) with their employment, earnings, and benefits data.

Our final article focuses on teachers' data literacy, something that is important to the appropriate use of students' test results. Annie Vincent, Nicky Rushton and Chris Jellis used a questionnaire and interviews with secondary school teachers to explore teachers' views on: the importance of engaging with data; skills and confidence in interpreting data; and training needs. Based on the findings, Annie, Nicky and Chris reflect on the need for schools to understand teachers' data literacy skills and training needs, and the role of assessment organisations in supporting the interpretation of assessment data.

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In This Issue

Victoria Crisp

This section aims to provide a quick introduction to the research in this issue including some context, key findings and their relevance.

The challenges of applying theories about learning

There is a considerable body of literature in psychology on how people learn. In principle, the learning theories in this literature should be able to inform the design of curricula and other educational materials. Researchers in our Research Division wanted to understand whether this was happening, and if not, how this could be facilitated.

In their article in this issue, Dominika Majewska and Jo Ireland reflect on three recent studies exploring this area. They note several obstacles to the use of learning theories, such as the volume of theories to choose from, their abstract nature and some overlap between them in their characteristics. They also reflect on how the curriculum development literature often does not state whether learning theories influenced the development of materials.

Dominika and Jo conclude that collaborations between developers, educators and researchers would be valuable and that developers need guidance on incorporating learning theories when designing a new or revised curriculum. One step that Cambridge University Press & Assessment has taken to support this is the development of an online resource which provides details of a large number of learning theories.

Not all bad? Some positives from the pandemic

We all know that there were lots of negative effects of the COVID-19 pandemic on education and that other kinds of crises also disrupt education. When interviewing teachers during the pandemic, Filio Constantinou noticed a range of positive themes that also arose and was able to categorise these as relating to emotions and attitudes, behaviours, interpersonal relationships and ideas about how education could be reimagined.

A number of positive benefits related to technology. For example, teachers noted an increase in the supply of online educational resources and improvements in the usability of technology, which changed their teaching behaviours. In turn, this had an influence on their attitudes in that their professional confidence in using

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certain tools increased. In various ways, the COVID-19 pandemic pushed forward the everyday use of technology in classrooms.

In terms of interpersonal relationships, the pandemic prompted an exchange of tips and resources between teachers, put teachers in more frequent contact with parents and provided parents with insights into teachers' work.

For the positive effects identified in this research, it could be useful to consider if they continued beyond the pandemic, and if not, whether there are ways that they could be facilitated on a longer-term basis, if sufficiently beneficial.

This research can potentially contribute to discussions about teaching strategies in both crisis and non-crisis circumstances. It is a reminder that just because something is usually done a certain way, does not mean it always has to be.

Could certain topics and skills be key in avoiding GCSE Maths resits?

Over a quarter of students in England do not attain a standard pass in GCSE Mathematics. Government funding conditions for schools and colleges require that these students retake their exams. This is intended to help provide a solid foundation for students' futures through additional opportunities to gain fundamental maths understanding and skills. However, there is concern that many students do not improve their grades when resitting, which is potentially demotivating and may contribute to disengagement with maths. How can this situation be improved?

Using data from foundation tier exams, Alejandra Miranda has found that geometry and algebra were the most challenging topics, and items requiring the use of problem-solving skills in context were also challenging. Students who achieved a standard pass (grade 4) performed disproportionately better than those who achieved the grade below (grade 3) in tasks involving routine procedures, multi-step solutions and interpreting results.

Extra teaching time spent on the topics and skills identified could plausibly support students who are at risk of not achieving a grade 4, either when taking their exams the first time or when resitting – but it remains to be seen whether this would have an impact in practice. In terms of teaching time, extra focus on some topics and skills could well mean less time for others. There may also be other barriers, such as students' beliefs about their own abilities in maths.

Alejandra's findings are relevant to current policy reforms in England, where there are plans to introduce a new level 1 maths qualification for post-16 students, with the intention that this would support knowledge development and rebuild confidence, moving students towards being ready to resit GCSE Maths exams.

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Students getting low grades at A Level have good prospects

Access to competitive university courses in England often requires high grades at A Level. But are A Levels still worthwhile for students who get only lower grades?

Carmen Vidal Rodeiro and Tim Gill used national data on educational backgrounds, exam results, employment, earnings and benefits, to explore students' progress after completing their A Levels. Compared to students with high A Level grades (lowest grade C), students with lower grades (highest grade D or E) entered employment more quickly and less frequently progressed into sustained education. However, after a few years, differences between these groups in terms of likelihood of being in education and in employment became small.

In terms of earnings, students with lower A Level grades tended to earn more in the short term than those with higher grades, but less in the long term. These differences were not trivial, but those with lower grades still achieved quite good earnings. For example, 15 years after completing A Levels the median daily earnings for those with a best grade of D was around £80, compared to a little over £100 for those with A Level grades of C or above.

The findings suggest that A Level qualifications are still valuable to students even when they achieve lower grades.

Teachers would like more training in data literacy

Among various other types of student data, teachers routinely use assessment data for purposes such as tracking student progress, informing teaching decisions and predicting future performance. Annie Vincent, Nicky Rushton and Chris Jellis used a questionnaire and interviews to investigate teachers' views about data literacy skills. Most teachers felt that data literacy was important and reported that they had at least some responsibility for using data within their role.

Data literacy skills were reportedly gained through experience or through input from colleagues. Most teachers were keen to receive more data literacy training. Notably, teacher training frameworks in England do not explicitly mention data literacy or data analysis. Teachers are required to have achieved a minimum grade in GCSE Maths, which may be a starting point for relevant skills, but some data literacy skills go beyond the GCSE Maths curriculum.

There are potential implications for schools and colleges in terms of being aware of teachers' data literacy skill levels and providing support where needed, and for assessment providers in terms of ensuring that data is provided in easy-to-understand formats and accompanied by guidance, if necessary.

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Learning theories unpacked: A discussion of the findings from three Research Division studies

Dominika Majewska (Research Division) **and Jo Ireland** (Research Division)

Background

The work of the Research Division at Cambridge University Press & Assessment includes providing research evidence to aid the decision-making of those who design curricula, learning materials and teacher support resources. Fundamental to the development of such materials is an understanding and integration of the most effective pedagogical strategies to enable learning to take place. Despite this, Schunk (2012) describes a problematic gap between learning theory and practice, which may relate to a historical separation of the fields of psychology and education. This article presents our findings from three studies related to learning theories, which aimed to understand how a stronger connection between learning theory and practice can be built.

What are learning theories and why are they important?

For centuries, philosophers have debated epistemological concepts such as rationalism (the belief that knowledge can exist outside of experience) and empiricism (the belief that experience is the source of all knowledge). From these foundations, psychological ideas were developed about how the mind works, how knowledge is created and how learning occurs. Learning theories strive to explain how people "acquire, process, retain, and recall knowledge during the process of learning" (Gandhi & Mukherji, 2023, first paragraph). Some learning theories are more familiar than others (e.g., behaviourism, which many might recognise from Pavlov's experiments), while some theories have lost their appeal over time or been discredited only to be replaced by others. As research has expanded in this area and built on prior concepts, there are now many learning theories in the field, including those that focus on factors which contribute to learning such as motivation and self-regulation (Schunk, 2012). The most prominent learning theories include behaviourism, cognitivism, constructionism, constructivism and humanism. These are explored in greater detail when we discuss the findings.

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An overarching aim of both pedagogy and curriculum is to ensure high-quality teaching to enable effective learning. In order to fulfil this aim, teachers, curriculum designers and resource developers can make use of learning theories to identify the most effective strategies for learning and teaching. Learning theories can provide evidence that can be used to decide which strategies can be deployed most successfully for different learning objectives, content and contexts. However, it is important to remember that not all theories are evidence-based and that some practices that derive from theory have more or stronger underpinning evidence than others.

Internationally, education systems usually present a curriculum as a formal document which sets out the learning content to be followed in formal schooling from early years to secondary education. Such documents may include mandatory or non-mandatory guidance on educational goals, content, pedagogy and assessment (OECD, 2020). Curricula can be complex documents and vary from country to country in how prescriptive the content is and how much autonomy schools and teachers have in interpreting, sequencing and delivering the curriculum. Curriculum developers must incorporate multiple considerations into their development frameworks including alignment to government policy and planning, stakeholder views and the operational capacity of the education system, including the practicalities of designing a curriculum that is deliverable within the available resources, such as funding and staffing levels. In addition, the learning theory and philosophy that underpin the curriculum are key aspects to be considered in the development process.

According to curriculum design training materials produced by the UNESCO International Bureau of Education (2017), an underpinning learning theory or philosophy for a curriculum should be suitable for the context (e.g., resulting in a programme which can be delivered using available resources) and be clearly articulated to teachers and stakeholders. However, although the training materials recommend that curriculum designers are familiar with the main learning theories, they do not provide guidance on how familiarity with learning theories can be translated into design decisions or how use of learning theories can be signposted for curriculum users. Similarly, Cunningham et al. (2007) found that there was a lack of information on how learning theories could inform curriculum design in higher education.

Our research into learning theories

This article explores three key pieces of work related to learning theories that were recently conducted in the Research Division: Ireland and Majewska (2024); Majewska et al. (2026); and Jin et al. (2026). The three pieces of work led to the identification of some of the main learning theories and their characteristics, along with a range of further learning theories that sit within these main categories. Table 1 shows the main learning theories identified and some key concepts relating to them. The work also provides insights into how these are used in curriculum development.

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Ireland and Majewska (2024) carried out an initial exploratory literature and document search to ascertain whether learning theories and research evidence have been used in the development of national or regional curricula. The curricula of Ontario (Canada) and Aotearoa New Zealand were used as case studies. Ireland and Majewska (2024) examined various academic databases and governmental websites and narrowed their focus to documents about the intended (written) curriculum. Majewska et al. (2026) identified meta-analyses and systematic reviews that investigated the effectiveness of pedagogical strategies and practices associated with various learning theories. The search was conducted in Google Scholar and Wiley and focused on evidence published between 2014 and 2024 from across the world. Relevant meta-analyses and systematic reviews were used to examine the evidence for the effectiveness of pedagogical strategies in supporting learning. Majewska et al. (2026) also noted pedagogical strategies for which there were no meta-analyses or systematic reviews. The outcome of this work was a comprehensive resource of learning theories, including their definitions, key characteristics, associated thinkers, explanations of how learning happens according to each theory, the pedagogical strategies associated with each theory, as well as the evidence behind them (or lack of such evidence). Lastly, Jin et al. (2026) conducted a systematic review of research published between 2014 and 2024 exploring the influences behind curriculum-makers' decisions. The search for literature was conducted in three databases (Scopus, Web of Science and ERIC [Education Resources Information Center]) and the literature was included on the basis of the following pre-determined criteria: peer-reviewed journal articles written in English and covering the intended curriculum from early years to upper secondary education only. The review followed the PRISMA guidelines (Page et al., 2021), which provide a well-defined process, including a strict screening and eligibility check.

What has our research into learning theories told us so far?

This section describes some overall observations and reflections on learning theories resulting from the three pieces of work conducted in the Research Division.

Table 1 shows a selection of the main learning theories and some key concepts associated with them. There are many further, more specific theories that sit within these categories.

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Table 1: An overview of the main learning theories, with information taken from Majewska et al. (2026)

Learning theory	Focus	Key concepts
Behaviourism	Link between stimuli and learner response	• Positive / negative reinforcement • Positive / negative punishment • Observed learning • Measurable objectives
Cognitivism	How learners think and transfer knowledge	• Working memory • Cognitive load • Relating new information to prior knowledge • Retrieval • Instructor-led
Constructionism	Learning through construction of artefacts	• Learner-centred • Learn by making • Tangible objects • Collaboration
Constructivism	Learners' mental construction of knowledge	• Learner-centred • Discovery • Experimentation • Problem solving • Collaboration
Humanism	Learning focused on the whole person; learners have freedom and autonomy	• Learner-centred • Holistic • Personal growth • Self-direction • Self-evaluation
Motivation and engagement	Factors driving enthusiasm for and willingness to engage in learning	• Competence • Autonomy • Belonging • Self-reflection • Goal setting • Task value

From the research studies, two observations became particularly clear. The first is that **there is a huge number of learning theories**. The second observation is that **there is a significant overlap in the characteristics of some learning theories**, making it difficult to disentangle them from one another. Figure 1 shows a high-level overview created to illustrate the similarities and differences between a selection of learning theories. The theories included in Figure 1 differ from those in Table 1 as they arose from the earlier exploratory work completed by Ireland and Majewska (2024). To examine overlapping learning theories more closely, we can compare constructivism and cognitivism as examples. This comparison demonstrates how learning theories which emphasise different learning processes can also share similarities. Constructivism sees learning as occurring through a process of reflection and one's active construction of ideas (Gandhi & Mukherji, 2023; Mascolo & Fisher, 2005, as cited in Brau, 2022). According to constructivism, learners consider new information through the lens of previous experiences. Thus,

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constructivism focuses on learners' internal thinking (Gandhi & Mukherji, 2023). In comparison, cognitivism puts a lot more emphasis on the mental processes that underpin learning, such as processing and reorganising information in relation to previously acquired information (Gandhi & Mukherji, 2023). Cognitivism highlights thought processes such as meta-cognition (thinking about one's thinking) (Gandhi & Mukherji, 2023). To evidence cognitive theory further, let us take the example of how we build schemas (units of knowledge and understanding about a specific action, event, object or experience) (Center for Teaching Excellence, n.d.). For instance, when having a meal at a restaurant, we build a schema about what eating out at a restaurant looks like; from entering the restaurant, looking at the menu, ordering, eating to paying. Without experiences, we may not be able to construct knowledge or build on it. In summary, both constructivism and cognitivism recognise the importance of experiences and prior learning.

There is also significant overlap between theories that derive from main learning theories, such as social constructivism (also known as socio-cultural theory) and social learning theory – both of which derive from constructivism. Social constructivism sees social and cultural backgrounds as important in learning and understanding behaviour, and it emphasises the interaction between interpersonal, cultural, historical and individual factors. Similarly, social learning theory emphasises the interaction between personal factors (such as cognitions), behaviours and the environment, stipulating that learning occurs in a social environment where we can observe others (Majewska et al., 2026). If there is no explicit mention of which learning theory has been used to inform a specific resource or curriculum, this overlap can present difficulties in correctly identifying the learning theory educational designers had in mind. For instance, a curriculum statement highlighting that activities should help students to integrate new learning with what they already know could be seen as relating to several theories, such as constructivism, information processing or situated learning.[1] It is also possible that the curriculum statement was not designed based on any particular learning theory.

1 Information processing theory explains learning in terms of how people attend to environmental events, encode information, relate it to their existing knowledge and retrieve it when needed (see Majewska at al., 2026). Situated learning suggests that learning should take place in the context in which it is situated, e.g., working in a physical location depicted on a map is helpful in teaching how to read and work with maps (Griffin, 1995).

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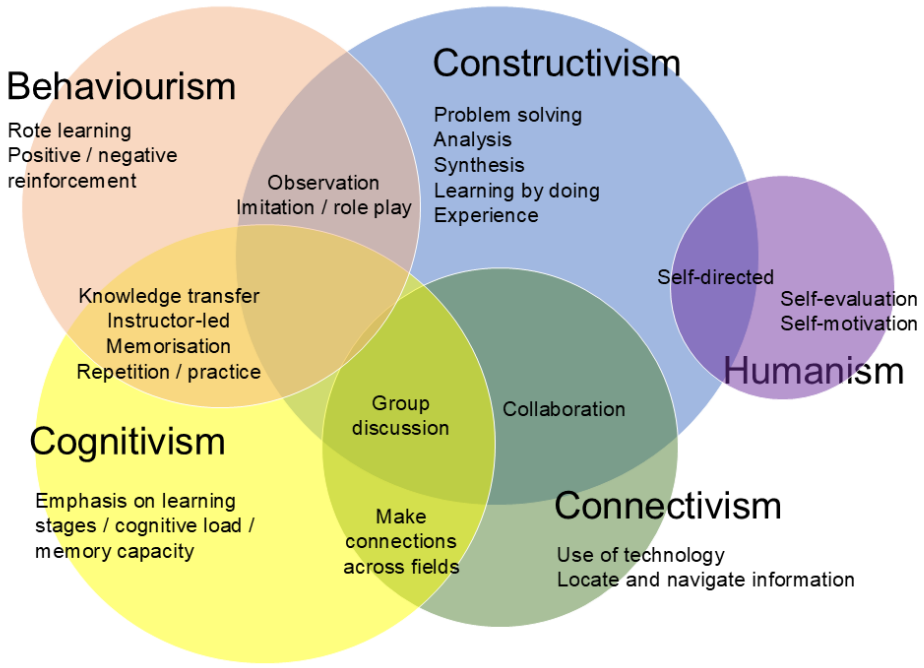

Figure 1: Diagram showing differences and similarities between some learning theories (taken from Ireland & Majewska, 2024)

A further observation is that **there is little evidence in the literature about how learning theories influence curriculum development**. Jin et al.'s (2026) review found that out of seventeen articles included in the review, only two articles explicitly stated and explained which learning theories were used during the curriculum-making. One article explicitly pointed out that the theoretical framework behind their curriculum design was based on constructivist principles (Haagen-Schützenhöfer & Hopf, 2020) and the second article stated that a social constructivist framework guided the construction of a primary school curriculum on artificial intelligence (Dai et al., 2023).

Similarly, Ireland and Majewska's (2024) literature review found limited evidence for the use of or reference to learning theories in the development of curricula in Aotearoa New Zealand and Ontario (Canada). Some evidence was noted of learning theories being considered during the development of the 2007 New Zealand Curriculum.[2] For instance, some authors involved in the development of the New Zealand Curriculum mentioned learning theories they had considered, although these could not be linked to any specific parts of the curriculum. In addition, a series of statements in the 2007 New Zealand Curriculum (Ministry of Education, 2007) seemed to relate to learning theories, as they mentioned the social and cultural context of learning and that students learn best "when they are able to integrate new learning with what they already understand" (p. 34), implying a constructivist approach to learning. However, these examples do not explicitly refer to learning theories and it is through interpretation that a link to a

2 The 2007 New Zealand Curriculum is the English-medium version in current use. Following a period of redevelopment, the updated curriculum will be compulsory in schools from 2027.

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specific learning theory can be inferred. Similarly, when inspecting documents and articles related to the Ontario curriculum, some evidence of use of learning theories was found, with constructivism being mentioned at times across the literature (e.g., Byers, 2004; Golafshani, 2020; Ruddock & Sainsbury, 2008; Zhu & Xie, 2020 – all as cited in Ireland & Majewska, 2024). However, no definitive evidence was found of how learning theories were used in the development of the Ontario curriculum and often, learning theories were only implied. The absence of references to learning theories in the curricula of New Zealand and Ontario prevents curriculum users from accessing the foundational principles of the curriculum content and may lead them to make their own assumptions. These findings support Schunk's (2012) assertion that there is a gap between learning theory and practice, considering that we might expect curriculum documents to represent a bridge between the two.

The findings relating to the lack of information about how learning theories have informed curriculum design also prompt another observation – namely that **we cannot be confident that learning theories have been considered when this is not stated explicitly and when we rely on implicit assumptions** based on the phrasing in curriculum documents. The importance of making explicit statements was stressed by Oates (2018), who stated that designers should be ready to specify what evidence and model(s) they used "to determine the construct base, to determine the domain, to sequence or order the content, ... and to determine key elements such as practice activities, formative assessments etc." (p. 13). This, he argued, ensures that materials are of a high quality and provides clarity on their purpose and use.

Another reflection from the work on learning theories is that **there is a need for practical guidance for educators and for content and curriculum designers about how to successfully translate the theories of learning into practice**. Although the literature on learning theories is vast, those working in the field of education may need training and guidance on how to use the theories when designing lessons, activities, tasks, curricula or resources, as it is difficult to bridge this gap from theoretical into practical without prior experience or support given the volume of information available. Majewska et al. (2026) reflected on this when creating the learning theories resource, which collated examples of pedagogical practices associated with each learning theory and the evidence behind them. This reflection posed several questions, such as "how can developers create an effective curriculum that follows principles of learning theories?" and "how can developers design activities that would benefit students the most if following specific learning theory principles?" Such questions highlight the need to create a bridge from the theoretical to practical, making use of evidence in order to support learners in the best way possible.

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Implications for practice: What do our findings mean for those working in education and curriculum development?

Given the large number of learning theories and the overlap in key concepts, it is perhaps unsurprising that practitioners may not make explicit references to the learning theories they use when doing so would involve disentangling the complexities of learning theories. In practice, education professionals may already be applying principles of learning theories in their work without consciously linking them to the wider framework they came from. For instance, a teacher may show how to solve a mathematical problem or equation on the board by providing step-by-step guidance. This is known as a worked example according to cognitive load theory. The theory stipulates that worked examples reduce unnecessary mental load in learners' working memory (see Majewska et al., 2026). This allows learners to focus on the steps necessary to solve a task without being overburdened by too much information being presented at once. To take another example, by encouraging students to work together, teachers may be using collaborative learning, which is a strategy associated with social constructivism. This enables learning through social interaction, sharing diverse perspectives, challenging each other's thinking and co-constructing understanding (see Majewska et al., 2026).

Support and training in this space may equip educators with shared professional language to aid discussions with colleagues and help them understand why certain practices may be more effective than others. It can also enable educators to become more conscious of decisions about their teaching practices and help them to reflect on those decisions rather than rely on habits. Jin et al.'s (2026) review also raised the need for guidance, finding that teachers reported a lack of knowledge of curriculum development and a lack of training opportunities as barriers to curriculum making. Through strengthened understanding of the mechanisms through which learning occurs, teachers can make informed decisions about which strategies are likely to be effective and match the learning theory to the intended outcome. For instance, teacher training courses could provide theories of learning alongside clear, applicable examples of how to use them when designing lessons and resources. While it might not be necessary (or achievable) to cover each of the many learning theories, the key messages from the main learning theories could be usefully conveyed. Such training could provide educators with important professional knowledge. For instance, it could highlight certain nuances of the application of learning theories, such as that some behavioural theories that are based on stimulus–response links might be useful for learning multiplication facts or vocabulary, while cognitive theories may be more useful for complex forms of learning, such as drawing inferences from text. Knowing what theories and practices are useful for specific learning situations could support teachers in their daily activities such as planning lessons.

Oates (2018) argued that those creating resources or curricula should explicitly outline the reasons and influences behind their decisions and should be able to explain how these have been applied to the curriculum or resources they

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have designed. Oates further stated that this enables transparency and allows users of the materials to scrutinise the evidence base for decision-making. When particular learning theory principles have been used, they should be clearly and explicitly explained. Developers should set out which elements were adopted for which aspects, why such theory was used and how those who will be working with the curriculum or resource should use it to maximise learning. This reduces the risk of varying interpretations of which learning theories have influenced a curriculum, enables educators to deploy the curriculum as intended and avoids "fragmented and even contradictory applications" (OECD, 2020, p. 26). It also enables those using the materials to make informed choices about how to apply curricula and integrate resources within their activities. Curriculum design courses should also give professionals the skills to think critically about using learning theory when designing curricula. However, it must be recognised that curriculum (re)development as a whole is a high-stakes, politically charged and multi-layered process (OECD, 2020). Within this, designing a research- and evidence-based curriculum is a demanding and time-consuming activity (Haagen-Schützenhöfer & Hopf, 2020).

Additionally, curriculum-makers, researchers and teachers should work collaboratively to bridge the gap between theory and practice. Jin et al. (2026) stated that "several authors of the reviewed articles called for more support from curriculum and subject specialists for future collaborative curriculum design" (p. 15). For example, Huizinga et al. (2014, as cited in Jin et al., 2026) proposed that the Ministry of Education should provide support to teachers through expertise from curriculum specialists across all stages of curriculum design. Additionally, the OECD (2020) noted that curriculum developers should consider the users of the curriculum and how they will interpret and put it into practice. Researchers should ensure that they are not just offering abstract theories, which could take educators hours to translate into practical, applicable scenarios for the classroom. They should aim to provide multiple practical, real-life examples of using principles from various learning theories in classrooms and when designing activities, tasks and resources. Teachers can support curriculum developers and researchers through participation in stakeholder consultations and involvement in research studies or other opportunities for co-creation of materials. However, we recognise that education professionals often work with time constraints and other pressures, such as a lack of funding and resources. Therefore, any such collaborative work should directly benefit the participating teachers, for instance, by enabling them to apply theory to their own practice in such a way that real improvements in learning can be observed.

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Reflection

Overall, we found that the practices associated with learning theories make a difference for learning (see Majewska et al., 2026). However, the recent work conducted in the Research Division has shown that there are still gaps that need addressing. This includes the need to draw on learning theories to inform the development of educational materials, the need to demonstrate that theory has been used to inform a product or curriculum and the need to provide guidance for curriculum developers and teachers on how to use learning theories effectively when creating curricula and educational content and activities.

Addressing these gaps can strengthen the design and application of curricula and learning resources. By including information on the learning theories underpinning curriculum and learning material design, teachers can better understand the evidence and principles behind these materials and apply the intended learning theory principles in the classroom, as well as evaluate their efficacy. Practical guidance for curriculum developers and teachers would go some way towards building the bridge between theory and practice that Schunk (2012) perceived to be missing.

The work by Ireland and Majewska (2024) and Jin et al. (2026) has provided valuable understanding of how learning theories relate to the curriculum development process. Additionally, the development of the learning theories resource (Majewska et al., 2026) is a vital step towards providing the much-needed links between learning theory and practice. Future work in this area could build on these by strengthening the link between theory and practice through deeper exploration of how learning theories can be embedded in curricula and by developing clearer guidance to help practitioners apply learning theories to boost learning outcomes.

Acknowledgement

We would like to thank everyone who has been involved in the work we have drawn on for this article.

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“Post-traumatic growth” in education: How crises can spark positive change

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Introduction

Crises such as epidemics, natural disasters, and armed conflicts can profoundly disrupt education. While these disruptions are often viewed only in negative terms, they may also create opportunities for positive change. As research on “post-traumatic growth” suggests, individuals, communities and systems can experience constructive development following adversity (see e.g., Alexander et al., 2021; Brooks et al., 2025; Tedeschi & Calhoun, 2004). To gain a comprehensive understanding of how crises may affect education, it is therefore essential to consider not only the challenges they pose but also their potential benefits. This study addresses this issue, using the recent COVID-19 pandemic as a case in point.

The COVID-19 pandemic, declared in 2020 (World Health Organization, 2020), significantly disrupted education, impacting both teachers and students. The most notable disruption was the widespread – partial or full – closure of schools. As the OECD (2022) reports, in 2020, 1.5 billion students across 188 countries were unable to attend school (p. 23). To reduce learning loss, many schools adopted “emergency remote education” (Hodges et al., 2020), although the transition from in-person to online teaching was often difficult. Challenges such as low digital literacy, limited access to devices and reliable internet, and poor student engagement hindered the effectiveness of remote lessons (Bond, 2020; Howard et al., 2021).

School closures led to several negative outcomes. In addition to learning loss (Carroll & Constantinou, 2022; Di Pietro, 2023; Newton, 2021), students and teachers experienced psychological strain. Many students showed signs of depression and anxiety (Deng et al., 2023; Panchal et al., 2023), while teachers reported reduced wellbeing, partly due to increased workloads during remote teaching (Kim et al., 2022; Wong et al., 2022).

While the pandemic’s challenges for education have been widely studied, its potential to inspire positive change remains underexplored. This imbalance is evident in several review studies (e.g., Bozkurt et al., 2022; Cachón-Zagalaz et al.,

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2020; Tang, 2023). For instance, Bozkurt et al. (2022) analysed 1 150 publications using text mining and social network analysis to provide a panoramic view of the pandemic-related themes discussed in the education literature. Their analysis yielded seven main themes, most of which focused on negative impacts like remote teaching challenges, mental health issues, and deepening inequalities. This suggests that possible benefits may have been overlooked. To address this gap, the present study explored the pandemic's positive educational effects, aiming for a more balanced understanding of its impact.

Theoretical lens: Post-traumatic growth

The idea that adversity can be transformative can be traced back to ancient Greek philosophy and religious traditions (Meyerson et al., 2011). However, systematic research attention to the positive outcomes of highly stressful events is relatively recent. The term post-traumatic growth refers to "the experience of positive change that occurs as a result of the struggle with highly challenging life crises" (Tedeschi & Calhoun, 2004, p. 1). Such crises may include serious illness, bereavement, abuse, war, and natural disasters (Tedeschi & Calhoun, 2004).

According to Tedeschi et al. (2015), traumatic events can disrupt individuals' "assumptive world", that is, their core beliefs about the meaning, predictability, and purpose of life. Although such disruption often leads to distress, it may also prompt individuals to reflect on and revise these beliefs, thereby fostering growth. This process may involve cognitive restructuring, through which individuals reinterpret the event and its implications in ways that help them make sense of what has occurred, as well as broader changes to core beliefs (schemas) about themselves, others, and the world. Through these processes, positive change may emerge across three main domains: self-perception, relationships, and life philosophy (Tedeschi & Calhoun, 1996). Such changes may include an enhanced sense of personal resilience, stronger relationships, a greater appreciation of life, the recognition of new possibilities, and, in some cases, spiritual development (Tedeschi et al., 2017; Tedeschi & Moore, 2021).

Applying this perspective to the educational disruption caused by the COVID-19 pandemic, some evidence points to a post-traumatic growth effect. For example, the shift to emergency remote teaching appears to have supported teachers' professional development by enhancing their digital skills (Akbana et al., 2021; Gao & Zhang, 2020) and encouraging experimentation with multimodal assessment approaches (Chung & Choi, 2021). Such evidence suggests that educational technology was a key domain of positive change (e.g., Moorhouse & Kohnke, 2021; Moorhouse et al., 2023). However, in the absence of more systematic research, it remains unclear whether these benefits extend beyond the technological domain.

Guided by post-traumatic growth theory, this study aimed to explore the broader educational benefits of the pandemic. Through teacher interviews, it addressed two questions:

(a) Which areas of education were positively affected by COVID-19? (macro-level benefits)

(b) How did these positive effects manifest? (micro-level benefits)

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Methodology

To explore the positive impact of the COVID-19 crisis on education, this study conducted in-depth semi-structured interviews with 13 teachers. These formed part of a broader mixed-methods project combining questionnaire and interview data to examine how schools worldwide experienced the COVID-19 disruption (see Carroll & Constantinou, 2022, 2023; Constantinou, 2023, 2024; Constantinou & Carroll, 2023). The interviewees were selected from the pool of questionnaire respondents to ensure diversity across education sectors (early years, primary, and secondary), school types (state and private), roles, subjects taught, and teaching experience (ranging from 6 to 35 years) (see Table 1). While both state and private schools were represented, the majority of interviewees worked in the private sector. The sample also included participants from schools across different European countries, providing a broader perspective and capturing a range of experiences.

Table 1: Interview participants (N = 13)

Characteristics		**N**
School location	UK	7
	Cyprus	1
	Italy	2
	Romania	1
	Spain	1
	Switzerland	1
Education sector	Early years	1
	Primary	2
	Secondary	10
School type	State-funded	3
	Independent	10
Gender	Female	8
	Male	5
Position in the school	Teacher with a leadership role (e.g., head of department)	8
	Teacher without a leadership role	5
Subject area*	Creative subjects (e.g., art, design and technology, music)	2
	Humanities and social sciences (e.g., English language, literature, history)	5
	Science and mathematics	3

* This category concerns only the secondary teachers (the early years and primary teachers taught all subjects).

Each 90-minute online interview, conducted in June and July 2021, invited teachers to reflect on their remote and in-person teaching, strategies used to address challenges, and any positive outcomes of the disruption. Written informed consent was obtained from all interviewees, and the process of data collection and storage was in line with the ethical guidelines for educational research issued by the British Educational Research Association (BERA, 2018).

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The interview transcripts were thematically analysed using MAXQDA (VERBI Software, 2021), following Braun and Clarke's (2021) approach. The analysis, which was largely data-driven, proceeded in two stages. First, 20 descriptive codes were developed to capture distinct examples of positive change (micro-level benefits). These were then grouped into four overarching themes representing broader domains of positive impact (macro-level benefits). Each code is illustrated below through representative interview excerpts, organised by domain.

Findings

The interview analysis revealed that the pandemic's positive impact on education was multifaceted, spanning four key domains: the *ideational*, the *affective*, the *behavioural*, and the *relational*. As outlined below, these domains correspond to how core educational actors *think*, *feel*, *act*, and *relate* to one another, respectively.

Ideational benefits

The disruption caused by the pandemic exposed some limitations of mainstream approaches to teaching and learning. As such, it challenged the educational status quo, encouraging teachers to reimagine education and consider new directions and possibilities. The perspectives described in this section capture some of these directions or ideas.

Students using electronic devices in face-to-face lessons

Following her experience of online teaching during school closures, one interviewee reconsidered the pre-pandemic ban on electronic devices in the classroom, viewing it as outdated. Online teaching highlighted the learning potential of internet access during lessons, leading her to envision a future where technology plays a more central role in face-to-face instruction:

> "One thing I would love to be able to do in the future, I would love to have a classroom where students have some kind of device with them as well as face-to-face learning. Because particularly in something like English, one really good thing for teaching things like digital literacy – you can actually give students a website, say a charity website and get them to look at the way the website actually looks, whereas if you've got a textbook with a printout of a website, it isn't the same. And that's also really useful for research. So, when we wanted students to find out who someone is, or the definition of a word, when they're all – because they're all connected to the internet, they could actually find a definition, and that was a good thing. So, I really like the idea, in the future, of classrooms being sort of hybrid, but in the sense that the students have all got their own devices [...]. A lot of schools have a 'no devices, no devices allowed', and actually I think that's a bit archaic, and maybe that's something we could learn moving forward." (Participant 13 – Secondary teacher, Cyprus)

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Playing to technology's strengths

The shift to online teaching during lockdown gave many teachers firsthand insight into both the strengths and limitations of technology in education. This experience fostered a more critical and context-sensitive view of its classroom use:

> "I think what the process has allowed teachers to do is understand when technology is necessary and when it's not. So, I think initially [in the earlier stages of the pandemic] it was a case of embracing everything to do with online learning, whereas now I am finding myself far more critical and asking myself the question: Is using a computer the best way to do this?" (Participant 9 – Secondary teacher, Italy)

> "Well, I think that certainly people now know what they're dealing with when it comes to technology. It's really forced the hand of teachers to come to terms with using technology in the classroom. So, only by doing that can they become aware of both its potential and its limitations. So, if it's done one thing, it's accelerated by a number of years that process, and we were on that track anyway. So, now we can go beyond the technicalities, and we can begin to have that discussion about yes, this is software or this is this or this is that, but is it actually helping our learners to learn? So, I think that's a real positive. [...]. I think we've gone beyond the basics, and now we're becoming more critical of: What can this do and what can it do to really teach learners something important as opposed to just the bare facts and the basic things?" (Participant 9 – Secondary teacher, Italy)

Hybrid lessons

Measures taken to reduce the spread of the virus after schools reopened, such as requiring infected students and close contacts to self-isolate, led teachers to deliver hybrid lessons (that is, lessons delivered simultaneously to students in the classroom and those joining remotely). Despite its challenges, this approach highlighted the potential of hybrid teaching to support students who are ill or have mobility issues. If effectively implemented, it could enhance lesson inclusivity in the future:

> "Another point that I find positive is, for example, the possibility for students that are sick, but not very sick, maybe they don't have a fever – so they can actually follow the lesson, but they can't come to school. So, I think that's fantastic, if they, in the years to come are still able to participate in the class activities remotely, without missing out on the entire school day just because, for instance, they have a cold, or they have a broken leg." (Participant 10 – Secondary teacher, Italy)

Paperless classrooms

As one interviewee noted, the pandemic accelerated technological progress and innovation, leading to the development of a wide range of digital tools and resources. This has drawn attention to the prospect of classrooms becoming paperless in the future, highlighting an additional route via which education could support the global environmental agenda:

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> "I would love to see a paperless classroom, and I think that environmentally that has potential. Again, we're not there yet in terms of the tablets and so on, haven't replaced pen and paper, but I think we're closer to that objective thanks to the pandemic. So, I think it has accelerated the technology and we're closer to where we should be in terms of using technology in the classroom." (Participant 9 – Secondary teacher, Italy)

Simplicity and outdoor learning

The experience of teaching in the pandemic enabled teachers to realise that much can be achieved with just a few key resources and that a simpler approach to teaching – one that is free from modern-life "clutter" and involves more frequent contact with nature – might provide a richer educational experience. Social distancing, for example, forced schools to move – where possible – some of their activities outdoors, allowing teachers to discover the benefits of outdoor education and develop a greater appreciation of it:

> "Oh, I just wanted to say something we learnt when we returned to school, after the last lockdown. We did notice that there was a greater simplicity of approach. The classrooms were empty, but we found that the children [aged 4 to 5] were coming in their own clothes and didn't have so much clutter. And we used nature a lot more because the classrooms didn't have stuff in them, and the children got closer to the outdoors last time, and didn't have so many trappings of modern-day life – they came in their own clothes, just with a small bag. And we noticed a simpler lifestyle in the last return, when we had less – we noticed something else within ourselves, that we could function in a different way that was quite rich, because we're lucky with our outdoors. So, that was a very nice discovery, that sometimes we have too many things, and we found ways to be happy, in a simpler way, during that period of time. [...] that sometimes the children can have too many things to wear and carry, and be. And less is more – they came in a pair of trainers, so they could run and jump. They didn't have trainers and shoes, they didn't have PE kit – they wore one set of clothes and it felt liberating." (Participant 3 – Early years teacher, UK)

> "Realising the absolute, not just benefit but absolute crucial element of non-classroom-based learning experiences for pupils is absolutely vital. And, so, I hope that other schools will pick up on that too, and see that as a really good way of recovering from the pandemic but also something that should stay in curriculums from now on. That it's not just all about being in a classroom." (Participant 7 – Secondary teacher, UK)

Importance of wellbeing

By drawing attention to the adverse effects that poor wellbeing may have on learning, the pandemic raised awareness among educators and schools of the importance of wellbeing for students' educational development:

> "It's brought, as well, more attention on emotional wellbeing. That might be something that we will look at a lot more in the future – if a student is

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emotionally struggling, then their learning is going to struggle, is going to be impacted." (Participant 13 – Secondary teacher, Cyprus)

Alternative approaches to assessment

The cancellation of national examinations in many parts of the world due to the pandemic exposed some limitations of current assessment approaches. By highlighting some of the problems that may arise from relying on one end-of-year assessment, it invited consideration of alternative approaches to student assessment:

> "I've been talking to some friends in the States who a few of them are principals of high schools. One's a principal of a middle school and he said, 'This pandemic was an opportunity to really rethink how we did education and assessment, and it's been a missed opportunity'. So, in the UK, we have this one test that we give at the end of the year for GCSE in each subject. But it's not a holistic approach, it's just pushing all of the knowledge down to one exam at the end of the year. And that's true at A Level, etc. And there need to be more things throughout the year, more assessments, more portfolio-based work that students can produce." (Participant 1 – Secondary teacher, UK)

Affective benefits

Apart from triggering new ideas and ways of thinking about how education could be delivered in the future, the pandemic also seems to have cultivated positive emotions and attitudes within the educational community.

Gratitude

The severe disruption caused by the pandemic resulted in some teachers becoming more appreciative of everyday experiences and interactions that had previously been taken for granted:

> "I think that we all, myself, and my colleagues, everyone – have learnt not to take for granted some experiences or some activities that we usually do – I mean, for example, being able to share an experience, being able to have a discussion – it's not so obvious anymore. So, I think somehow they have got more value now." (Participant 10 – Secondary teacher, Italy)

According to the interviewees, similar feelings of gratitude also developed among students, many of whom seemed to be more appreciative of in-person schooling following the experience of remote learning during lockdown:

> "I think that students in general are more appreciative of being at school and realising the good things about it. Definitely my Year 10s are much more like, 'Oh, no, it's so much better at school because we can use materials and we can do all ...'. So, I think the kids have found the more positive-ness about being at school. My son for example is very like, 'Oh, no, school is much better, much more fun because I can play with my friends' [Laughs]." (Participant 8 – Secondary teacher, Romania)

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> "On the flipside, some of them coming back this term, it's been amazing to see some pupils really have a greater gratitude for what school can offer, and wanting to get involved in anything they can, because they realised that they missed it. And actually, when they're here all the time, they hadn't realised how much it meant to them until it was kind of taken away, if you like. So, that has been actually a really good thing to see some pupils want to do more, because, actually, they kind of realised the value in it and they enjoy it, and they've missed it, which is a good thing." (Participant 7 – Secondary teacher, UK)

Professional confidence

When instruction suddenly moved online, teachers had to rapidly upskill by familiarising themselves with the use of different digital tools and by learning how to design and deliver online lessons. While this process was challenging, it was also rewarding, as it seems to have equipped teachers with a stronger sense of self-efficacy:

> "And this online learning platform is a fantastic resource. I would never, in a million years, have chosen to use it, but because I had to use it, I made myself work with it, and found, actually, it's a really useful tool. The fact that we can do online meetings like this. This is technology that two years ago, I didn't even know existed. I remember the Head saying when we set into this, she said, 'You will find that this is going to be challenging, but it will be so beneficial for your teaching, it'll be so beneficial for our learning, and you'll be so much better, tech-savvy', and she's right. It's been a great challenge, but it's been worth it in the end. So, I feel I'm a better teacher as a result of what we've been through." (Participant 2 – Primary teacher, UK)

Willingness to change

The disruption caused by the pandemic forced schools to move away from long-established routines and practices – as these had proved ineffective or no longer applicable – and to search for alternatives. To cope with the constantly evolving crisis, teachers had to become more flexible, adaptable and creative, which seems to have led some of them to develop a more positive attitude towards change:

> "But I think one of the main things is the need to be flexible and to be creative and to say, 'Right, we're going to try and make as much happen as we can, within the guidelines and within a safe environment.' So, developing that spirit and that kind of outlook amongst staff is sometimes hard in a school, because schools tend to have really structured calendars that go up from one year to the next and they say, 'Oh, but we've always done it like this'. [...]. And so, I think there's been quite a lot learnt from just being more creative and actually thinking about how we can still provide opportunities for students and make it fulfilling. But in a safe way. So, we're doing a performance – we've got, I think, four different productions this term happening, all of them are happening outside because they can't happen inside. So, actually, using our space better, using our facilities in a different

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way because, actually, we've been made to look at it differently. And I really hope that in the future we'll continue that, and it won't just go back to, 'Oh well, we're back to normal'." (Participant 7 – Secondary teacher, UK)

"When we go back, we don't know what is going to happen, we have to be ready for everything. That's what I think this pandemic has showed us, that we have to be ready and improvise, and be ready to change everything from one moment to another – adapt, and apparently, we're good at adapting." (Participant 11 – Secondary teacher, Spain)

Resilience

The various challenges with which teachers were confronted during the pandemic seem to have helped them build resilience, while equipping them with confidence about their ability to recover from future crises:

"I've felt, maybe if we can survive this, then we can survive anything. There is an element of going, 'Look, we're all still sane and we're all still standing'. I think there's some pride, perhaps." (Participant 11 – Secondary teacher, Spain)

"And there's also a sense of resilience, because if we can do this, we can do anything. We've got through this, and we'll get through it again. Bring it on. That's the biggest thing. [...]. But we've learnt a lot, we've come a long way, and I think it's made us stronger." (Participant 2 – Primary teacher, UK)

Behavioural benefits

Apart from supporting education at an ideational and an affective level, the pandemic has also benefited the sector at a behavioural level by positively influencing key educational actors' actions and practices.

Movement of professional development courses online

The pandemic encouraged many teacher professional development providers and educational conference organisers to move their events online, thereby normalising the online delivery of these activities while also considerably reducing their cost and the inconvenience often involved in attending them (e.g., travel time). This resulted in both domestic and international training courses and events becoming more accessible to teachers:

"I think, actually, it's given teachers more confidence in operating online and doing things remotely. Like for example training. I don't think if you'd have said to any teacher, 'do an online course' – they would have not wanted to [do one]. But now, actually, it's the preferred way of doing it. And it means you can access training all across the country. It's not dictated to by where you have to go to do the course, for example, if it's online. Certain things are better meeting, like networking and that's good, but sometimes it's much better just to be able to, if you're going to go to a place like a 40-minute drive, especially in [location] where we are, it can be quite a long journey to

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where the training is. So, things like that will be helpful and, actually, might work a lot better in the future." (Participant 6 – Primary teacher, UK)

"The ability to go to conferences online is amazing. [...]. And they do amazing CPD [Continuing Professional Development courses] for teachers on – it's really high-end thinking stuff, retrieval practice, all of that kind of stuff, which I've done because it's online. So, I have done a lot of CPD which I would never have done because they don't pay for us to go from here to England very much." (Participant 12 – Secondary teacher, Switzerland)

Increase in the supply of online educational resources

To facilitate the shift to online teaching during lockdown, educational companies developed a wide range of online teaching and learning materials and tools, providing teachers and students with a greater choice of educational resources:

"And I think so many educational companies have stepped up with online resources – all of those kinds of things that you can now get, there are so many chemistry – so many online chemistry practicals now that you can just do online." (Participant 12 – Secondary teacher, Switzerland)

Improvements in the usability of technology

The shift to online teaching did not only increase the volume and variety of online educational resources but also improved user experience through encouraging providers to quickly adapt and upgrade the technology underpinning their digital tools:

"[Providers] have been amazing at updating this technology, this is so easy now, and everybody just goes, 'Oh, I've got a meeting in', and we go from one meeting to another meeting, and we flip in and out, and all this kind of – so, you know, the technology has adapted really, really well, which I really like." (Participant 12 – Secondary teacher, Switzerland)

Expansion of teachers' instructional toolkit

Online teaching during lockdown gave teachers the chance to explore a range of digital resources. As the interviews revealed, some proved so effective that teachers chose to integrate them into their post-lockdown classroom practice:

"Our use of this platform has meant we've carried on using it, so actually there are certain things we've developed which we're going to carry on doing. So, this is a way of posting homework, a way of getting children to post things and send pictures of things they're doing at home, and we'll keep that going." (Participant 6 – Primary teacher, UK)

"I'm going to use my visualiser now and for my [art] demonstrations on the table in the classroom, where sometimes some people can't see it and things like that. I'm going to use my visualiser now, so that everybody can see it on the big screen. So, that is definitely going to be used. My newfound tool." (Participant 8 – Secondary teacher, Romania)

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> "Personally, [in my online lessons] I've used lots of things to do with video, so like short films and so on, for learning. Again, that's not going to go away, that's something which has enriched my teaching." (Participant 9 – Secondary teacher, Italy)

It is worth noting that some of the online resources embraced by teachers appear to offer added value by supporting the needs of specific student groups – such as those unable to attend in person or with learning difficulties – making them beneficial not only for learning but also for promoting greater equity in schools:

> "And even things like being able to record lessons for pupils that are absent, and making sure that they can access that work, is a really useful thing. So, I think that will definitely stay as a strategy in this school." (Participant 7 – Secondary teacher, UK)

> "And another valuable resource that I had the opportunity to know were the podcasts. I didn't listen to many podcasts before, I do now, and sometimes I find something that is very interesting, very close to the content that I am supposed to deliver. And, I think, that is useful, for example, for students with learning issues, maybe if someone suffers from dyslexia, for example, to listen to a podcast could be useful. So, I'm planning on keeping on using those kinds of resources that I have discovered during the lockdown." (Participant 10 – Secondary teacher, Italy)

Greater student autonomy

Some of the practices or routines adopted in response to the pandemic seem to have strengthened, to some extent, student autonomy. A primary school teacher, for example, commented on the independence that children at his school were able to develop as a result of having to go into the school unaccompanied by their parents:

> "Some of the routine things, like going in and out of school, we might keep things similar. That's been a way of experimenting, which we think, actually, that works quite well. The children, in some ways, are more independent because they are being dropped off at the school gate and they're coming in themselves. Often the parents would come in, they'd help them settle down. The parents would be in the classroom, they'd get their work out for them. They'd go and put their coats on their pegs. The parents would do all that for the children. Actually, the kids have got to do it for themselves, which we – that sort of independence a little bit in school is actually something that we might try and encourage them to keep going with." (Participant 6 – Primary teacher, UK)

A form of autonomy also seems to have developed in contexts where students had the opportunity to use their devices during in-person lessons, a practice that became more common following the phase of online teaching:

> "I think we have become a bit more reliant on devices, even though we're in person again. I'm letting the students use their devices more. And that may be a good thing, putting assignments up and having them work and then I

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move around the classroom and help. [...]. I did support for Year 11, I wasn't teaching Year 11 class, but some of the kids were very self-directed because they were left to use their devices and search up a video or watch a video on a topic that they were struggling with. So, they were a bit more self-directed and self-motivated." (Participant 1 – Secondary teacher, UK)

Relational benefits

According to the interviewees, the positive impact of the pandemic on education also extended to the domain of interpersonal relations. As indicated below, certain changes resulting from the disruption may have helped to strengthen the relationships among teachers, students and parents.

Exchange of tips and resources among teachers

The sudden shift to online teaching, and the various challenges accompanying it, encouraged many teachers to connect with colleagues from around the world and from different education sectors, and share teaching advice and resources. This sharing process was facilitated by popular social media platforms, fostering a spirit of solidarity and cooperation among educators while helping to create a global community of practice:

> "One of the things that I did over lockdown was spend quite a lot of time on Twitter, which I've never used before, and I got into the Education, you know, I follow a lot of education people on Twitter now, whether they're at university or in schools. And it's really – I will have changed my teaching practice totally by the time we go back to normal because of all the stuff that I've managed to learn. [...]. So, all of that's amazing – the sharing of resources between teachers on Twitter and a lot of that stuff is amazing." (Participant 12 – Secondary teacher, Switzerland)

Teachers in more frequent contact with parents

As one interviewee noted, the shift from in-person to online meetings during lockdown enabled teachers in international schools to connect with parents based overseas and to begin building relationships with them:

> "And also it [holding meetings online] means we can speak to the parents in China and America, which we never used to be able to do, so it's much more efficient. They're just a normal parent now, whereas before they were these parents that were absent, but they're not anymore – so yeah for us it's much better." (Participant 12 – Secondary teacher, Switzerland)

As remote meetings become normalised in education, and some teacher–parent meetings continue online post-pandemic, communication may become more frequent, potentially strengthening teacher–parent relationships:

> "We might keep parent–teacher meetings online, because it's quicker and the parents don't have to travel, so it allows them to be at home, and they can just interface with you." (Participant 2 – Primary teacher, UK)

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Parents gained insight into teachers' work

During the period(s) of online teaching, many parents had the opportunity to observe some of their children's lessons, which appears to have deepened their understanding and appreciation of teachers' work:

> "The parents, again, are highly supportive, they've seen what we're doing, and a lot of them had to see far more into the classroom than they'd previously done, and they understand us a lot more." (Participant 2 – Primary teacher, UK)

> "Because I have been on the screen, the insight that it has given some parents into what we do – as weird as it was knowing that some of those parents were watching my lessons – and then they sent me feedback about it. That was actually really nice, and, I have to say, it gave me a really positive boost when I felt really, probably, quite fed up. So, that was lovely." (Participant 4 – Secondary teacher, UK)

Greater parental involvement in students' learning

School closures resulted in many parents becoming more involved in their children's education. According to an early years teacher, this allowed parents – especially those who pre-pandemic were not very involved in their children's learning – to appreciate this experience. This, in turn, may have incentivised them to seek ways to maintain this "mentoring" relationship and to continue to provide their children with more direct forms of educational support:

> "Parents not having to go to work has meant children have seen their parents more during lockdown. And for some parents who've been very busy, it has made them think they would like to not lose that again. And that is very helpful for the growing child, the little child. So, parents realising that they can be part of their child's educational journey, is useful. So, they started to learn to read, for example, with their parent, and now the parents may be thinking, 'I don't want to lose that little link with helping them to read, so I will try and find more time'. So, children and parents, that's been something useful that they have learnt – how valuable it is to be a parent." (Participant 3 – Early years teacher, UK)

Discussion and implications

This study has helped to illuminate some of the less visible and less frequently acknowledged effects of the COVID-19 pandemic on education. Specifically, it has highlighted the ways in which the disruption seems to have generated positive outcomes. While the adverse consequences of the crisis have been widely researched and documented (see e.g., Carroll & Constantinou, 2022; Howard et al., 2021; Thorn & Vincent-Lancrin, 2021), its potential benefits have received comparatively little attention, despite calls within the academic community to view the pandemic as a "blessing in disguise" and an opportunity to reimagine education (e.g., Taberski, 2020; Zhao, 2020). Beyond a limited body of work

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highlighting positive developments in educational technology (e.g., Akbana et al., 2021; Moorhouse et al., 2023), few, if any, studies have systematically explored the broader transformative potential of the disruption.

To address this gap, the present study adopted a holistic approach to examining the beneficial impact of the pandemic on education. Drawing on interviews with early years, primary, and secondary teachers based in schools across various European countries, the study identified four domains in which the disruption seems to have had a positive influence: the ideational, the affective, the behavioural, and the relational. These domains correspond to the thoughts, emotions, practices, and relationships of key educational stakeholders (i.e., teachers, students, and parents) respectively.

At the ideational level (domain of thoughts), the disruption challenged dominant educational ideologies and practices, opening up space for alternative approaches. These included a renewed focus on simplicity and outdoor learning, greater attention to student wellbeing and mental health, reconsideration of assessment practices, environmentally sustainable teaching (e.g., "paperless classrooms"), and the integration of student devices into face-to-face lessons. At the affective level (domain of emotions), the pandemic fostered positive emotional responses and attitudes, such as gratitude, resilience, openness to change, and enhanced self-efficacy through upskilling. Behaviourally (domain of practices), the benefits ranged from the expansion and refinement of digital tools by educational providers to the continued use of such tools by teachers in post-lockdown classroom practice. Relationally (domain of relationships), the disruption appeared to strengthen connections among teachers, students, and parents. Specifically, it offered each party greater insight into one another's work and circumstances (e.g., parents observing teachers' online lessons), while also increasing opportunities for interaction (e.g., parents becoming more involved in their children's learning during lockdown and wishing to sustain this involvement post-lockdown; teacher–parent communication being facilitated by the shift from in-person to online meetings).

In line with the literature on post-traumatic growth, these multi-dimensional benefits suggest that major educational disruptions, such as those caused by pandemics, can also yield constructive outcomes. To develop a more balanced and comprehensive understanding of the impact of such events, it is essential to investigate both their negative and positive dimensions. By proposing a typology of crisis-induced educational benefits (see Table 2), this study aims to support future efforts to assess the educational implications of crises such as epidemics, natural disasters, and armed conflicts. Given the increasing frequency of such events globally (see e.g., Acevedo & Novta, 2017; Haileamlak, 2022), frameworks like the one developed here are vital for advancing a more nuanced understanding of their effects on education.

If embraced and further explored, the trends and directions identified in this study could help shape a future for education that is not only more effective, but also more inclusive, resilient, and environmentally sustainable. By capturing and documenting these "seeds of change", the study seeks to inform and inspire ongoing discussions about the future(s) of education. Crucially, it aims to help sustain the momentum for educational transformation sparked by the COVID-19 crisis.

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Table 2: A typology of crisis-induced educational benefits

Macro-level benefits	Micro-level benefits
Ideational benefits	Students using electronic devices in face-to-face lessons
	Playing to technology's strengths
	Hybrid lessons
	Paperless classrooms
	Simplicity and outdoor learning
	Importance of wellbeing
	Alternative approaches to assessment
Affective benefits	Gratitude
	Professional confidence
	Willingness to change
	Resilience
Behavioural benefits	Movement of professional development courses online
	Increase in the supply of online educational resources
	Improvements in the usability of technology
	Expansion of teachers' instructional toolkit
	Greater student autonomy
Relational benefits	Exchange of tips and resources among teachers
	Teachers in more frequent contact with parents
	Parents gained insight into teachers' work
	Greater parental involvement in students' learning

Limitations and future directions

Given the small sample size, the range of positive effects and the domains identified are unlikely to be exhaustive. Further research involving larger and more diverse teacher populations is therefore needed to extend this understanding. Such work would provide deeper insight into the positive impact of the COVID-19 pandemic – and potentially of similar future disruptions – on education, as well as into the durability of these effects over time.

While the experiences captured here may resonate with many teachers globally, they do not reflect the experiences of all. Future studies should explore (a) how widespread these views are, and (b) the personal, socioeconomic, cultural, and political factors that may explain variation. This is crucial for understanding the diverse challenges and opportunities across teaching contexts, and for identifying potential inequalities within the profession.

Finally, the possibilities for the future of education identified in this study offer promising directions for further research. For example, it would be valuable to investigate the conditions under which some of these possibilities, or innovations, can be effectively implemented to enhance learning outcomes in both crisis and non-crisis contexts. Key questions that merit exploration include:

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- How can devices be best integrated into in-person lessons?
- What kinds of assessment approaches could help make education more crisis-proof?
- How can hybrid lessons be designed to ensure high-quality learning for both in-person and remote students?

These questions are now even more relevant. The interviews were conducted before generative AI chatbots, such as ChatGPT and Copilot, became widely available. In post-2022 contexts, teachers may view the integration of devices into in-person lessons differently, particularly in relation to when technology strengthens learning and how far it supports or constrains student autonomy. Similarly, debates about more crisis-proof assessment approaches may now need to consider how learning can be evidenced when students have access to AI-generated support. Future research could therefore examine whether, and how, generative AI has reshaped teachers' views on these issues.

Overall, it is hoped that the current findings and the questions they raise will inspire further research into more effective and inclusive approaches to delivering education in the future.

Acknowledgements

I would like to thank my colleagues at Cambridge Insight for their contributions to the design of the broader study and for their support in recruiting participants.

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Gaps in foundation mathematics understanding among 16-year-olds in England

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Introduction

GCSE Mathematics (graded 9–1, U) is one of the compulsory subjects – alongside English and Science – for students aged 16 in England. It has two tiers, foundation (graded 5–1, U) and higher (graded 9–4, U). One of the objectives of GCSE Mathematics is to "provide a strong mathematical foundation for students who go on to study mathematics at a higher level post-16" (Department for Education, 2013, p. 3). However, in England, 71.9 per cent of 16-year-old students achieved grade 4 or above in 2025 (Ofqual, n.d.), which means that more than a quarter of students were required to resit their GCSE Mathematics, in accordance with the Department for Education policy (Department for Education, 2014).

Given the high stakes for students, it is important to identify the gaps in mathematics understanding to determine where support is needed in the curriculum and assessment. This is particularly relevant in foundation tier, as students entering foundation tier are more likely to have lower levels of prior attainment (Vitello & Crawford, 2018) and a larger proportion of students are entered for foundation tier compared to higher tier. For example, foundation tier represented 59 per cent of national entries in summer 2023, and 64 per cent of OCR entries (Cambridge OCR, 2025).

The aim of this study was to provide insights about the extent to which student performance is associated with different item characteristics, such as content area and assessment objective. The overarching research question for this study was:

- What are the gaps in mathematics understanding for learners in foundation tier?

Specific key questions were:

1. Are item-level statistics for the foundation tier assessment associated with item characteristics?
2. What are the characteristics of items that strongly discriminate between grade-3 and grade-4 students?
3. How do item characteristics relate to item facility value among grade-3 and grade-4 students?

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Background to the study

A large body of literature has highlighted the importance of having strong mathematical skills. For example, early mathematical achievement has been shown to predict reading and science performance in secondary school (Claessens & Engel, 2013) and labour market outcomes such as higher earnings and employment rates (Cherry & Vignoles, 2020; Dickerson et al., 2022; Duncan et al., 2023; Watts, 2020).

In England, research on educational progression and labour market outcomes has further reinforced the value of GCSE results. For example, students who do not achieve grade 4 in English and / or Mathematics face additional barriers in their post-16 transitions compared to higher-achieving peers, regardless of whether they performed far below or just missed out on the standard pass grade (Lupton et al., 2021). Parsons and Elliot Major (2024) found that students who did not pass their English and / or Mathematics GCSE at the end of Year 11 tended to have lower educational aspirations and expectations, and were more likely to report poorer wellbeing and general health. In relation to the labour market, Hodge et al. (2021) found that each additional GCSE Mathematics grade was associated with higher income returns, although the size of these returns varied depending on the grade transition. These findings suggest that low GCSE attainment in English and / or Mathematics can have detrimental effects across several aspects of students' lives.

As described earlier, students who do not gain a standard pass (grade 4 or above) in GCSE Mathematics and English are required to continue studying these subjects and resit the exams until the age of 18 or until a standard pass is achieved (Department for Education, 2014). This represents over 30 per cent of each cohort who do not achieve a grade 4 or above in GCSE Mathematics (Ofqual, n.d.). Furthermore, evidence shows that resit outcomes are often low, for example, Vidal Rodeiro (2018) found that almost 60 per cent of resit students did not improve their grade in GCSE Mathematics. Several factors may contribute to this outcome, including demotivation of students, negative attitudes towards re-engaging with GCSE study, and a shortage of subject-specific teachers (Crisp et al., 2023). For example, in a study conducted by IFF Research (2016), 27 per cent of post-16 institutions that offered GCSEs reported having an insufficient number of mathematics teachers for retakes, and 37 per cent of students attending these institutions reported the same concern.

In summary, GCSE Mathematics results can have important and long-lasting effects on student education and wellbeing. Although several studies have primarily explored student and family characteristics associated with GCSE grades (Cassen & Kingdon, 2007; Elliot Major & Parsons, 2022; Sammons et al., 2014; Vidal Rodeiro, 2018), far less attention has been paid to the characteristics of the assessment items themselves. This study aimed to address that gap by investigating the association between item characteristics and gaps in mathematics understanding.

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GCSE Mathematics

The GCSE Mathematics qualification is a simple linear assessment model with two tiers: foundation and higher. The foundation tier focuses on essential topics, targets lower levels of understanding and covers grades 1 to 5, whereas the higher tier focuses on more advanced content, targets higher levels of understanding, and covers grades 4 to 9 (with an "allowed" grade 3 for students who missed the grade 4 boundary by a small number of marks). At least 20 per cent of each exam paper must include common questions between the two tiers.

In addition, GCSE Mathematics covers three assessment objectives (AOs) with different mark weights by tier (Table 1). For example, there is greater focus on assessing AO1 (use and apply standard techniques) in the foundation tier, where 50 per cent of the total marks should be related to AO1, compared to 40 per cent at higher tier. Some items assess more than one AO. In such cases, item marks are allocated to the corresponding assessment objectives.

Table 1: GCSE Mathematics assessment objectives and distribution of total marks by tier

Assessment objective	Description	Foundation tier	Higher tier
AO1	Use and apply standard techniques	50%	40%
AO2	Reason, interpret and communicate mathematically	25%	30%
AO3	Solve problems within mathematics and in other contexts	25%	30%

Source: Department for Education (2013)

In addition, each assessment objective consists of multiple strands with each strand made up of one or more elements (Table 2), resulting in a total of 22 assessment elements. (Note that an empty cell in the "element" column of Table 2 means that the strand is a single element.)

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Table 2: Strands and elements by assessment objective

Assessment objective	Strand	Element
AO1	1 – Accurately recall facts, terminology and definitions	
	2 – Use and interpret notation correctly	
	3 – Accurately carry out routine procedures or set tasks requiring multi-step solutions	3a – Accurately carry out routine procedures
		3b – Accurately carry out set tasks requiring multi-step solutions
AO2	1 – Make deductions, inferences and draw conclusions from mathematical information	1a – Make deductions to draw conclusions from mathematical information
		1b – Make inferences to draw conclusions from mathematical information
	2 – Construct chains of reasoning to achieve a given result	
	3 – Interpret and communicate information accurately	3a – Interpret information accurately
		3b – Communicate information accurately
	4 – Present arguments and proofs	4a – Present arguments
		4b – Present proofs
	5 – Assess the validity of an argument and critically evaluate a given way of presenting information	5a – Assess the validity of an argument
		5b – Critically evaluate a given way of presenting information
AO3	1 – Translate problems in mathematical or non-mathematical contexts into a process or a series of mathematical processes	1a – Translate problems in mathematical contexts into a process
		1b – Translate problems in mathematical contexts into a series of processes
		1c – Translate problems in non-mathematical contexts into a process
		1d – Translate problems in non-mathematical contexts into a series of processes
	2 – Make and use connections between different parts of mathematics	
	3 – Interpret results in the context of the given problem	
	4 – Evaluate methods used and results obtained	4a – Evaluate methods used
		4b – Evaluate results obtained
	5 – Evaluate solutions to identify how they may have been affected by assumptions made	

Source: Ofqual (2015)

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The GCSE Mathematics curriculum also covers different content areas (Department for Education, 2013), with the foundation tier focusing more on number and the higher tier more on algebra:

- *Number:* structure and calculation, fractions, decimals, percentages.
- *Algebra*: notation, vocabulary and manipulation, graphs, equations, and inequalities.
- *Ratio, proportion and rates of change*: scale factors, ratio notation, and lengths comparison.
- *Geometry and measures*: properties and constructions, mensuration and calculation, vectors.
- *Probability and statistics*: probability experiments, randomness, distribution, predictions.

Each content area includes a set of content statements, or content references, outlined in the GCSE Mathematics specification document (Department for Education, 2013). Each content reference specifies a mathematical topic that students are expected to know. For example, the GCSE Mathematics specification includes 16 content references in number, where the first one is "order positive and negative integers, decimals and fractions; use the symbols =, ≠, <, >, ≤, ≥" (Department for Education, 2013, p. 4).

The GCSE Mathematics specification also includes 25 content references in algebra, 16 in ratio, proportion and rates of change, 25 in geometry and measures, and 15 in probability and statistics, resulting in a total of 97 content references (Department for Education, 2013).

In England, four awarding organisations offer GCSE Mathematics, one of them being Cambridge OCR. Cambridge OCR GCSE Mathematics includes three written papers at each tier with equal mark allocations of 100 points and equal length (1 hour and 30 minutes) across papers (Cambridge OCR, 2026). Each paper makes one-third of the total GCSE mark, and candidates are expected to take all three papers and answer all questions. In this study, we analysed Cambridge OCR GCSE Mathematics data at foundation tier.

Methods

Data

We collected information on item characteristics from the exam papers' specification grids. Each exam paper has a specification grid that outlines all items, their corresponding total mark, and the number of marks targeting each specific assessment objective, strand, element, content area, and content reference. The grids ensure that assessment objectives and content areas are appropriately aligned with Ofqual requirements (Department for Education, 2023). In total, 15 specification grids for GCSE Mathematics foundation tier exams (papers 1, 2, and 3) from five exam series (June 2023, November 2023, June 2024, November 2024, and June 2025) were used.

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Data from the specification grids was collated with item-level statistics, which included the omit rate and facility value. Across the 15 papers, there were on average 26 questions per paper, with a minimum of 23 and a maximum of 29. As many questions included multiple items, the average number of items per paper was 48, ranging from 44 to 56 items.

Analysis

To answer the first research question (are item-level statistics for the foundation tier assessment associated with item characteristics?), we calculated item-level statistics (omit rate and facility value) and reported the mean values by assessment objective and content area.

The omit rate is an item statistic that shows the proportion of students who did not respond to an item; higher values indicate that students skipped the item more frequently. The facility value is the mean mark of an item divided by its maximum available mark. Thus, it reflects the easiness of an item, with higher values indicating easier items. It is important to note that items with high omit rates tend to have low facility values because omitted responses are scored as zero.

To address the second research question (what are the characteristics of items that strongly discriminate between grade-3 and grade-4 students?), item discrimination was operationalised as the difference between the facility values for grade-4 and grade-3 students. Across items, the mean facility difference was 12.1 percentage points (standard deviation (SD) = 7.4), indicating that, on average, grade-4 students outperformed grade-3 students by about 12 percentage points. "Strongly discriminating" items were defined as those with a facility difference of at least 1 SD above the mean. The threshold 19.5 was rounded up for simplicity, that is, items with a difference of 20 percentage points or more were defined as strongly discriminating.

We then grouped the items into those that were classified as strongly discriminating and those that were less discriminating, and for each of these groups looked at the percentages of items with different item characteristics (i.e., assessment objective, content area, content reference).

Lastly, to examine the association between item facility values and item characteristics (how do item characteristics relate to item facility value among grade-3 and grade-4 students?), a linear regression model was used. The dependent variable was the item facility value. The facility value was calculated separately for grade-3 and grade-4 students, that is, each item had two observations, one for its grade-3 facility value and one for its grade-4 facility value. Standard errors were clustered by item to account for this nested structure.

The independent variables included in the model were the assessment objective elements and the content area assessed by the item, and a grade indicator specifying whether the facility value corresponded to grade-3 or grade-4 students. As items could assess more than one AO and content area, each AO and content area was entered as a separate binary (0/1) indicator.

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We also tested whether the association between item characteristics and facility value differed between grade-3 and grade-4 students, by including interaction terms between each assessment objective / content area indicator and the grade variable. A significant interaction would indicate that the performance gap between grade 3 and grade 4 varied depending on the assessment objective or content area assessed. In contrast, a non-significant interaction would indicate that the association between item characteristics and facility value was consistent across grade-3 and grade-4 students.

Results

Characteristics of items analysed

In the five series analysed, there were 386 questions (717 items). Table 3 shows the number and percentage of items included in the study by assessment objective and content area. Sixty-eight per cent of the items assessed AO1, 39.1 per cent assessed AO2, and 32.5 per cent assessed AO3. There were 44 items (6.1 per cent) that assessed all three AOs and 481 (67.1 per cent) that assessed only one AO. It is important to note that these percentages represent the percentage of items assessing each AO, not the percentage of marks allocated to each AO. That is why the values differ from those shown in Table 1.

The most frequently covered content area was number (31.9 per cent of items), whereas the least frequently covered was geometry (16.6 per cent of items). Also, there were 83 items (11.6 per cent) that covered more than one content area (80 items assessed two areas and 3 items assessed three areas), and the rest of the items (88.4 per cent) covered only one content area.

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Table 3: Number of items analysed by characteristic

Item characteristic	N	%
Assessment objective 1 (AO1)	484	67.5
AO 1.1	52	7.3
AO 1.2	45	6.3
AO 1.3a	260	36.3
AO 1.3b	154	21.5
Assessment objective 2 (AO2)	280	39.1
AO 2.1a	60	8.4
AO 2.1b	18	2.5
AO 2.2	15	2.1
AO 2.3a	75	10.5
AO 2.3b	102	14.2
AO 2.4a	26	3.6
AO 2.4b	2	0.3
AO 2.5a	5	0.7
AO 2.5b	10	1.4
Assessment objective 3 (AO3)	233	32.5
AO 3.1a	41	5.7
AO 3.1b	36	5.0
AO 3.1c	36	5.0
AO 3.1d	83	11.6
AO 3.2	28	3.9
AO 3.3	47	6.6
AO 3.4a	13	1.8
AO 3.4b	7	1.0
AO 3.5	10	1.4
Item assessed all AOs	44	6.1
Item assessed only one AO	481	67.1
Content area		
Number	229	31.9
Algebra	154	21.5
Ratio, proportion and rates of change	162	22.6
Geometry and measures	119	16.6
Probability and statistics	139	19.4
Item assessed more than one content area	83	11.6
Item assessed only one content area	634	88.4

In relation to the content reference, items assessed 82 out of the 97 references. All 16 content references from number were covered, whereas 21 out of the 25 in algebra, 14 out of the 16 in ratio, 19 out of the 25 in geometry, and 12 out of the 15

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in probability were assessed.[1] The number of items per content reference ranged from 1 to 63, with a mean of 11.3 (SD = 11.1) items per content reference (see Table A1 in the appendix).

It is worth noting that all assessment objective elements and content references were included in the analyses; however, only assessment elements and content references with at least 10 items are discussed in the results.

Item-level statistics and their characteristics

The omit rate of the items ranged from 0 per cent to 64 per cent, with a mean of 12.9 per cent (SD = 11.5 per cent). The mean rates of item omission were similar across series. The lowest mean item omit rate by series was 12 per cent in November series and the highest mean item omit rate was 14 per cent in June 2023 and 2024 (Table 4). Across papers, paper 3 showed slightly higher mean omit rates compared to papers 1 and 2, but differences were relatively small.

Table 4: Mean omit rates across items within a paper and series

	Paper 1	Paper 2	Paper 3	Total
June 2023	10.9	13.6	16.7	**13.8**
June 2024	11.8	14.8	14.6	**13.8**
June 2025	11.0	12.1	14.3	**12.5**
November 2023	12.8	11.0	13.4	**12.4**
November 2024	11.5	11.2	14.0	**12.2**
Total	**11.6**	**12.5**	**14.6**	**13.0**

Regarding facility values, the mean item facility, expressed as the percentage of the maximum mark, ranged from 0 per cent to 98 per cent, with a mean of 43.2 per cent (SD = 26.7 per cent). The mean item facility value was slightly higher for June series, 44.8 per cent in 2023 and 2025, and 44.0 per cent in 2024, compared to November series, which were 40.4 per cent in 2023 and 42.1 per cent in 2024 (Table 5). This was expected as facility values are cohort-dependent and most students in November series are resitting their GCSEs. Across papers, paper 3 showed slightly lower mean facility values (i.e., items were more difficult) compared to papers 1 and 2.

Table 5: Mean facility values across items within a paper and series

	Paper 1	Paper 2	Paper 3	Total
June 2023	47.9	46.6	40.2	**44.8**
June 2024	47.5	43.9	40.6	**44.0**
June 2025	47.8	45.4	41.5	**44.8**
November 2023	38.8	41.7	40.5	**40.4**
November 2024	46.7	42.1	37.6	**42.1**
Total	**45.8**	**43.9**	**40.1**	**43.0**

1 There were 15 content references that were not assessed in the dataset analysed. This is likely to be a result of the small number of series included (only five) and the fact that some of the content references are only assessed in the higher tier.

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In relation to the AO and content area, mean omit rates and facility values varied across item characteristics (see Table 6). Items that assessed AO2 and AO3 had higher mean omit rates than items that assessed AO1. Items assessing all three AOs showed higher mean omit rates (17.7 per cent) compared to the average rate across all items (12.9 per cent) and compared to items that assessed only one AO (10.8 per cent). Items that were more challenging for students (lower mean facility values) were more likely to assess AO2 (38.7 per cent) and AO3 (31.2 per cent), compared to AO1 (45.4 per cent). Additionally, items assessing all three AOs had a lower mean facility value (30.5 per cent) than the average facility across all items (43.2 per cent), and than items assessing only one AO (48.2 per cent). Items that assessed more than one content area also showed lower mean facility values (36.6 per cent compared to 44.1 per cent) and higher mean omit rates (17.2 per cent compared to 12.4 per cent) compared to items that assessed only one content area.

Table 6: Mean facility values and omit rates by assessment objective and number of content areas assessed

Item characteristic	Mean omit rate	Mean facility value
Assessment objective		
Assessment objective 1	11.6	45.4
Assessment objective 2	15.9	38.7
Assessment objective 3	17.4	31.2
Item assessed all AOs	17.7	30.5
Item assessed only one AO	10.8	48.2
Content area		
Item assessed more than one content area	17.2	36.6
Item assessed only one content area	12.4	44.1
Total	**12.9**	**43.2**

Figure 1 shows the mean facility values and omit rates by assessment objective elements.[2] Items with lower facility values covered assessment objective elements AO 3.1b, AO 2.5b, AO 3.5, AO 3.4a, and AO 3.2, which relate to the evaluation and critique of methods, solutions, and mathematics results, as well as mathematical reasoning.

The assessment objective elements with the highest omit rates were AO 2.2, AO 3.1b, AO 3.2, and AO 3.5, which are topics related to the evaluation of solutions, the use of connections between parts of mathematics, and mathematical reasoning. Items assessing AO 3.4b also had a lower facility value and high omit rate; however, there were only seven items assessing this content.

2 Only assessment objective elements and content references assessed by at least 10 items are discussed in the results.

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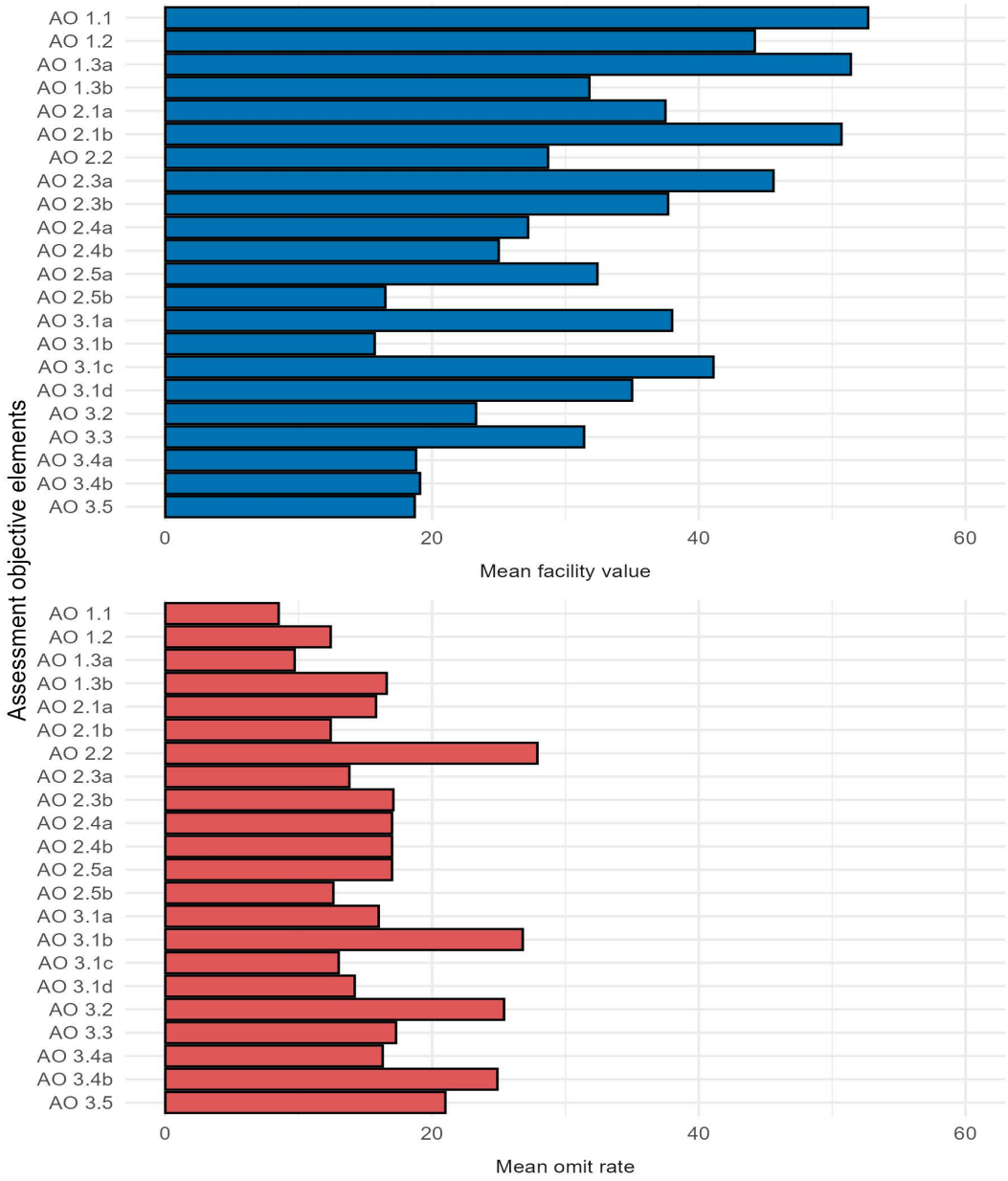

Figure 1: Mean facility values and omit rates by assessment objective elements

Regarding content area, among all items, geometry and algebra were more challenging for students as they showed higher mean omit rates and lower mean facility values compared to number, ratio, and probability (Figure 2). In particular, items assessing content references G20, A21, and G25 had mean facility values below 19 per cent. Items covering G20 assessed student knowledge about Pythagoras' theorem, trigonometric ratios, and the skills to apply them to find angles and lengths in right-angled triangles. Content reference A21 assessed student skills to translate simple situations or procedures into algebraic expressions or formulae, derive an equation (or two simultaneous equations), and solve the equation(s) and interpret the solution. Lastly, G25 in foundation tier assessed student skills to apply addition and subtraction of vectors, multiplication of vectors by a scalar, and diagrammatic and column representations of vectors.

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In relation to mean omit rates, items assessing content references G25, A21, and A2 had mean omit rates above 25 per cent (see Table A1 in the appendix). These content references assessed the student ability to "apply addition and subtraction of vectors, multiplication of vectors by a scalar, and diagrammatic and column representations of vector" (G25), "translate simple situations or procedures into algebraic expressions or formulae; derive an equation (or two simultaneous equations), solve the equation(s) and interpret the solution" (A21), and to "substitute numerical values into formulae and expressions, including scientific formulae" (A2).[3]

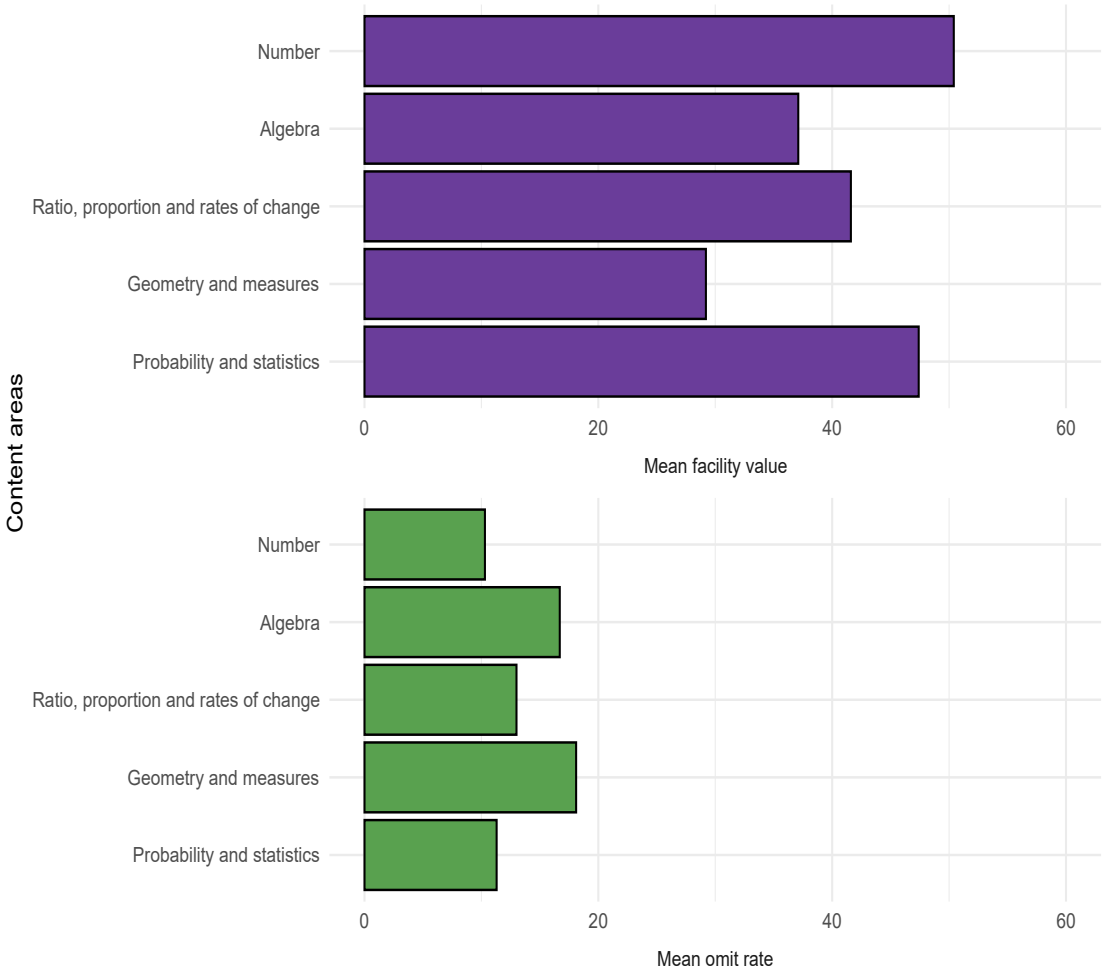

Figure 2: Mean facility values and omit rates by content area

Item statistics might be affected by item position, that is, items appearing at the end of an exam could have higher omit rates and lower facility values. This is particularly relevant because certain AOs might be primarily assessed later in the paper. In order to account for this, the last five items of each paper (around 10 per cent of the average paper length) were removed, and the descriptive statistics were recalculated. Although the absolute values slightly changed, the overall patterns were similar, with more challenging items assessing AO2, AO3, algebra, and geometry (see Table A2 in the appendix).

3 Content reference descriptions are quoted from Department for Education (2013, pp. 4–12).

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Discriminating items and their characteristics

We also analysed the characteristics of items that discriminated between grade-3 and grade-4 students. An item was defined as "strongly discriminating" when the difference in mean item facility values between grade-3 and grade-4 students was 20 percentage points or more (see the *Analysis* section for more details). Of the 717 items analysed, 123 (17.2 per cent) items showed strong discrimination between grade-3 and grade-4 students and 594 (82.8 per cent) items were less discriminating.

If the items with a particular discrimination level were a random subset, not associated with AOs (or content area), the proportion of items assessing each AO (or content area) within the subset should closely match the proportion in the total item pool. However, this was not the case as certain AOs were overrepresented among strongly discriminating items relative to the less discriminating item group and the total item pool. Specifically, 89.4 per cent of strongly discriminating items (i.e., 89.4 per cent of 123 items) assessed AO1, 30.1 per cent assessed AO2, and 48.0 per cent assessed AO3, whereas these percentages were 67.5, 39.1, and 32.5, respectively, in the total item pool. This indicates that a higher proportion of strongly discriminating items assessed AO1 and AO3, compared to the total item pool and the less discriminating items. In addition, results indicate that many of the strongly discriminating items targeted more than one AO. For example, 44.7 per cent of strongly discriminating items (44.7 per cent of 123 items) assessed only one AO, compared to 71.7 per cent of less discriminating items (71.7 per cent of 594 items) and 67.1 per cent in the total item pool (67.1 per cent of 717 items). Similarly, 12.2 per cent of strongly discriminating items assessed all three AOs, compared to 4.9 per cent of less discriminating items and 6.1 per cent in the total item pool. In relation to the number of content areas assessed, items covering more than one content area were overrepresented in the strong-discriminating item group.

Table 7: Percentage of strongly discriminating and less discriminating items by assessment objective and number of content areas assessed

Item characteristic	Strongly discriminating items (n = 123)	Less discriminating items (n = 594)	Total item pool (n = 717)
Assessment objective			
Assessment objective 1	89.4	63.0	67.5
Assessment objective 2	30.1	40.9	39.1
Assessment objective 3	48.0	29.3	32.5
Item assessed all AOs	12.2	4.9	6.1
Item assessed only one AO	44.7	71.7	67.1
Content area			
Item assessed more than one content area	17.1	10.4	11.6
Item assessed only one content area	82.9	89.6	88.4

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Figure 3 shows the percentage of items in the strongly discriminating and less discriminating groups by assessment objective element. Most of the strongly discriminating items, that is, items with a large difference between grade 3 and grade 4, were found in items assessing AO 1.3a, AO 1.3b, AO 3.1d, and AO 3.3. These AOs were related to the ability to apply routine procedures and multi-step solutions, translate problems in non-mathematical contexts, and results interpretation.

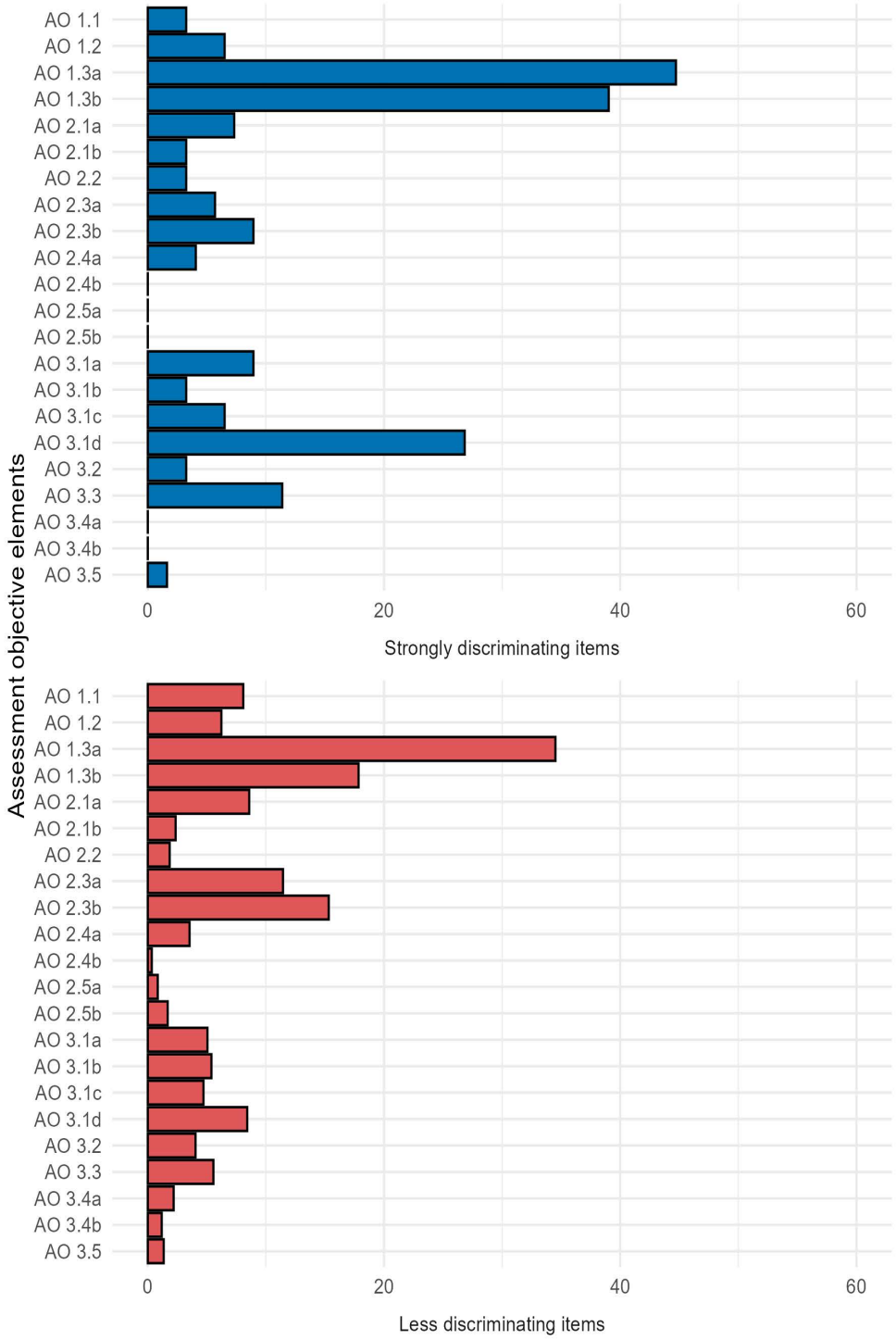

Figure 3: Percentage of strongly discriminating and less discriminating items that assess each assessment objective element

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With respect to the content area, Figure 4 shows that there were no major differences between discriminating and less discriminating items, except for items assessing ratio. Forty-one per cent of strongly discriminating items assessed ratio, compared with 18.9 per cent of items in the less discriminating group.

Regarding the content reference, discriminating items were overrepresented in R5, R9, R1, and N12 (Table A2 in the appendix). Three of these content references were from ratio (R5, R9, and R1) and one from number (N12). For example, 13.8 per cent of discriminating items assessed content reference R5, compared to only 2.4 per cent of less discriminating items.

R5 assessed the skills to "divide a given quantity into two parts in a given part:part or part:whole ratio; express the division of a quantity into two parts as a ratio; apply ratio to real contexts and problems (such as those involving conversion, comparison, scaling, mixing, concentrations)", whereas R9 assessed the skills to "define percentage as number of parts per hundred; interpret percentages and percentage changes as a fraction or a decimal, and interpret these multiplicatively; express one quantity as a percentage of another; compare two quantities using percentages; work with percentages greater than 100 per cent; solve problems involving percentage change, including percentage increase/decrease and original value problems, and simple interest including in financial mathematics". R1 assessed the skills to "change freely between related standard units (e.g. time, length, area, volume/capacity, mass) and compound units (e.g. speed, rates of pay, prices, density, pressure) in numerical and algebraic contexts", and N12 assessed the skills to "interpret fractions and percentages as operators".[3]

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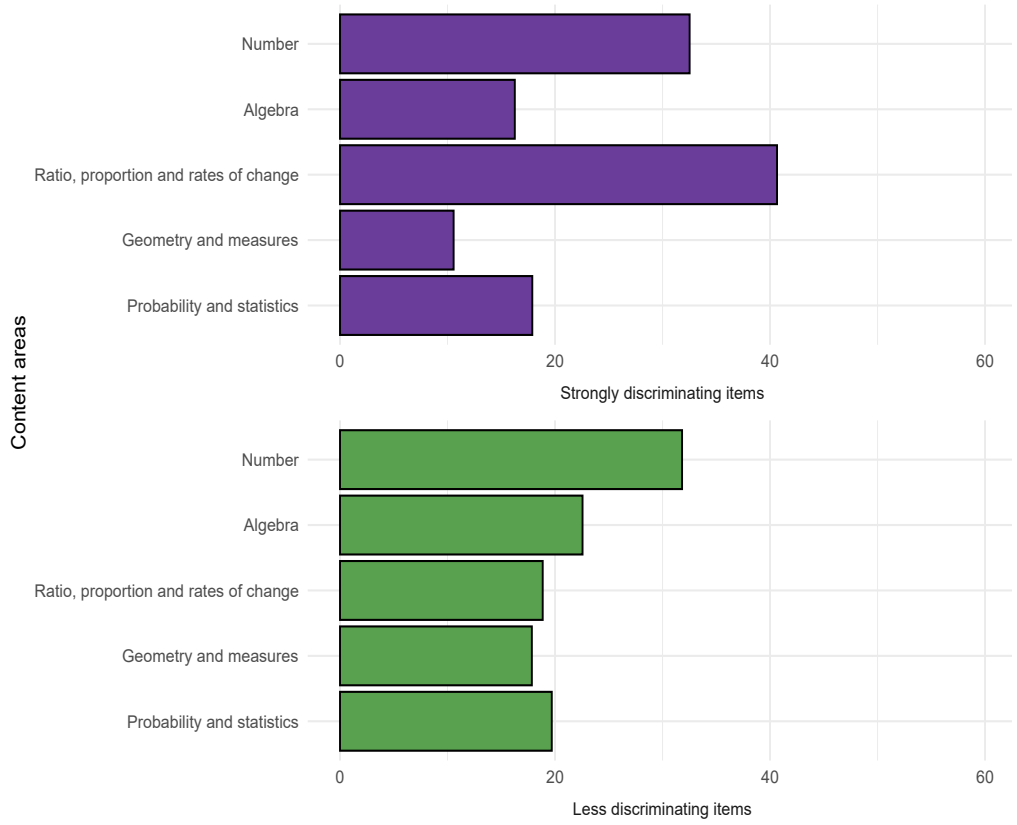

Figure 4: Percentage of strongly discriminating and less discriminating items that assess each content area

Regression analysis

We explored the extent to which item characteristics were associated with item facility value for grade-3 and grade-4 students using the regression analyses described in the *Analysis* section. The results are shown in Table 8. The coefficient associated with grade 4 shows the mean overall item facility difference between grade-4 and grade-3 students.

The coefficients reflect the difference in facility value when the item assesses a specific AO element or content area. The large negative coefficients of some AO elements indicate that items assessing these elements tended to have lower facility values, particularly items assessing AO 3.5, 2.5b, 3.4a, 2.4a, and 3.1b (Table 8), which were related to the evaluation and critique of methods, solutions, and mathematics results, as well as the presentation of proofs, and the translation of problems in mathematical contexts into a series of processes.

In addition, items assessing algebra or geometry showed significantly lower facility values suggesting these were more challenging. For example, items assessing geometry showed a 15-percentage point reduction in facility value. These findings are consistent with the results shown in Figure 1 and Figure 2.

We also explored whether there was a differential effect for grade-3 and grade-4 students by interacting AO elements and content areas with the grade variable.

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None of the interaction terms were significant, and therefore, the model is not reported here. However, this finding suggests that the association between item characteristics and facility value is similar across students who achieved both grade 3 and grade 4.

Table 8: Regression results of grade-3 and grade-4 student facility values on assessment objective elements and content area

	Coefficient	Standard error	P-value
Intercept	0.59*	0.04	0.000
Grade 4	0.12*	0.00	0.000
AO 1.1	-0.01	0.04	0.756
AO 1.2	-0.10*	0.04	0.014
AO 1.3a	-0.02	0.03	0.572
AO 1.3b	-0.13*	0.04	0.002
AO 2.1a	-0.11*	0.04	0.010
AO 2.1b	-0.10	0.05	0.062
AO 2.2	-0.17*	0.06	0.004
AO 2.3a	-0.10*	0.04	0.017
AO 2.3b	-0.09*	0.03	0.005
AO 2.4a	-0.21*	0.06	0.001
AO 2.4b	-0.02	0.08	0.818
AO 2.5a	-0.13	0.10	0.214
AO 2.5b	-0.50*	0.06	0.000
AO 3.1a	-0.10*	0.04	0.022
AO 3.1b	-0.19*	0.06	0.001
AO 3.1c	-0.09	0.05	0.094
AO 3.1d	-0.07	0.05	0.152
AO 3.2	-0.04	0.05	0.446
AO 3.3	-0.07	0.04	0.125
AO 3.4a	-0.43*	0.07	0.000
AO 3.4b	-0.36*	0.09	0.000
AO 3.5	-0.50*	0.06	0.000
Number	0.04	0.03	0.275
Algebra	-0.09*	0.04	0.027
Ratio, proportion and rates of change	0.01	0.03	0.831
Geometry and measures	-0.15*	0.04	0.000
Probability and statistics	0.07	0.04	0.077

Note: * indicates $p < 0.05$. Grade 3 was the reference category of the grade variable.

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Summary

GCSE Mathematics performance is associated with long-term educational progression and labour market outcomes. Although many studies have explored student and family characteristics associated with GCSE grades and resits, far less is known about how item characteristics (e.g., assessment objective, content area) relate to GCSE Mathematics outcomes.

The aim of the study was to provide insights about the extent to which student performance in GCSE Mathematics at foundation tier is associated with different item characteristics, such as content area and assessment objective. Specifically, we explored whether item-level statistics are associated with a particular assessment objective element, content area, and content reference.

Firstly, we looked at item omit rates and facility values and examined whether these were associated with item characteristics. We found that items assessing the following assessment objective elements were the most challenging for students sitting GCSE Mathematics foundation tier:

- Translate problems in mathematical contexts into a series of processes (AO 3.1b).
- Make and use connections between different parts of mathematics (AO 3.2).
- Evaluate solutions to identify how they may have been affected by assumptions made (AO 3.5).

Geometry and algebra had, on average, the items with the highest omit rates and lowest facility values, especially items related to:

- Apply addition and subtraction of vectors, multiplication of vectors by a scalar, and diagrammatic and column representations of vectors (G25).
- Translate simple situations or procedures into algebraic expressions or formulae; derive an equation (or two simultaneous equations), solve the equation(s) and interpret the solution (A21).
- Know the formulae for: Pythagoras' theorem and the trigonometric ratios, and apply them to find angles and lengths in right-angled triangles (G20).[3]

Secondly, we explored the item characteristics for which there were the largest differences in item performance (facility values) between grade-3 and grade-4 students. We found that the largest differences were in items assessing:

- Accurately carry out routine procedures (AO 1.3a).
- Accurately carry out set tasks requiring multi-step solutions (AO 1.3b).
- Translate problems in non-mathematical contexts into a series of processes (AO 3.1d).
- Interpret results in the context of the given problem (AO 3.3).

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In relation to the content area, performance gaps between grade-3 and grade-4 students were found in ratio, proportion, and rates of change, specifically in items assessing:

- Divide a given quantity into two parts in a given part:part or part:whole ratio; express the division of a quantity into two parts as a ratio; apply ratio to real contexts and problems (such as those involving conversion, comparison, scaling, mixing, concentrations) (R5).
- Define percentage as "number of parts per hundred"; interpret percentages and percentage changes as a fraction or a decimal, and interpret these multiplicatively; express one quantity as a percentage of another; compare two quantities using percentages; work with percentages greater than 100 per cent; solve problems involving percentage change, including percentage increase/decrease and original value problems, and simple interest including in financial mathematics (R9).
- Change freely between related standard units (e.g., time, length, area, volume/capacity, mass) and compound units (e.g., speed, rates of pay, prices, density, pressure) in numerical and algebraic contexts (R1).[3]

Lastly, we explored whether any specific assessment objectives or content areas were associated with the mean item facility value for grade-3 and grade-4 students. The results were consistent with the findings of the descriptive analysis, and the association between item characteristics and facility value is similar across students who achieved both grade 3 and grade 4.

These are interesting findings because, in a recent OCR study (Clarke, 2024), most mathematics teachers recommended removing items involving vectors (G25) from the GCSE specification to allow students to develop a deeper understanding and mastery of the fundamentals. In the same line, Clarke (2024) recommended that more demanding content could be moved into additional mathematics qualifications taken at age 16 or post-16. However, the recent Curriculum and Assessment Review concluded that the mathematics curriculum is "rigorous and ambitious" and that the volume of content is appropriate, though it raised concerns about how classroom time is allocated (Department for Education, 2025). The Review indicated that limited opportunities to engage with foundational mathematical concepts may lead to a superficial understanding of the fundamentals, which is consistent with the finding from the current study that the highest differences between grade-3 and grade-4 performance were linked to the use and application of standard techniques (AO1).

Limitations

The study has a few limitations. Firstly, it is worth noting that when calculating item facility values by assessment objective elements and content areas, we assumed that the distribution of marks remained consistent with the proportions provided in the specification grids. This assumption is relevant for multi-mark items, as the item-level data only provided the total mark each student achieved on those items.

Secondly, the study focused on GCSE Mathematics foundation tier, but it would be important to investigate whether the findings also hold for the higher tier.

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Lastly, a more detailed analysis of the content reference and some assessment objective elements would require additional data, that is, including more series to ensure there are enough items within each content reference. For example, the assessment objective element related to "evaluate results obtained" (AO 3.4b) was also challenging for students. However, there were only seven items that assessed this element.

Recommendations

Based on the findings of this study, it is recommended that additional support is provided to students sitting the GCSE Mathematics foundation tier in the following areas:

- **Skills related to Assessment Objective 3.** Additional emphasis on AO3 could be valuable since this was the most challenging objective for students, particularly the skills of translating mathematical and non-mathematical problems into a series of processes, and evaluating results and solutions.
- **Geometry and algebra.** More practice with geometry and algebra tasks could help learners improve their performance across both these content areas, as these were the most challenging for students.
- **Understanding of ratio, proportion, and rates of change.** Additional support in this area may help reduce the performance gap between grade-3 and grade-4 students, and in turn help reduce the number of students needing to resit the GCSE.

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Appendix

Table A1: Item-level statistics by content reference

Content reference	N items	% items	Mean omit rate (%)	Mean facility value (%)	Strongly discriminating items (%)	Less discriminating items (%)
A1	4	0.6	13.3	36.8	0.8	0.5
A2	13	1.8	25.7	26.3	2.4	1.7
A3	5	0.7	8.6	19.2	0.0	0.8
A4	31	4.3	13.2	40.3	2.4	4.7
A5	9	1.3	18.1	21.9	3.3	0.8
A6	2	0.3	21.0	16.5	0.0	0.3
A7	9	1.3	8.7	59.1	1.6	1.2
A8	8	1.1	4.3	78.3	0.0	1.3
A9	5	0.7	40.0	4.8	0.0	0.8
A10	2	0.3	22.5	26.0	0.0	0.3
A11	3	0.4	46.0	2.0	0.0	0.5
A12	5	0.7	15.0	33.4	0.0	0.8
A14	8	1.1	14.1	41.6	0.0	1.3
A17	13	1.8	20.8	36.3	3.3	1.5
A18	8	1.1	36.4	10.1	0.0	1.3
A19	4	0.6	23.5	14.5	0.8	0.5
A21	18	2.5	26.9	15.9	2.4	2.5
A22	5	0.7	17.0	28.8	2.4	0.3
A23	11	1.5	4.0	70.5	0.0	1.9
A24	10	1.4	11.0	39.8	0.0	1.7
A25	4	0.6	18.5	29.3	0.0	0.7
G1	12	1.7	10.7	46.0	0.0	2.0
G2	6	0.8	30.2	8.2	0.0	1.0
G3	13	1.8	21.8	23.1	0.8	2.0
G4	9	1.3	17.6	29.9	0.0	1.5
G5	2	0.3	19.0	18.5	0.0	0.3
G6	2	0.3	11.5	24.0	0.0	0.3
G7	14	2.0	11.7	37.1	1.6	2.0
G9	4	0.6	20.3	42.0	0.0	0.7
G11	1	0.1	19.0	8.0	0.0	0.2
G12	3	0.4	0.3	68.3	0.0	0.5
G13	4	0.6	15.5	29.8	0.0	0.7
G15	6	0.8	12.8	46.8	0.0	1.0
G16	18	2.5	18.1	25.2	5.7	1.9
G17	17	2.4	23.9	20.8	2.4	2.4
G18	2	0.3	45.0	3.0	0.0	0.3
G19	2	0.3	27.5	5.5	0.0	0.3
G20	11	1.5	24.4	8.7	0.0	1.9

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Content reference	N items	% items	Mean omit rate (%)	Mean facility value (%)	Strongly discriminating items (%)	Less discriminating items (%)
G21	2	0.3	25.0	10.5	0.0	0.3
G25	10	1.4	27.9	18.7	0.8	1.5
N1	11	1.5	4.7	52.8	1.6	1.5
N2	63	8.8	8.2	52.9	8.9	8.8
N3	41	5.7	9.8	54.2	9.8	4.9
N4	33	4.6	10.4	53.2	2.4	5.1
N5	3	0.4	3.7	65.3	0.0	0.5
N6	21	2.9	8.7	60.5	0.8	3.4
N7	9	1.3	13.6	38.6	1.6	1.2
N8	9	1.3	10.8	41.7	2.4	1.0
N9	9	1.3	14.7	42.8	0.8	1.3
N10	6	0.8	3.7	63.2	0.8	0.8
N11	2	0.3	7.0	57.0	0.8	0.2
N12	14	2.0	12.1	43.7	7.3	0.8
N13	11	1.5	8.7	48.6	2.4	1.3
N14	7	1.0	13.4	39.9	0.0	1.2
N15	23	3.2	13.5	38.4	4.1	3.0
N16	6	0.8	35.2	7.3	0.0	1.0
P1	9	1.3	11.0	52.4	1.6	1.2
P2	6	0.8	10.0	35.3	3.3	0.3
P3	16	2.2	10.4	40.5	1.6	2.4
P4	4	0.6	18.0	36.8	0.8	0.5
P5	3	0.4	21.3	21.3	0.0	0.5
P6	13	1.8	8.1	62.1	0.8	2.0
P7	9	1.3	10.2	55.2	0.8	1.3
P8	7	1.0	22.9	20.0	1.6	0.8
R1	31	4.3	13.3	33.3	9.8	3.2
R2	7	1.0	15.7	40.1	0.8	1.0
R3	11	1.5	8.5	50.1	3.3	1.2
R4	11	1.5	12.6	41.6	0.8	1.7
R5	31	4.3	13.2	42.1	13.8	2.4
R6	5	0.7	20.2	35.0	2.4	0.3
R7	1	0.1	16.0	11.0	0.0	0.2
R8	5	0.7	12.8	46.2	0.8	0.7
R9	47	6.6	11.3	43.5	13.8	5.1
R10	19	2.6	10.1	47.9	4.9	2.2
R11	25	3.5	16.8	33.9	4.1	3.4
R12	1	0.1	20.0	5.0	0.0	0.2
R14	3	0.4	26.3	20.3	0.0	0.5
R16	4	0.6	18.5	27.3	0.8	0.5

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Content reference	N items	% items	Mean omit rate (%)	Mean facility value (%)	Strongly discriminating items (%)	Less discriminating items (%)
S1	4	0.6	13.3	28.0	0.0	0.7
S2	32	4.5	8.3	57.2	3.3	4.7
S4	21	2.9	11.5	48.1	4.9	2.5
S6	21	2.9	13.1	40.7	2.4	3.0

Note: A = Algebra, G = Geometry, N = Number, R = Ratio, P = Probability, S = Statistics. For more information about each content reference, see Department for Education (2013). Probability and statistics have been listed separately here because this is how they are treated in Department for Education (2013); however, they have been grouped together in most of this article because they are treated together in Cambridge OCR's GCSE Mathematics specification.

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Table A2: Mean facility values and omit rates by assessment objective and content area, after removing data for the last five items of each exam

Item characteristic	Mean omit rate (%)	Mean facility value (%)
Assessment objective 1	9.7	49.0
AO 1.1	7.5	54.2
AO 1.2	10.5	47.7
AO 1.3a	8.1	53.9
AO 1.3b	14.2	36.4
Assessment objective 2	13.2	43.2
AO 2.1a	11.8	44.1
AO 2.1b	12.4	50.7
AO 2.2	19.8	40.9
AO 2.3a	11.7	48.4
AO 2.3b	15.4	40.4
AO 2.4a	14.4	32.8
AO 2.4b	17.0	25.0
AO 2.5a	15.8	36.5
AO 2.5b	9.4	17.3
Assessment objective 3	14.5	35.7
AO 3.1a	11.6	44.4
AO 3.1b	22.9	21.6
AO 3.1c	11.3	44.3
AO 3.1d	12.6	38.2
AO 3.2	21.9	28.9
AO 3.3	14.2	37.2
AO 3.4a	16.3	18.8
AO 3.4b	22.2	23.8
AO 3.5	20.7	17.1
Item assessed all AOs	14.0	37.8
Item assessed only one AO	9.6	50.1
Content area		
Number	8.8	53.2
Algebra	13.3	41.3
Ratio, proportion and rates of change	11.8	44.1
Geometry and measures	14.2	35.3
Probability and statistics	10.6	48.7
Item assessed more than one content area	14.5	41.0
Item assessed only one content area	10.5	47.3
Total	**10.9**	**46.6**

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Progression and earnings of students who leave post-16 education with low grades in their A Level qualifications

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Introduction

After completing secondary education, usually at the age of 16, students in England are required to remain in education or training until their 18th birthday and can choose from a range of academic, technical, and vocational pathways. The most established academic route post-16 is the A Level route, typically involving the in-depth study of three subjects over two years and being the primary form of entry to higher education. Alternatively, students can pursue T Levels,[1] apprenticeships, or a range of vocational and applied qualifications (e.g., BTECs and Cambridge Technicals).

One of the purposes of education is to support young people's progression to further or higher education, training and employment. In England, the Department for Education (DfE) publishes destination measures that provide information about what young people do in the year after leaving post-16 study (e.g., DfE, 2026). While this information is useful, it only provides a general view of the short-term educational and labour market trajectories.

Research on longer-term post-16 education and labour market outcomes has been carried out using linked administrative data. This enables the tracking of students over time as they move through further and / or higher education and into the labour market. For example, Anderson and Nelson (2021a) provide a comprehensive analysis of the education and labour market activities followed by several cohorts of young people after completing secondary school in England.

Research on progression of students with different programmes of study post-16 and labour market returns to different qualifications has also been carried out to date (e.g., Conlon & Patrignani, 2015; Dearden et al., 2002; Espinoza et al., 2020; Hayward et al., 2014) using data from large-scale surveys or from cohort studies.

1 T Levels offer a technical alternative equivalent in size to three A Levels, combining classroom-based learning with a substantial industry placement usually aligned to specific occupational areas.

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However, although some of the above research focuses on programmes of study (vocational versus academic) or on certain subjects (e.g., STEM), research on progression and earnings of young people based on the specific qualifications achieved during post-16 study (e.g., A Levels, BTECs, Cambridge Technicals) and their performance on them (e.g., at least ABB at A Level; at least 136 UCAS points based on A Levels and other equivalent Level 3 qualifications) is scarce.

As mentioned earlier, A Levels are the most popular qualification taken by students post-16. The majority of A Level entries achieve good grades, with around 75 per cent graded A* to C every year (JCQ, 2026). A Levels are the most common route to get into higher education (HE) and most courses require specific A Levels (or combinations of A Levels) and a minimum level of performance on them. A Levels are also valued by employers because they can show a good level of knowledge and skills (UCAS, 2026).

However, not all A Level students achieve good grades and, every year, around 25 per cent of A Levels are graded D, E or U (JCQ, 2026).

What happens to students who leave school or college having done their A Levels but achieving only grades D, E or U? Are their opportunities for progression similar to those of students who get better A Level grades? Or are they similar to those of students who achieved alternative qualifications (e.g., vocational qualifications)? Do they have good progression outcomes and / or good labour market returns?

Understanding the post-16 destinations and future earnings of students with low attainment at the end of upper-secondary education provides critical evidence on whether existing qualifications support successful progression and good long-term outcomes, or whether targeted policy interventions may be needed to improve outcomes for this group.

The current research and its aim

This research investigates the education, training and employment destinations, as well as the labour market outcomes (i.e., earnings), of students who leave post-16 education with A Level grades that are typically regarded as having little currency (i.e., grades D, E or U).

As post-16 destinations can be shaped by factors beyond qualification outcomes, the research accounts for individual background characteristics (e.g., gender, average academic performance, socioeconomic status, ethnicity) in order to provide a more comprehensive assessment of progression and earnings.

Data

The research uses the Longitudinal Education Outcomes (LEO) data (DfE, 2024b), a database developed by the DfE. LEO connects individuals' education with their employment, benefits and earnings and includes the types of data shown in Table 1.[2]

2 See DfE (2024a) for information on the key parts of the LEO standard extract.

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Table 1: Types of data in the LEO database

Data type	Source	Availability[3]
School records	National Pupil Database (NPD)	2001/02 – 2020/21
Further education college and apprenticeship data	Individualised Learner Records (ILR)	2002/03 – 2020/21
Higher education records	Higher Education Statistics Agency (HESA)	2004/05 – 2019/20
Employment spells	His Majesty's Revenue and Customs (HMRC)	1997/98 – 2020/21
Earnings	His Majesty's Revenue and Customs (HMRC)	2003/04 – 2020/21
Self-assessment earnings	His Majesty's Revenue and Customs (HMRC)	2013/14 – 2020/21
Out of work benefits	Department for Work and Pensions (DWP)	1999/00 – 2020/21

For the current research, using the Key Stage 5 extracts of the NPD, we selected the students who achieved their A Level qualifications between 2004/05 and 2011/12 (eight cohorts) and we followed their education and labour market activities until 2019/20. Several years of data on education and labour market outcomes were available for each cohort. For example, students who achieved their A Levels in 2004/05 were 33 years old in 2019/20 and 15 years of education, employment and earnings data was available for them; students who achieved their A Levels in 2011/12 were 26 years old in 2019/20 and eight years of data were available for them. The number of years after completion of A Levels or other Key Stage 5 qualifications is referred to in this article as "Year 1", "Year 2", and so on.

Education data is centred on the academic year, which usually runs from 1 September to 31 August for schools and higher education and from 1 August to 31 July for further education. The employment, earnings, benefits and self-assessment data is structured around the tax year, which runs from 6 April to 5 April the following year. This makes it difficult to combine data from all the different sources. In this article, we have used the academic year for any analyses including education data (e.g., progression). For analyses not including any education data (e.g., earnings), we have used the tax year.

All data was accessed and used in line with the requirements of the organisations that administer these databases. This work was carried out in the Secure Research Service, part of the Office for National Statistics (ONS).

Students and their characteristics

The focus of this research was on students who achieved low grades in their A Levels, specifically on those with at least two A Levels and who achieved grades D, E or U[4] in all of them. Progression (e.g., to education and employment) and

3 Table 1 shows availability at the time the research was carried out. On 15 May 2026, a new release of LEO became available: this new iteration includes an update of benefits, earnings and tax data up to the financial year 2023/2024.

4 Students with grade U in all their A Level qualifications were excluded from the research.

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earnings for these students were compared to progression and earnings of other groups of students: students with two or more A Levels, all at grades C or above; and students with other Level 3 qualifications (i.e., BTECs).

Based on the above, students were classified in four mutually exclusive groups as follows:

- *A Level best grade E*: the student took at least two A Levels, and their best A Level grade was E (A Levels must make up at least 50 per cent of their qualifications)[5]
- *A Level best grade D*: the student took at least two A Levels, and their best A Level grade was D (A Levels must make up at least 50 per cent of their qualifications)
- *A Level grade C or above*: the student took at least two A Levels, and their worst A Level grade was not lower than C (A Levels must make up at least 50 per cent of their qualifications)
- *BTECs*: the student took at least two BTECs (any grades) and BTECs made up at least 50 per cent of their qualifications.[6]

Students not included in one of these groups were not considered in the research. This was done to have distinct groups of students and to allow for straightforward comparisons between the focus groups (A Level best grade E; A Level best grade D) and the comparator groups (A Level lowest C; BTECs). For example, A Level students who achieved one or more grades above a D and one or more grades below a C were not included in this research – such students would have grades which might be considered to have little currency but would also have A Levels with good grades, and it would have been impossible to isolate the effect of the lower A Level grades on progression or earnings.

For students in the groups above, background characteristics were available in the NPD, as follows:

- Gender[7] (male / female)
- Students' average academic performance (prior attainment) was measured by an average GCSE and equivalents point score.[8] This score

5 This was calculated based on measures of qualification size provided in the NPD.

6 BTECS were considered as an alternative qualification because they are the most popular Level 3 qualification taken at Key Stage 5 other than A Levels (Gill, 2013). BTEC grades are Pass, Merit, Distinction and Starred Distinction. The overall qualification can have one, two or three grades depending on its size (e.g., equivalent to one, two, or three A Levels). Deciding which grades to keep or exclude was not straightforward and the decision to consider all BTECs, independently of their grade, was made.

7 Throughout this article the word "gender" has been used instead of "sex". This approach was taken to follow the terminology used in the NPD extracts, which are the source of this data in the current research.

8 Points were assigned to grades (e.g., A* = 58, A = 52, B = 46, C = 40, etc.).

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was used to divide students into approximately equally sized groups: low, medium and high attainment. These terciles were based on the students included in the research only (that is, those in the four student groups above).

- The level of income-related deprivation (proxy for socio-economic background) that a student experienced was inferred using the Income Deprivation Affecting Children Index (IDACI).[9] As above, this measure was used to divide students into three approximately equally sized groups: low deprivation (more affluent), medium deprivation and high deprivation.
- Students were grouped into six ethnic categories: Asian (excluding Chinese), Black, Chinese, White, Mixed, or Other.
- Students were classified into three different groups according to whether they had a statement of special educational needs (SEN), special educational needs but no statement, or did not have special educational needs.
- Schools where students gained their Key Stage 5 qualifications were classified into three groups: state schools (which included selective and non-selective schools), independent schools, or colleges (sixth form colleges and further education colleges).

Some of the variables described above are collected as part of the annual school census, so they are primarily available only for students at state-maintained schools (which do not include independent schools or colleges). This can lead to missing data for some variables (e.g., IDACI deprivation, special educational needs or ethnicity).

Destinations

In a first step, for each academic year (up to a maximum of 15 years after completing Key Stage 5 as described earlier), students were assigned each of the following destination measures, using data from the ILR, from the HESA student records, and from the employment and out of work benefits extracts of the LEO data:

- *Being in sustained education*

  To be categorised as in sustained education, an individual needed to be in sustained further education (FE) or sustained higher education (HE), defined as follows:

  - Sustained further education: the individual appeared in the ILR aims data for at least one day in each of six consecutive months of the academic year.

9 For further information on IDACI see Smith et al. (2015).

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- Sustained higher education: the individual appeared in the HESA student records data for six consecutive months of the academic year.[10]

- *Being in sustained employment*

  An individual was counted as in sustained employment if they were recorded as being employed (for at least a day) in five out of the six months between October and March in the academic year (e.g., five out of six months between October 2010 and March 2011 for the academic year 2010/11). Only employment spells for those who pay tax through PAYE (Pay As You Earn)[11] were considered to record an individual as being in sustained employment.[12]

- *Claiming out of work benefits*

  An individual was counted as having sustained benefits if they were recorded as being on benefits (for at least a day) in five out of the six months between October and March in the academic year. Only out of work benefits were considered. The benefits classed as out of work for the analyses carried out in this research are listed in Anderson and Nelson (2021a, p. 8). They include, for example, Jobseeker's Allowance, Universal Credit and Pension Credit. Other benefits such as Statutory Sick Pay or Disability Living Allowance are not classified as out of work benefits and were not included here.

- *No sustained destination*

  The individual had some paid employment, participated in some learning (HE and / or FE) or claimed some out of work benefits, but did not fulfil the requirements of "sustained" destinations in any of these.

- *No destination identified*

  The individual was not found in any of the education, employment or benefits datasets for the year in question.

In a second step, for each academic year, each individual was assigned a main (or principal) destination based on their education and their labour market activity. Unfortunately, when an individual met the criteria for more than one destination in the same year, it is not possible to tell from the data which activity they spent more of their time on. Therefore, for such cases a hierarchical approach, as previously used by Anderson and Nelson (2021a), was applied:

10 The definitions for sustained further and higher education are slightly different in form due to the data available.

11 UK Government. (n.d.).

12 Self-employment was not included in the analyses reported in this article but was considered separately (see Vidal Rodeiro & Gill, 2025).

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- Education and employment: education was assigned to be the main destination.
- Education and claiming out of work benefits: education was assigned to be the main destination.
- Employment and claiming out of work benefits: claiming out of work benefits was assigned to be the main activity.

The focus of this article is on *progression to sustained education* and *progression to sustained employment*. For progression to other destinations, see Vidal Rodeiro and Gill (2025).

Earnings

For each individual, in each tax year (up to a maximum of 15 years), we calculated their average daily earnings.[13] This was done by taking their annual earnings reported in a given tax year and dividing by the number of days recorded in any employment spells in that same tax year.

Only people in sustained employment and with earnings greater than zero were included in the research. As it is not possible to identify which individuals were working part-time, this was intended to minimise the impact of including individuals who might be working part-time while studying.

As our data included several cohorts of individuals, their earnings were from different tax years. To be able to make year-on-year comparisons, we adjusted earnings from all years in line with the most recent tax year (2020/21). That is, all earnings are presented in terms of their equivalent value in 2020/21. To do that we used the Bank of England inflation calculator (Bank of England, 2026).

Methods

Destinations

In the first instance, descriptive statistics were produced to show young people's destinations. In particular, graphs showing the percentages of young people (among the groups of interest and the comparators) in each destination outcome, by year after completion of Key Stage 5 (labelled from "Year 1" to "Year 15"), were produced.

To further explore destination outcomes, taking into account the type of student (i.e., A Level best D, A Level best E, A Level lowest C, BTECs) and while controlling for students' backgrounds, multilevel logistic regression analyses (with students clustered within schools) were carried out. These focused on Year 1, Year 5 and Year 10 only, rather than on each year after completion of Key Stage 5.

The outcomes (dependent variables) in the regression models were as follows: progression to sustained education; progression to sustained employment.

13 The earnings data covered those individuals with records submitted through the PAYE system. As such, it did not include those who are self-employed.

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The principal destinations, as determined using Anderson and Nelson's (2021a) approach, were used.

The independent variables in the regression models included: the type of student, the gender of the student, the type of school attended during Key Stage 5, the student's level of deprivation, their prior attainment, an indicator of special educational needs, and the student's ethnicity. A variable indicating the Key Stage 5 cohort (e.g., 2004/05, 2005/06, etc.) was also included in the regression models to account for changes over time.

Earnings

As for the destinations analyses, descriptive statistics were produced in a first step, to show the average daily earnings of the different groups of students. In particular, graphs showing the median[14] daily earnings of young people by year after completion of Key Stage 5 (from Year 1 to Year 15) were produced.

In a second step, we carried out regression analyses to further explore the relationship between earnings and the different groups of students. Specifically, multilevel linear regression models for the earnings measure (daily earnings) were fitted. Note that we used the logarithm of the daily earnings as the dependent variable instead of the daily earnings, to account for the fact that the earnings data had a right-skewed distribution. A log-transformation can help make the data more normally distributed, improving linearity, and facilitating easier interpretation of coefficients as percentage changes.

The regression models controlled for the students' background characteristics, including the student group (i.e., A Level best D, A Level best E, A Level lowest C, BTECs), and had students clustered within schools. A variable indicating the Key Stage 5 cohort (e.g., 2004/05, 2005/06, etc.) was included in the regression models to investigate whether there were changes in daily earnings over time. As above, regression analyses were carried out for Year 1, Year 5 and Year 10.

Findings

Table 2 presents the total number of students included in the research by year of Key Stage 5 completion. The percentages of students in each of the four student groups are also reported. The smallest percentages of students were in the A Level best E and A Level best D groups. The percentages in these groups decreased over time, from 13.9 to 7.7 per cent for A Level best D and from 3.8 to 1.5 per cent for A Level best E. However, as the overall number of students increased significantly over time, the numbers of students in the A Level best D group was very similar in 2011/12 (17 933) and in 2004/05 (17 873), despite the change in the percentage. The number of students in the A Level best E group decreased from 4 839 to 3 384 in the same time period.

14 We have used the median instead of the average (or mean) as the earnings data had outliers (e.g., fairly high or low daily earnings) and the median is less susceptible to such extreme values.

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By far, the largest group of students in each year was A Level at grades C and above (over 60 per cent in each year). However, the percentage in this group decreased steadily over time, down from 69.3 to 60.0 per cent in 2011/12. There were, on the contrary, increasing numbers of students with BTECs over time: percentages increased from 12.9 per cent in 2004/05 to 30.8 per cent in 2011/12.[15]

Table 2: Students in each group, by Key Stage 5 cohort

Year	Students (N)	A Level C and above (per cent)	A Level best D (per cent)	A Level best E (per cent)	BTECs (per cent)
2004/05	128 166	69.3	13.9	3.8	12.9
2005/06	155 719	65.8	12.8	3.4	17.9
2006/07	163 325	64.8	11.3	2.9	21.0
2007/08	172 442	64.9	10.3	2.4	22.4
2008/09	184 118	64.0	8.9	2.0	25.1
2009/10	200 916	62.1	8.3	1.8	27.9
2010/11	209 479	62.1	7.6	1.5	28.8
2011/12	232 211	60.0	7.7	1.5	30.8

Destinations

Figure 1 and Figure 2 show the percentages of students in each destination (i.e., education and employment, respectively) in Year 1 to Year 15 after completing Key Stage 5, by the type of student.

Figure 1 shows that, as one might expect, in the first few years, the students with low A Level grades (best grade E) had the lowest progression to sustained education (for example, 47 per cent in Year 1 and 51 per cent in Year 2) while students with better grades (best grade D and lowest grade C) progressed to sustained education at higher rates (56 and 76 per cent in Year 1 and 61 and 89 per cent in Year 2, respectively). However, after Year 3, progression to sustained education decreased for all groups of students and by Year 6 rates were very similar, independently of A Level performance.

A Level students with low grades (best grade E) had lower progression to sustained education in the first three years after completing Key Stage 5 than BTEC students, but not from Year 4 onwards.

15 This reflects the increased popularity of Applied General qualifications (which include BTECs) in the period of study. See, for example, Gill (2013) for details on the uptake of Level 3 qualifications in English schools between 2008 and 2012.

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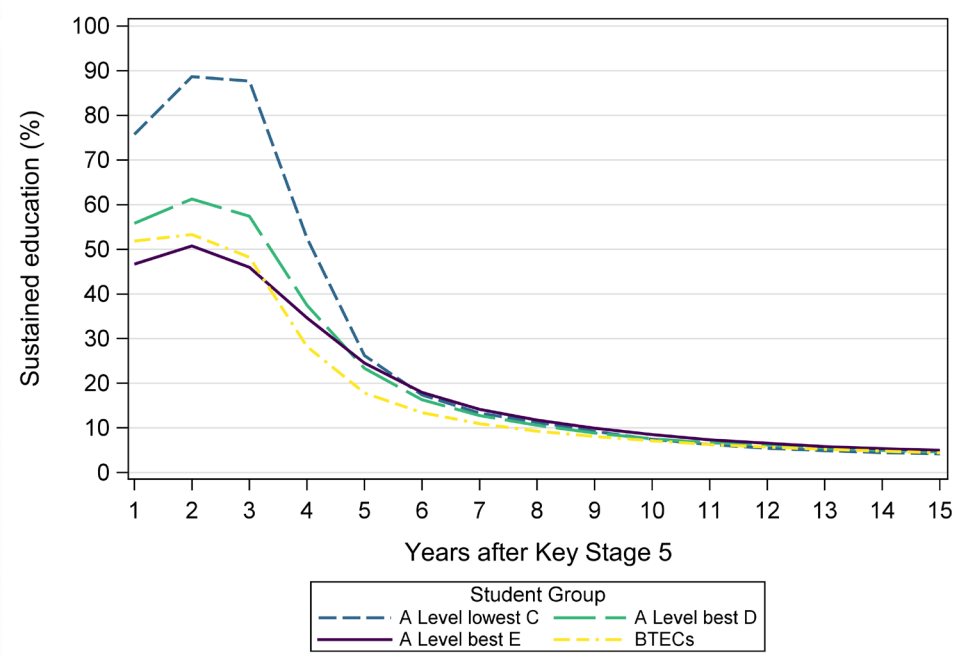

Figure 1: Percentages of students (all cohorts combined) in sustained education after completing Key Stage 5 (Year 1 to Year 15), by type of student

Regarding progression to sustained employment, Figure 2 shows the opposite pattern, with the students with low A Level grades (best grade E) having the highest progression to sustained employment in the first few years after completing their post-16 study (followed very closely by students with BTEC qualifications) and those with the best A Level grades (lowest C) having the lowest. However, after six or seven years, the likelihood of being in sustained employment was fairly similar for all types of students.

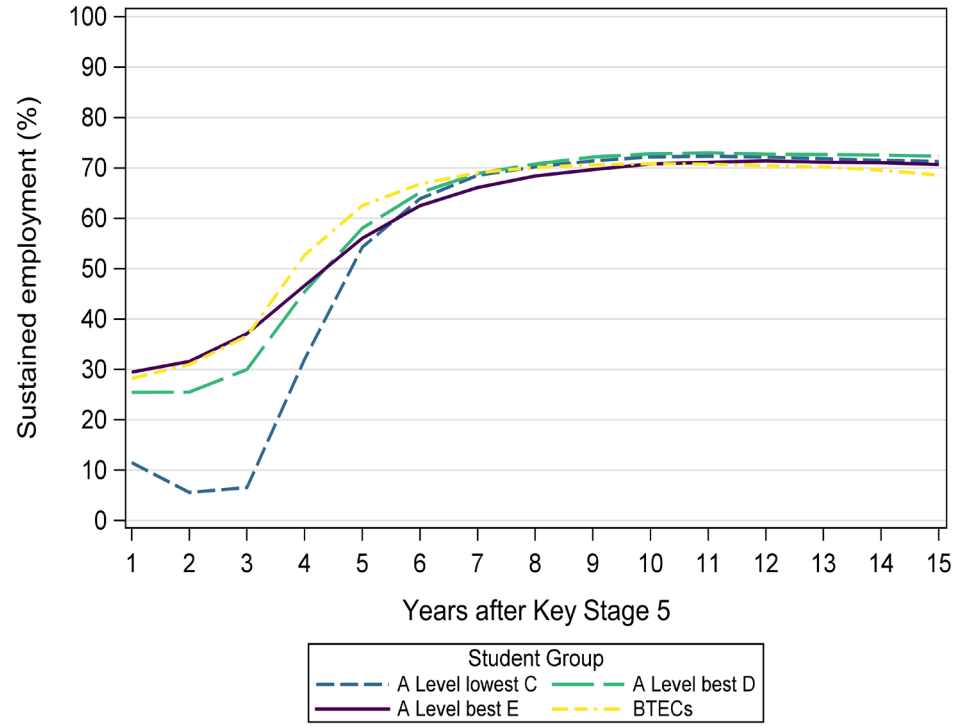

Figure 2: Percentages of students (all cohorts combined) in sustained employment after completing Key Stage 5 (Year 1 to Year 15), by type of student

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We further explored progression to education and employment in Year 1, Year 5 and Year 10, using regression analyses to control for students' backgrounds.

Table 3 presents the parameter estimates for the student categories in each of the years (full results from the regression models are available from the authors upon request). These estimates show the effect of the predictor (student category) on the probability of the outcome (progression to sustained education) occurring, expressed on a logit scale. Positive coefficients indicate an increased probability relative to the reference group (A Level students with a best grade of E) and negative coefficients indicate reduced probabilities. The last column of the table shows the probability of progression for a "typical" student[16] – for example, a typical A Level student with a lowest grade of C had a 78.1 per cent probability of being in sustained education one year after completing Key Stage 5.

From Table 3 we can see that:

- In Year 1, the probability of progression to sustained education was significantly higher for each of the student categories compared to the reference group (A Level students with a best grade of E), once their background characteristics were accounted for.
- In Year 5, the probability of being in sustained education was similar for the students with A Level qualifications but there was a larger difference between students who achieved BTEC qualifications and those with a best grade of E in their A Levels: students with BTECs were notably less likely to progress.
- In Year 10, the probability of being in sustained education was significantly lower for each of the student categories compared to the reference group (A Level students with a best grade of E). In particular, students with BTEC qualifications had the lowest probability of progression in Year 10, followed by students in the A Level lowest C group. However, it should be noted that the differences between the different types of students, although statistically significant, were generally small.

16 This is the probability of progression for a typical student who completed Key Stage 5 in the academic year 2009/10 (female, White, in the medium deprivation group, with medium prior attainment, no special educational needs and in a state school during Key Stage 5).

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Table 3: Progression to sustained education in Years 1, 5 and 10 – regression parameter estimates for the student categories

Year	Student category	Estimate	Standard error	*p*-value	Probability of progression
1	A Level lowest C	1.263	0.012	<.0001	0.781
	A Level best D	0.369	0.013	<.0001	0.593
	BTECs	0.306	0.013	<.0001	0.578
	[A Level best E]	.	.	.	0.502
5	A Level lowest C	-0.096	0.014	<.0001	0.190
	A Level best D	-0.051	0.014	0.000	0.197
	BTECs	-0.332	0.015	<.0001	0.156
	[A Level best E]	.	.	.	0.205
10	A Level lowest C	-0.193	0.024	<.0001	0.075
	A Level best D	-0.132	0.025	<.0001	0.079
	BTECs	-0.270	0.025	<.0001	0.070
	[A Level best E]	.	.	.	0.089

As for progression to sustained education, we looked at progression to sustained employment in Year 1, Year 5 and Year 10, by student category and accounting for students' background characteristics. Table 4 presents the parameter estimates for the student categories in each of the years and the probability of progression for a typical student[16] (full results from the regression models are available from the authors upon request) and shows that:

- In Year 1, the probability of progression to sustained employment was significantly lower for each of the student categories compared to the reference group (A Level students with a best grade of E), once their background characteristics were accounted for. The lowest probability of progression was, by far, that of the A Level lowest C group.
- In Year 5, the probability of progression to sustained employment was similar for the students with A Level qualifications but there was a larger and statistically significant difference between students who achieved BTEC qualifications and those with a best grade of E in their A Levels: students with BTECs were significantly more likely to progress.
- In Year 10, the probability of progression to sustained employment was significantly higher for each of the student categories compared to the reference group (A Level students with a best grade of E) and, in particular, students with BTECs were the most likely to progress to sustained employment.

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Table 4: Progression to sustained employment in Years 1, 5 and 10 – regression parameter estimates for the student categories

Year	Student category	Estimate	Standard error	*p*-value	Probability of progression
1	A Level lowest C	-1.123	0.014	<.0001	0.138
	A Level best D	-0.227	0.014	<.0001	0.281
	BTECs	-0.176	0.014	<.0001	0.291
	[A Level best E]	.	.	.	0.329
5	A Level lowest C	-0.001	0.012	0.927	0.674
	A Level best D	0.044	0.013	0.001	0.684
	BTECs	0.200	0.013	<.0001	0.717
	[A Level best E]	.	.	.	0.675
10	A Level lowest C	0.090	0.015	<.0001	0.764
	A Level best D	0.088	0.015	<.0001	0.763
	BTECs	0.103	0.016	<.0001	0.766
	[A Level best E]	.	.	.	0.747

Earnings

In this section, the earnings of students in the different student categories in the period of study are presented. Figure 3 shows the median daily earnings in Years 1 to 15 following completion of their Key Stage 5 studies, for students in the different groups.

In the first few years, the students with low A Level grades (best grade E or best grade D) had the highest median daily earnings. However, after Year 5, students with better grades (lowest grade C) had a higher median, with this advantage increasing over time. By Year 6, the difference was around £10 per day, rising to around £20 per day after 10 years. In Year 15, the median daily earnings was over £100 for A Level lowest grade C students, compared with £80 for A Level best grade D, around £75 for A Level best grade E, and just over £70 for BTEC students.

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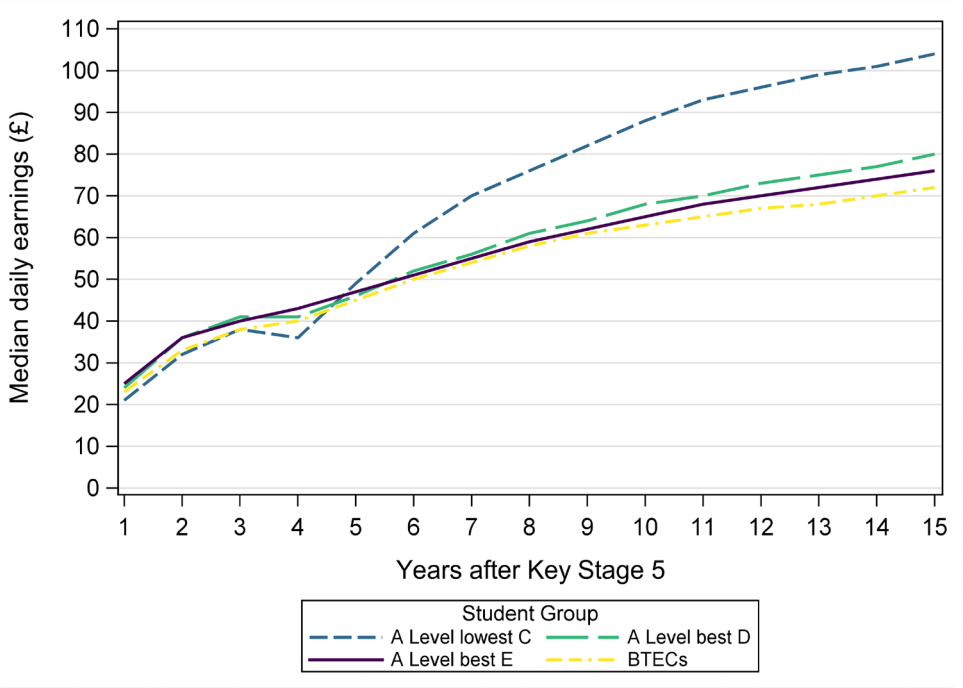

Figure 3: Median daily earnings after completing Key Stage 5 (Year 1 to Year 15), by type of student (all cohorts combined)

As with the students' destinations, we further explored earnings via regression analyses. In particular, we looked at earnings in Year 1, Year 5 and Year 10, by student category and accounting for students' background characteristics. Table 5 presents the parameter estimates for the student group variable in each of the regression models. Full outputs of the regression analyses are available from the authors upon request.

The parameter estimates in Table 5 represent the changes in the log of the daily earnings compared to the reference group (A Level students with a best grade of E). This makes them hard to interpret directly. However, if we take the exponential of the estimates, the interpretation of the new value is the multiplicative factor due to being in each category compared with the reference category. For example, in Year 1 the exponentiated value of the estimate for the A Level lowest C group is 0.90. This means that students in this group were predicted daily earnings which were 10 per cent lower than the reference group. Furthermore, since all the parameter estimates are values close to zero, the exponential will be approximately equal to 1 plus the original coefficient. Thus, the estimates themselves can approximately be interpreted as percentage increases and decreases in earnings associated with different student background characteristics (compared to the reference group).

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Table 5: Daily earnings in Years 1, 5 and 10 – regression parameter estimates for the student categories

Year	Student category	Estimate	Standard error	*p*-value	Multiplicative factor
1	A Level lowest C	-0.105	0.009	<0.001	0.90
	A Level best D	-0.013	0.009	0.132	0.99
	BTECs	-0.031	0.009	0.007	0.97
	[A Level best E]	.	.	.	.
5	A Level lowest C	-0.038	0.006	<0.001	0.96
	A Level best D	-0.014	0.006	0.017	0.99
	BTECs	-0.031	0.006	<0.001	0.97
	[A Level best E]	.	.	.	.
10	A Level lowest C	0.190	0.005	<0.001	1.21
	A Level best D	0.034	0.005	<0.001	1.03
	BTECs	0.009	0.005	0.072	1.01
	[A Level best E]	.	.	.	.

Table 5 shows that:

- In Year 1, there were significant differences in earnings by student group. In particular, students in the A Level lowest C group and the BTECs group were predicted significantly lower earnings than students in the reference group (A Level best E). A Level lowest C students were predicted earnings 10 per cent lower than the A Level best E group and the BTECs group were predicted earnings 3 per cent lower.
- In Year 5, all three student groups were predicted significantly lower earnings than the reference group, but the differences were small (between 1 and 4 per cent).
- By Year 10, the pattern was reversed, with all groups of students apart from those with BTECs predicted significantly higher earnings than students with the lowest A Level grades. This was particularly the case for the A Level lowest C group, who were predicted 21 per cent higher earnings than the reference group.

It is worth noting that, in all years, there were only very small differences in the earnings for those in the A Level best D group compared to the A Level best E group (even though some were statistically significant).

Summary and conclusions

This research looked at the education and employment destinations as well as the labour market outcomes (i.e., earnings) of almost 1.5 million young people who completed Key Stage 5 between 2005 and 2012, with a focus on those who achieved low grades (grades D, E or U) in their A Level qualifications.

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Destinations

The destinations of students who finished post-16 education with low A Level grades differed from those of students who achieved better grades or obtained BTEC qualifications.

In the first few years after completing post-16 education, students with low A Level grades (best grade E) were the least likely to progress into sustained education but were the most likely to enter sustained employment, with BTEC students showing a similar pattern just behind them. By contrast, students with higher A Level grades were more likely to remain in education and less likely to move directly into employment, even after accounting for background characteristics. This in not unexpected, as students with good A level grades are likely to enrol in higher education courses and, therefore, less likely to be in sustained employment in the short term.

Over time, however, these differences became less pronounced. After around six or seven years, the likelihood of being in sustained education or employment was broadly similar across all groups of students. By Years 5 and 10 in particular, progression to both sustained education and sustained employment showed little variation among A Level students, regardless of their grade outcomes.

Earnings

Median daily earnings increased over time for all student groups as the number of years since completing Key Stage 5 increased. However, although higher grades at A Level led to lower earnings in the short term, they were associated with better labour market outcomes in the longer term.

In the first four years after completing Key Stage 5, the lowest median daily earnings were in the A Level lowest C group, and in Year 1 both students in this group and students with BTECs earned significantly less than students in the A Level best E group. However, from Year 6 onwards students in A Level lowest C group had the highest median daily earnings.

By contrast, there were only very small differences in the earnings for those in the A Level best D group compared to the A Level best E group. This suggests that getting grade Ds rather than grade Es at A Level does not increase earnings much.

Overall, 15 years after completing Key Stage 5, the gap in median daily earnings between the highest performing (lowest grade C) and lowest performing (best grade E) A Level groups amounted to £28 per day, equivalent to an annual difference of approximately £10 220.

Limitations

There were a few limitations to the LEO data when used to look at young people's destinations and labour market outcomes in the context of the research presented in this article. Some of them are briefly discussed below.

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1. The LEO data combines information from several administrative sources that require matching across individuals. For example, not all Key Stage 5 records could be matched to employment or learning data.[17] This could affect the magnitude of our estimates if different types of individuals are more or less likely to be observed in the data, albeit the impact is likely to be small.

2. When an individual met the criteria for more than one destination in the same year, the nature of the data did not allow us to determine in which destination they spent most of their time. A main destination was therefore assigned following the hierarchy described in Anderson and Nelson (2021a) which, for a minority of individuals, might not actually reflect the main activity during that year.

3. The employment and earnings data comes from records submitted through the Pay As You Earn (PAYE) system, which can likely be subject to data entry and processing errors. As a result, even though we cleaned the data as far as was possible, there is a risk that some errors remained.

4. There is no information on hours worked so analysis might under-estimate the earnings of part-time workers compared to full-time workers. This is a particular concern for women, who are more likely than men to work part-time (Francis-Devine et al., 2026).

5. Although we requested the most recent data available, there is a long delay associated with earnings and employment data becoming available in LEO.

6. A final limitation relates to the regression models used to investigate students' destinations and earnings. Even if an association is found between the independent variables in our models (e.g., performance in Key Stage 4, gender, school type, ethnicity) and the predictor variable of interest (e.g., being in sustained education, daily earnings), we still cannot be sure of a causal relationship. There may be other factors which we cannot measure but which are important in determining the likelihood of progression or having a particular level of earnings.

Conclusions and implications

Within the above limitations, the outcomes of this work provide evidence of the need for policy decision-making which improves the destinations and labour market outcomes of students who finish school with low A Level grades.

The research has indicated that individuals in their early thirties who had achieved A Levels which might be considered to have little currency have worse labour market outcomes than their peers who achieved good grades (A Level lowest C), after controlling for their background characteristics and educational attainment at age 16. However, we must consider that we are measuring earnings

17 For details on how the data from the different sources is matched to create the LEO extracts, see Anderson and Nelson (2021b).

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fairly early in their careers. It might be worth updating this work when the LEO data includes employment and labour market outcomes in later years.

There are several **implications** from the research, which are summarised below.

Firstly, although differences in destinations between the different groups of students (A Level lowest C, A Level best D, A Level best E, BTECs) narrowed over time, there were early disparities especially in progression to sustained education. This highlights the importance of targeted support for students with low A Level grades during the transition from post-16 education.

Secondly, the research showed that after the first few years, the students with "good" A Level grades had the highest earnings and that this advantage increased over time. Therefore, although achievement at Key Stage 5 may not yield immediate financial returns, it is strongly associated with better long-term labour market outcomes. Policy makers should take a long-term perspective when evaluating the value of post-16 qualifications and attainment, recognising that its benefits may not be immediately visible in early labour market outcomes.

Thirdly, there were very small differences in the average earnings of those in the A Level best D and A Level best E groups. Based on this, improving from an E to a D grade does not seem to provide much benefit.

Finally, in comparison with BTEC students, the findings indicate that individuals with lower A Level grades (best grade E) tended to achieve similar earnings over time (while there were early disparities, these narrowed over time), despite some BTEC students having higher prior attainment. The research also highlights that it remains possible for students with low A Level grades to secure well-paid employment.

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Data literacy: Exploring secondary school teachers' perspectives and skills

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Introduction

Assessment providers are also data providers, with a responsibility to facilitate the use of data in teachers' data-driven decision-making. As data-driven decision-making is often culturally embedded in schools, to thrive in that environment teachers need strong data literacy skills. However, there is limited research evidence about whether teachers, who are expected to use and interpret often complex assessment data tables and visualisations, have the data literacy skills and training to do so effectively. Therefore, it is important that data providers reflect on the skills of their users and consider how to best present them with assessment data. This article reports the findings from a study that explored the data literacy skills of secondary school teachers in England, particularly how they interpret and use assessment data in schools.

Understanding what it means to be data literate in schools is critical for determining educators' data literacy skills and identifying areas for development and support. There is no agreed definition of data literacy that applies to all contexts (Ghodoosi et al., 2023). In education, Mandinach and Gummer's (2016) definition of data literacy for teachers is widely cited and is the definition used in our study:

> "Data literacy for teaching is the ability to transform information into actionable instructional knowledge and practices by collecting, analyzing, and interpreting all types of data (assessment, school climate, behavioural, snapshot, longitudinal, moment-to-moment, etc.) to help determine instructional steps." (p. 367)

Mandinach and Gummer (2016) stressed that data literacy for teachers was not simply data analysis: contextual understanding, data handling and analytical skills, evaluation and critical thinking are all required components to enable effective decision-making from data.

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Critically, in the context of educational assessment, statistical literacy and assessment literacy underpin data literacy. This view is supported by Ghodoosi et al. (2023), who determined that numeracy and statistical literacy are necessary building blocks for data literacy, but that data literacy is a broader competence, combining quantitative reasoning, critical thinking, contextual interpretation, ethical judgement and evidence-based decision-making. Cowie and Cooper summarise this relationship succinctly: "data literacy … subsumes assessment literacy, which relates to student assessment data specifically" (2017, p. 148).

Moving beyond definitions and into practice, we need to understand what terms like "analysing" and "interpreting" really mean in an educational context. Pierce and Chick (2011) summarised the crucial tasks and skills involved in handling school assessment data into a three-level framework. Each level increases in complexity and is dependent on the preceding levels. Pierce et al. (2014) described the levels as follows:

a. "Reading values involves understanding features … together with the capacity to read specific data points … These features are, usually, explicit components of the data as presented in a report or similar" (p. 198).

b. "Comparing values … involves awareness of relative and absolute differences, early informal inference, and low-level statistical tools" (p. 198).

c. "Analyzing the data set, involves being able to consider the data as a whole entity: observing and interpreting variation, trends, and changes with time or other variables; and attending to the significance of results" (p. 198).

These skills are surrounded by the context needed for *interpreting* the data (Pierce et al., 2014). There are two, potentially overlapping, context components: the *professional* context that "concerns information relevant to the profession and needed to interpret the data set", and the local context that "comprises knowledge about the situation or context that gave rise to the data that are not evident in the data set alone" (p. 199).

The importance of these skills for schools in England is apparent. The Teachers' Standards (DfE, 2011) state that schools and teachers should use assessment data for monitoring progress, setting targets and planning lessons. Assessment and performance data are used to inform teaching and learning and determine interventions. Schools also monitor safeguarding, attendance and behavioural data, with data contributing to regulatory school inspection processes (Morris-King & Howe, 2025). With a significant flow of data like this, it becomes important that staff can read, compare and analyse it within their local and professional context so that it can be used accurately and effectively in decision-making.

Research indicates that while teachers value data literacy skills, they may struggle to comprehend data, describe progress monitoring graphs, extract relevant information from graphs and link data to instructional changes (Filderman et al., 2021). One study discovered a disconnect between perceived capability and true capability: while most teachers felt they could interpret the data they received, very few were able to answer correctly when tested on their

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interpretation of educational assessment graphs (Chick & Pierce, 2013). Teachers with higher levels of statistical literacy are likely to be more positive about using data and perceive there to be fewer barriers to using it (Pierce et al., 2014). Means et al. (2009) suggested that teachers would benefit from training, coaching and structured support when analysing and using data to inform changes in their instructional practice.

Other studies have considered the impact of self-reported confidence on data literacy. It has been suggested that data analysers' confidence is affected by perceived knowledge gaps – the difference between analysers' knowledge and the knowledge required to complete analysis tasks – and uncertainties within the task (Musleh et al., 2025). Low levels of confidence in mathematical skills can impact on motivation to complete data tasks or to learn how to do so (Cowie & Cooper, 2017). Additionally, understanding that confidence with the many subskills comprising data literacy might vary could be key to understanding how far a person might be able to progress with their data tasks (Kim et al., 2025).

Training might positively impact on confidence and yet, the literature suggests that data literacy training for teachers around the world remains "inconsistent, neither systematic nor official" (Brazauskienė & Melnikova, 2024, p. 20). This is perhaps because teacher training courses tend to focus more on assessment literacy than on data literacy (Cowie & Cooper, 2017). However, studies have also suggested that data literacy skills can be acquired when instruction on these skills is included within teacher training courses, or they can be developed later through professional development programmes (e.g., Cui & Zhang, 2022; Filderman et al., 2021).

This section has considered the meaning of data literacy and explored some of the previous research in this area. This study investigated the data literacy of secondary school teachers in England, in particular the way teachers interact with data provided by Cambridge Insight[1] about student test results. The Cambridge Insight datasets provided to teachers report standardised scores, confidence intervals, and residuals – metrics that tend to be less familiar to teachers more accustomed to handling exam-related data. Cambridge Insight offers training and support to new users to understand these metrics, but limited research has been conducted to understand how data literacy skills in teachers might impact on their ability to use and engage with such data. This study aims to contribute to the exploration of teachers' data literacy, considering how teachers understand and interact with assessment data, particularly when encountering less familiar metrics.

1 Cambridge Insight, part of Cambridge University Press & Assessment, develops baseline assessments to report on students' capability in literacy, numeracy and non-verbal ability.

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Research aim

In this article, we explore data literacy among a sample of teachers in a bid to understand:

- How important data literacy is for teachers
- What data literacy training teachers have and need
- How teachers use and interpret data
- How confident teachers are in interpreting data

Method

Our study was carried out in two stages:

1. A questionnaire to collate a broad picture of data use, responsibility and confidence;
2. An interview to investigate the ways in which teachers interact with different types of data, including some exemplar Cambridge Insight reports.

We generated ideas for the questions using findings from reviewing the literature and our knowledge of areas of data literacy that would be of interest to Cambridge Insight. Questions were allocated to the questionnaire or interview depending on which format they were most suited to. The remainder of the Method section describes the research process for the questionnaire and interview.

Questionnaire

Design

We drafted the questionnaire from the initial question ideas. Most questions were multiple choice, but some free-text responses were also included. Areas covered (in order) were participants' background including teaching role and highest maths qualification (to discover what mathematical / statistical skills they had), data responsibilities, understanding of data literacy, importance of data literacy, data literacy training, interactions with different datasets, and confidence in using data.

After providing their understanding of data literacy, questionnaire respondents were shown this simplified version of Mandinach and Gummer's (2016) definition to ensure they had a common understanding of it before answering further questions:

> "Data literacy for teaching is the ability to collect, analyse and interpret all types of school-related data and use it to inform teaching and learning knowledge and practices."

Three questions about respondents' interactions with data were informed by Pierce and Chick's (2011) framework. One question asked who analysed different types of data (e.g., assessment, attendance). The second of these questions asked whether respondents read and compared values, and used context to interpret data in tables. The third question was identical to the second but asked about

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charts and graphs rather than tables. At the end of the questionnaire, respondents were asked to provide their contact details if they were interested in taking part in a follow-up interview.

The questionnaire was reviewed by a colleague with a background in data literacy. It was delivered on an online survey platform.

Recruitment

Questionnaire participants were recruited through emails to secondary school teachers in England who indicated that they would be interested in taking part in future Cambridge Insight research, and by advertising the questionnaire at OCR and Cambridge Insight events, in their newsletters and in social media posts. This recruitment strategy means that our sample is likely to have included some teachers with experience of using Cambridge Insight tests and some without.

We received 55 responses to the questionnaire. Of these, 15 respondents did not finish the questionnaire so their responses were removed from the analysis.

Twenty-two responses were from classroom teachers. Twelve were from teachers in middle leadership roles (ML), for example heads of subject or year. The remaining six were from teachers in senior leadership teams (SLT), for example, headteachers, and assistant headteachers. Fifteen respondents taught STEM[2] subjects. Just over half the respondents (21) stated that their highest mathematical qualification was GCSE (or equivalent) (Figure 1).

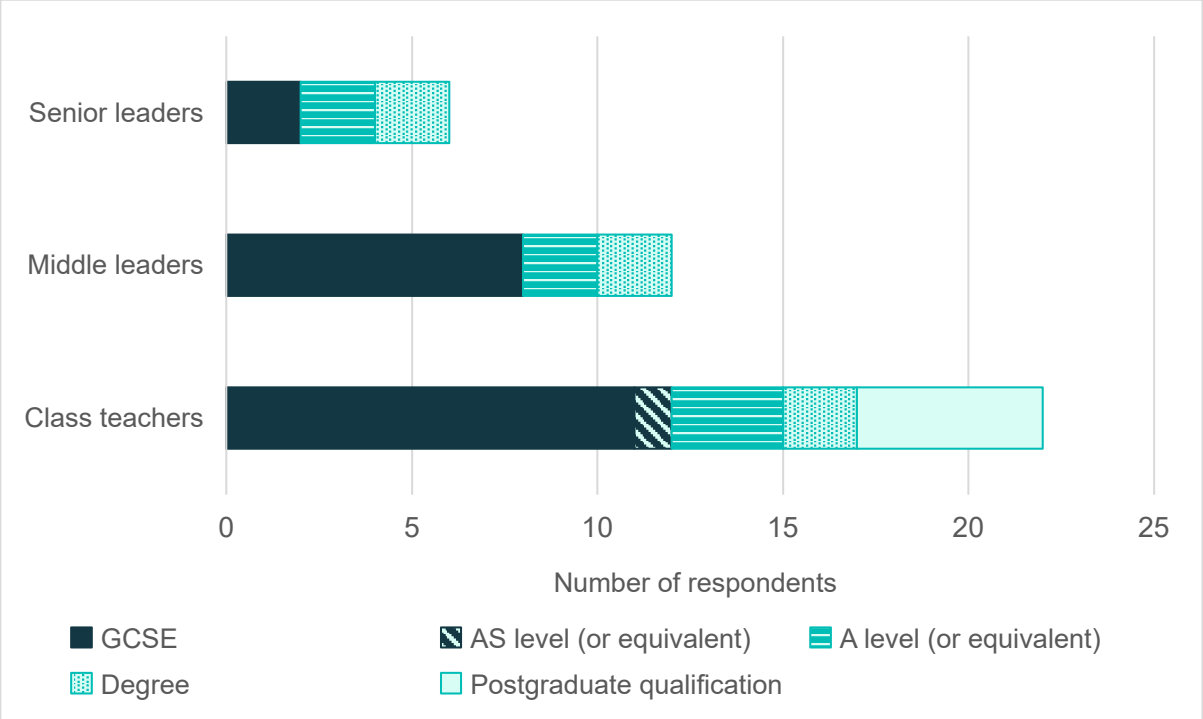

Figure 1: Questionnaire respondents' highest mathematics qualification

2 STEM subjects are those in the science, technology, engineering and mathematics domains.

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Analytical approach

The dataset containing all the responses was downloaded from the survey platform, and the contact information was removed from the dataset and stored separately. The remaining data was analysed using a mixed-methods approach. The multiple-choice questions were analysed using descriptive statistics. For the free-text questions, a series of hierarchical codes were established to describe the main features of the responses.

Interview

Design

The interview schedule focused on teachers' interactions with data and their confidence in interacting with it. The draft interview schedule was reviewed by a colleague with a data literacy background. The interviews were carried out on Microsoft Teams.

We showed participants three data representations, taken from Cambridge Insight reports, to investigate their interactions with data: a predictions table for individual students across a range of subjects, a chart showing an individual student's progress in five tests over time, and a school value added chart showing the difference between predicted performance and attainment for a cohort of students at one school. For each data representation, interviewees were asked whether they were familiar with this type of table or graph and were given an explanation if they were not. They were then asked: what the dataset showed; to identify and explain any interesting data points within it; what conclusions they could draw from it; and what actions they might take after seeing it.

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Predictions table

The predictions table (Figure 2) shows: the standardised scores on Cambridge Insight's Yellis assessment[3] (5th column) for nine fictitious students from one class;[4] the ability band from A (highest) to D (lowest) that their score fell into (6th column); and their predicted GCSE grades[5] in a range of subjects based on those scores (column 7 onwards). It would normally be possible to sort the columns in this table, but we showed interviewees a static image. We expected that most interviewees were likely to be familiar with this style of data presentation and most of the table's contents.

Forename	Surname	Gender	Class	Std. Score	Band	(9-1) Art & design	(9-1) Biology	(9-1) Business studies	(9-1) Chemistry	(9-1) Computer science	(9-1) Design & technology	(9-1) Drama	(9-1) English	(9-1) English literature
EDITH	EIGHTEEN	Female	CEM10	87	D	4.3	3.9	3.2	3.9	2.2	3.6	3.9	3.6	3.7
IBRAHIM	FIFTEEN	Male	CEM10	94	C	4.8	4.6	4	4.6	3.1	4.2	4.5	4.3	4.4
DARCIE	FOUR	Female	CEM10	105	B	5.5	5.8	5.2	5.7	4.5	5.3	5.5	5.3	5.4
JACKSON	FOURTEEN	Male	CEM10	129	A	7.1	8.2	7.8	8.1	7.3	7.5	7.5	7.4	7.6
ELOISE	NINETEEN	Female	CEM10	123	A	6.7	7.6	7.2	7.5	6.7	7	7	7	7.1
MYLA	ONE	Female	CEM10	120	A	6.5	7.3	6.9	7.2	6.3	6.7	6.8	6.7	6.8
TOBIAS	SIX	Male	CEM10	123	A	6.7	7.6	7.2	7.6	6.7	7	7.1	7	7.1
FATIMA	TWENTY	Female	CEM10	120	A	6.5	7.3	6.8	7.2	6.3	6.7	6.7	6.7	6.8
AMELIE	TWO	Female	CEM10	109	B	5.7	6.1	5.6	6.1	4.9	5.6	5.8	5.6	5.7

Figure 2: Predictions data table from Cambridge Insight's Yellis assessment

3 Note that since this research was carried out, the Yellis assessment has been renamed as Cambridge Secondary Insight (Baseline) (14–16).

4 The 4th column shows the name of the school class the students were in – for the research, the fictional name "CEM10" was used.

5 GCSEs are a qualification for 16-year-olds in England. They are graded from 1 (lowest pass grade) to 9 (highest grade).

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Individual student's progress chart

The individual student's progress chart (Figure 3) shows one primary-aged student's progress in five test modules: mathematics, arithmetic, reading, spelling and developed ability[6] skills. These modules were tested several times between the ages of 6.5 and 11. We expected that interviewees were likely to be reasonably familiar with this style of data presentation. It is important to note that we have changed the line colours and formats for this article to aid accessibility, but the placement of the lines and data points has not been changed.

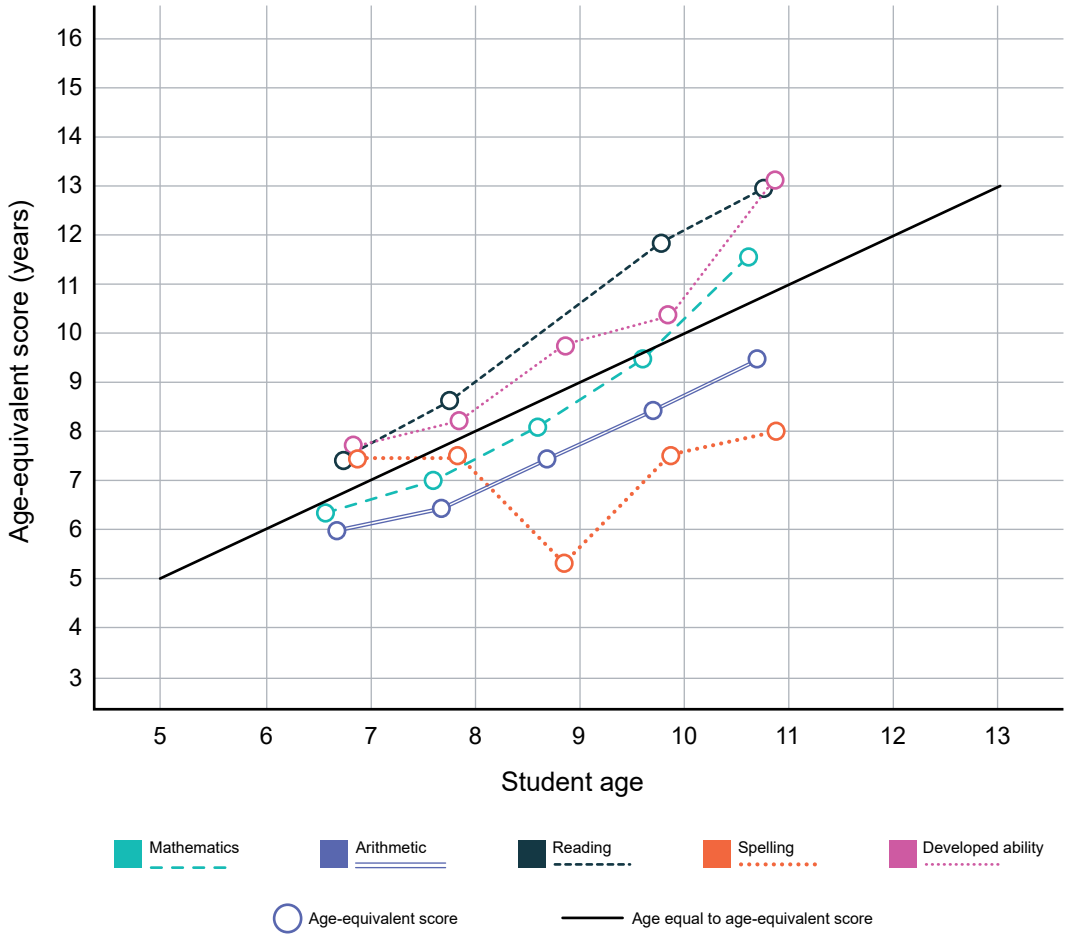

Figure 3: Progress tracking chart for one student from Cambridge Insight's primary assessment

6 Developed ability is a general measure of ability based on non-verbal tests, for example, recognising patterns.

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School value added chart

The school value added chart (Figure 4) shows how the predictions for GCSE results in particular school subjects for students at a certain school (based on Cambridge Insight tests) compared to achieved GCSE results. The chart reports "average residuals" – the "gap" between predicted and achieved results. It was technically the most complex data we shared with interviewees and was chosen because some schools had found it difficult to interpret. We expected that interviewees were likely to be unfamiliar with this style of data.

The individual bars in the centre of each subject show the difference between the predicted grades for students in the school and the grades they actually achieved. Bars that fall within the dark blue shading (for the 95 per cent confidence limit) represent a result that is not (statistically) significantly different from zero (i.e., the results are not considered to be different from the predictions). Any bars outside that area, including bars in the light blue shaded area, represent a result that is statistically significant (i.e., the results are considered to be different from the predictions), where the difference may be caused by factors such as teaching and learning. For example, the results for English fall within the darker blue area, which shows students' results were within the predicted range; however, the bar for biology extends into the light blue area, which shows that the students' results were better than predicted.

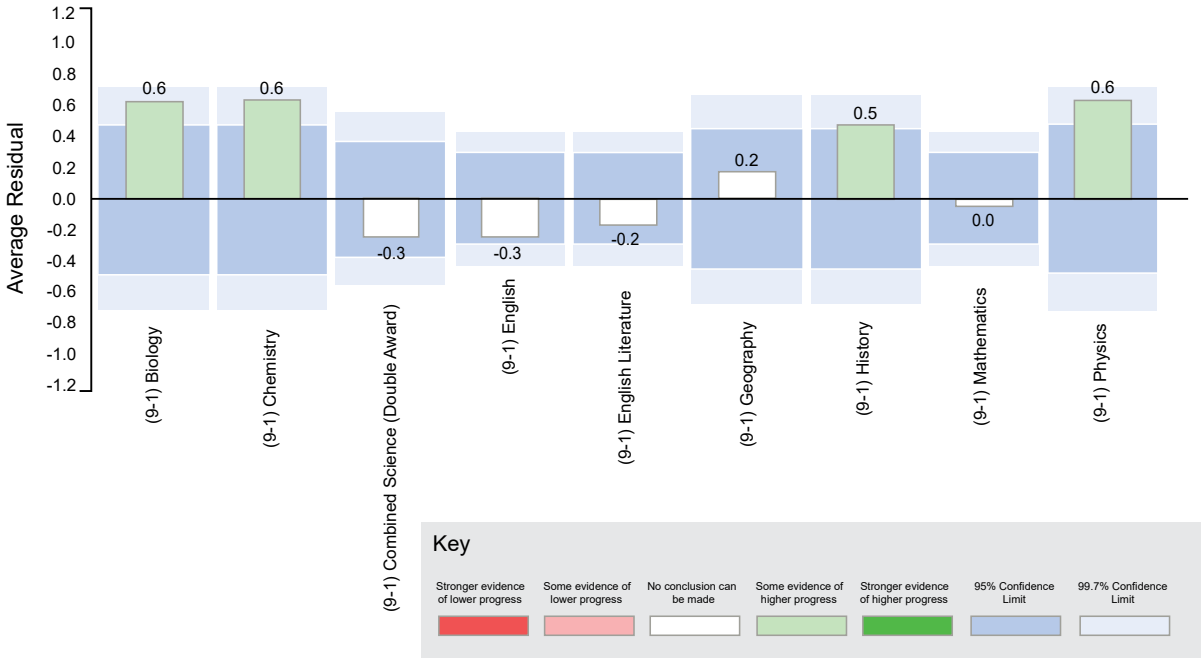

Figure 4: School value added chart from Cambridge Insight's primary assessment

Recruitment

We selected six participants for the interviews from the interested questionnaire respondents. They represented a range of positions in school, levels of mathematics / statistics qualifications, and subject specialisms (see Table 1). None had mathematics qualifications beyond A Level as there were no interested questionnaire respondents with that background.

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Table 1: Background of interviewees

Subject	Position	Highest maths / statistics qualification
Classics	Senior leadership	GCSE / O Level
English	Middle leadership	GCSE / O Level
English	Classroom teacher	AS Level
English	Classroom teacher (previously middle leadership)	GCSE / O Level
Science	Middle leadership	A Level
Science	Middle leadership	GCSE / O Level

Although all six participants were interviewed, two interviews were cut short by them due to unforeseen circumstances. These participants were not shown the school value added chart but answered the other questions.

Analytical approach

The interviews were transcribed using Teams' in-built AI transcription. Speech fillers (e.g., "umm", "err") were removed and any obvious transcription errors were corrected by listening to the relevant part of the audio recording. Then the transcriptions were anonymised. We identified key trends and patterns in the data and used MAXQDA to record this coding.

Ethics

The project (including final drafts of the questionnaire and interview schedule) was reviewed by our institution's Research Ethics Committee to ensure it met ethical standards.

Results

Views on the importance of data literacy and on training

All questionnaire respondents said data literacy was at least somewhat important to their role. The six SLT respondents and half of the ML respondents thought that it was essential to be data literate in their role. One respondent also used the free-text comment at the end of the questionnaire to comment that data literacy was "very important".

Many respondents, including all the SLT respondents, wanted to improve their data literacy (see Figure 5), either for their current role (26) or for possible future roles (two classroom teachers, one ML and one SLT). The ML respondents showed the highest immediate interest, with nine respondents wanting to improve their data literacy in their current role. Of the ten respondents who did not want to improve, eight were classroom teachers. The desire to improve did not appear to have an obvious relationship with their mathematics qualifications. All levels of mathematics qualifications were represented in the respondents who wanted to improve.

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Several respondents also used the free-text comments to highlight issues with teachers' data literacy capabilities. These were described as being "patchy" by one respondent and two respondents suggested that it might vary across the school:

> "We're not always very good at it – perhaps depends on our subject?"

The respondents highlighted particular issues:

> "Teachers can't create an Excel spreadsheet"
>
> "Type two error abounds"
>
> "SLT don't understand the limitations of uncontrolled small sample sizes, which can lead to unhelpful comparisons"

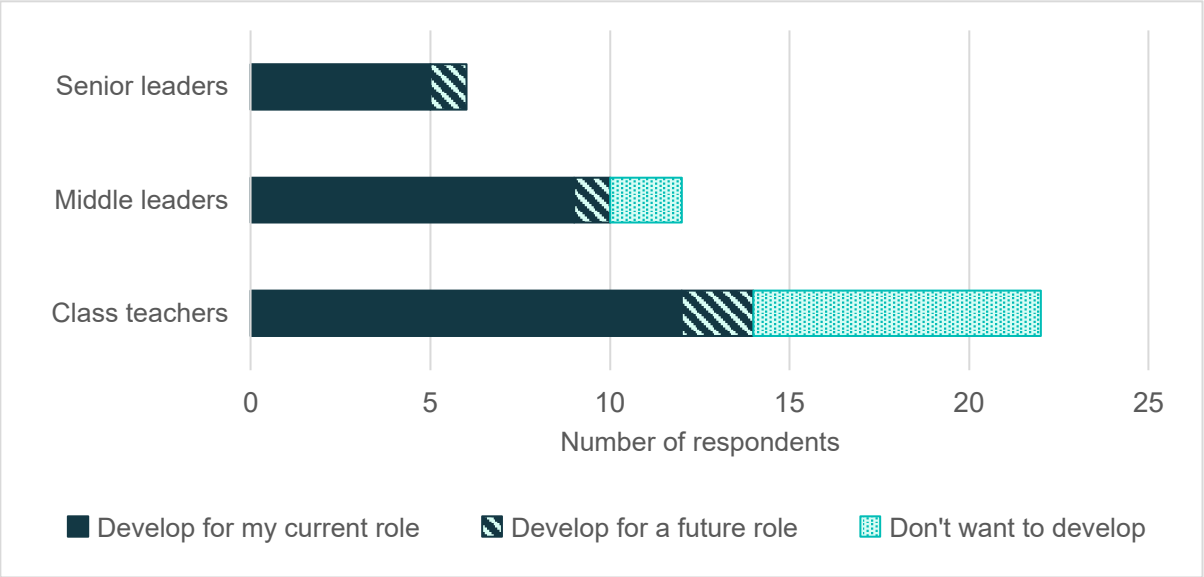

Figure 5: Questionnaire respondents' desire to improve their data literacy

When asked "What data literacy training is available for teachers in your institution?", most respondents indicated they had access to data literacy training. Only six respondents selected that no training is or has been available to them. The most common method was another staff member informally sharing their expertise (27 respondents). Staff meetings were also commonly mentioned (20 respondents), but fewer respondents cited school INSET[7] courses (12) or free online courses (10). Five respondents also used the additional comments question at the end of the questionnaire to state that more training was needed; for example:

> "It should be included in staff training – or, even better, in initial teacher training."

A lack of training but a desire to engage with some was a theme that emerged in the interviews, too. Interviewees reported little to no formal training in data analysis, with some describing a culture of "bluffing" or pretending to understand data. One respondent stated that:

7 INSET stands for in-service education and training.

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> "We're not massively accountable in terms of the way that we're using data and manipulating it, I think the honest answer to that is I might choose to ignore it and actually I'd probably get away with that."

Another, a senior leader with responsibility for data systems in school, described a journey of self-teaching, using tools like Microsoft Power BI and AI-assisted coding to build dashboards and streamline access to data in their schools. They said:

> "I've never had any training in this. I sort of got thrown into the deep end. [...] I've learned as I go along."

There was a strong desire for better support and professional development. Several interviewees advocated embedded training and habitual use of data in departmental meetings. One senior leader emphasised the need to "learn from the best practitioners" and build a culture of shared understanding. Interviewees also requested "straightforward packages" and "user-friendly resources" to help them understand and apply data, and called for simpler, more intuitive tools and visualisations.

Using and interpreting data

The majority of respondents (33) stated they had a specific responsibility for working with data, but seven respondents, all classroom teachers, stated that they did not. When asked what those responsibilities were, those reported by classroom teachers related to entering and tracking data or using assessment and attainment data for planning and teaching. Middle leaders tended to use data for oversight and accountability, reporting and departmental management. Senior leaders tended to use data for overall leadership and strategic purposes.

Questionnaire respondents were asked who analysed different types of data in their school. All the SLT respondents and 10 of the ML respondents analysed some form of data within their school, but only just over half (14) of the classroom teachers did so. The two ML who did not analyse data reported that they saw the results of other people's data analysis. Assessment data was most commonly analysed (27 respondents), but respondents also analysed behavioural data (6 respondents), attendance data (3 respondents) and SEND[8] data (3 respondents).

Questionnaire respondents were asked to indicate how often data was used for tasks (Figure 6). Almost all respondents used data to track students' progress and inform classroom decisions, although there were variations in how often they did so. Only one respondent – a classroom teacher – did not track students' progress, reflecting the responsibility across all teacher roles for students' development and progress. The task most commonly reported as not being carried out by respondents was using data to inform sets or teaching groups; this was the case for four classroom teachers and one ML.

8 SEND stands for special educational needs and disabilities.

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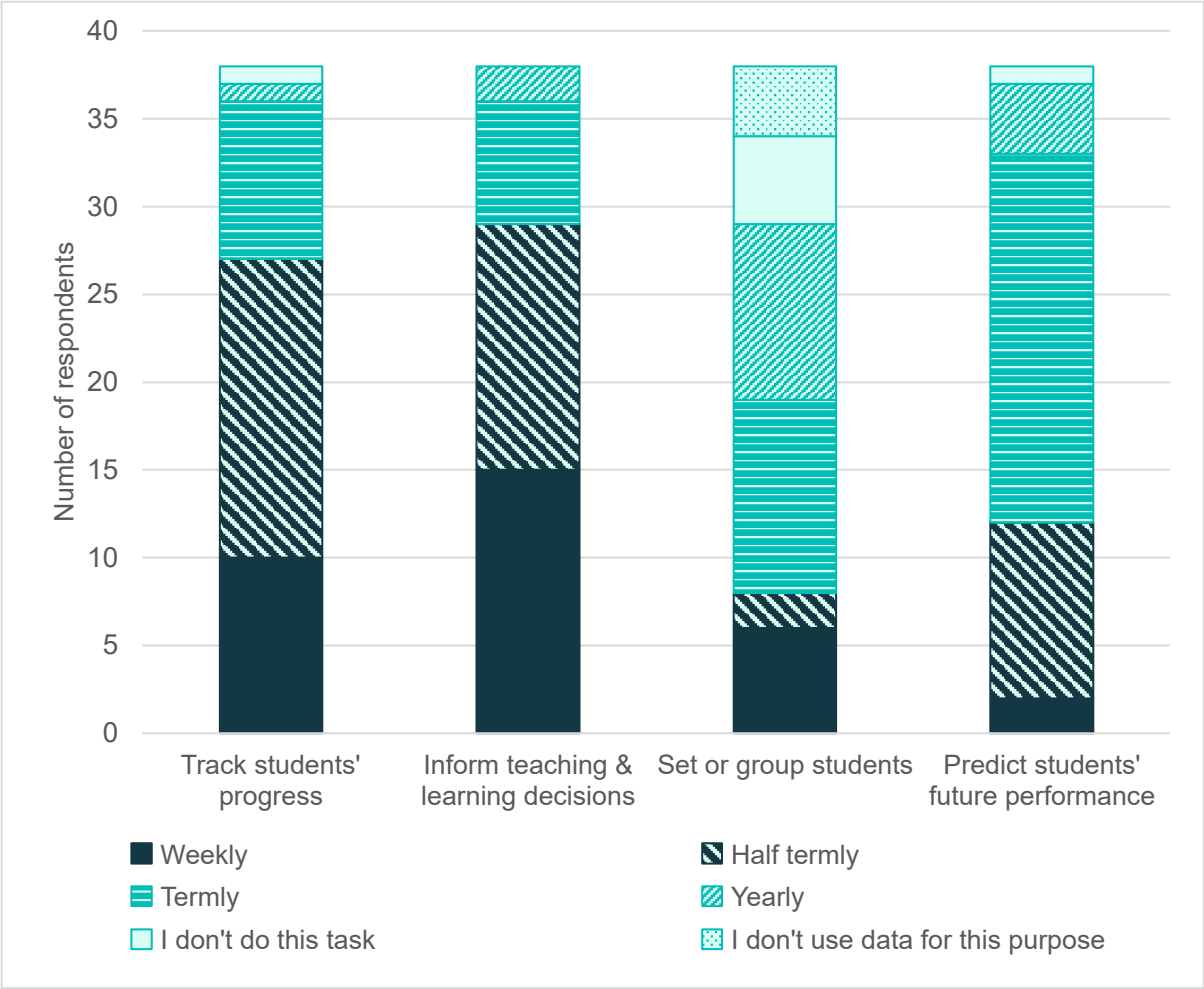

Figure 6: Frequency of respondents using data to carry out tasks

Respondents were asked how they interact with data visualisations as part of their work (Figure 7). Nearly all respondents reported that they read, interpreted, and compared information presented in tables. However, slightly fewer regularly constructed their own tables. Approximately half of the respondents contextualised tabulated data within their school, local, or national settings. A similar proportion considered how such data might change over time or across different student groups.

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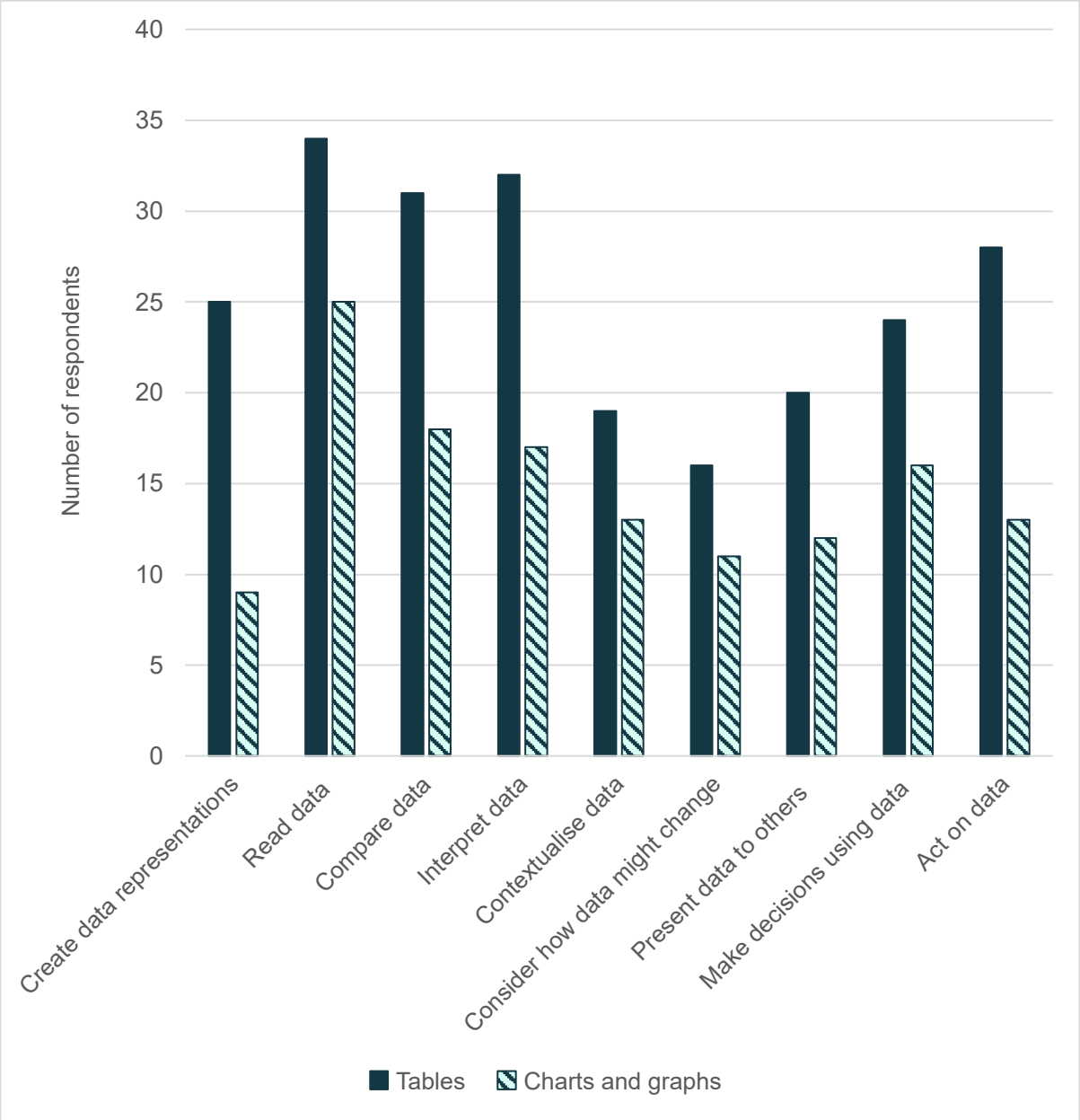

Figure 7: Ways in which respondents interact with data in tables and in charts and graphs

Fewer respondents reported that they interacted with data presented in charts and graphs than they did for tables (Figure 7). Eleven respondents reported that they did not complete any of these interactions. Reading data from charts and graphs was more common than the other interactions.

In the interviews, participants remarked on the data they receive internally, usually supplied by their senior leadership team. Comments indicated that data presentations were sometimes overly complex or poorly aligned with teachers' needs. One interviewee stated:

> "I just seem to get so much data that it was really hard to navigate that and it was all on different tabs. And it all seemed to be measuring different things."

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Finally, both questionnaire respondents and interviewees were asked about the types of data they felt most and least confident analysing and interpreting. Questionnaire respondents' free-text responses focused on data types and systems. They felt most confident interpreting assessment data (11), attendance (6), academic results (6), and student progress (5). Conversely, they expressed lower confidence in interpreting SEND-related data (4). Many concerns were linked to specific data systems (e.g., Sisra and Arbor[9]), or to situations where the source or relevance of the data was unclear.

Interviewees' answers suggested their confidence varied between subject specialisms. The two science teachers reported high confidence, often citing their disciplinary background and familiarity with data analysis.

> "I think my background helps me. I, we use a lot of data in, in, in, in practicals we collect data. We, you know, we're always doing data-based stuff within science."

That interviewee then went on to discuss what happened when they gave their data responsibility to colleagues without that background.

> "A few years ago, I tried to transfer my responsibility to a couple of colleagues just so that if I left the school there would be some kind of continuity and they didn't cope with it very well. And so I never quite gave up the role because I, they would be doing the sending the data out and there would be mistakes and issues and errors that they just didn't identify."

Conversely, the four Humanities and English teachers expressed low confidence, particularly when dealing with spreadsheets or statistical measures. One English teacher stated:

> "I'm least confident with like a spreadsheet, I guess, or kind of a something that has been...Data that has been given to me that feels very separate from the student."

Insights into teachers' interactions with data representations

Teachers' interactions with data representations were investigated in more detail through asking the interviewees to interpret the three data representations.

Predictions table

For the predictions table, most interviewees started their interpretations by describing what they could see, for example:

> "It's a predictions table. OK, so I've got student's surname, gender and class, standardised score."

However, two interviewees needed some clarification of the values in the table before they were able to vocalise their understanding of it, for example:

> **Interviewee**: "Is that the kind of average grade? That doesn't really make sense."

9 Sisra is data analytics software designed for secondary schools, allowing schools to analyse and report on assessment data. Arbor is a management information system. One of its features is allowing schools to collect and analyse different types of data (e.g., assessment data, attendance data).

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> **Interviewer:** "No. OK. Well, I'll tell you that because you wouldn't be able to work it out otherwise. So that's their predicted grade if they were to do GCSE."

The standardised scores in column 5 were a talking point, with two of the six interviewees able to read and explain this data point, with comments such as: "87 is low, but functional", or "average is around 100, isn't it?" The other four interviewees needed support to understand this metric.

Similarly, the segmenting of students into bands (column 6) drew queries about whether A was high or low and why there needed to be a band presentation alongside a standardised score. Again, once they were given time to absorb the information, most were quick to take on the new data and start to describe how they could use it:

> "I've got a student in band D. They probably need to be near the front, and I want to check in with them. And then when I look at their English, they're on a 3.7. So, I want to get them over the line to a 4."

Individual student's progress chart

Although this was a primary stage chart and not directly applicable to subject-focused secondary teachers, some interviewees were able to start understanding the data straight away:

> "The improvement in reading is fairly consistent, although they are missing an assessment...The developed ability is, again, positive correlation, although accelerated progress between ages 10 and 11."

Others needed a little bit of time or help to understand it. One interviewee used the chart name to support their orientation:

> "Knowing this is a progress report, I assume that...."

Another sought validation from interviewers as to whether their interpretation was correct:

> "Isn't it how the student is doing in relation to their, to the average for their age? Is that right, student age?"

Several interviewees took time over this visualisation, unpicking it carefully and asking searching questions:

> "I'd be very interested in the kind of those two different aspects of, of English or of literacy [spelling and reading]. And you know why, why that student's performing differently at such a radically different way in each of those two areas?"

This visualisation showed a number of areas that a discerning teacher could spot, and many did so. One interviewee commented:

> "What on Earth has happened to spellings? [...] it's roughly going horizontal. So, their spelling ability isn't continuing to improve. It's kind of plateauing."

School value added chart

This type of information would not necessarily be shared with classroom teachers, so it was anticipated that SLT interviewees might be more familiar with this type

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of graph, than ML and classroom teachers. The SLT interviewee stated: "We use this. We, we report to governors on it". Other interviewees appeared less familiar with this data presentation, with one commenting that they were "not especially" familiar with it. Two interviewees tried to work out what the graph was showing them. One interviewee was successful in doing so:

> "I've got two different sets of information there. I've got something up at the top and a key at the bottom. Okay. So the key is colour coded so I can work out from the blocks of colour what's the, what's going on. So I can see that, for example if I look at English language and literature, that no conclusion can be made because it's too close to that, the kind of the baseline or the zero point."

The other interviewee misinterpreted what the zero-point meant, thinking that it represented a particular grade:

> "I'm assuming that the, the nought point is equating to a grade at GCSE. That's what I would imagine that is equating to. So, one zero would be a full grade at GCSE."

The term "residual" was another source of confusion. One interviewee commented:

> "That word residual. I'm, I'm, that's foxing me a little bit. [I'm] not too sure what that means."

However, one interviewee did stand out here. As a STEM teacher, it was clear that they not only understood residuals ("that's what I use in science") but actively engaged with them in the graph:

> "It's not a surprise because your individual sciences have a positive residual and your combined sciences a negative residual, but your more capable students are in your triple [individual] science classes."

Despite the issues with the term "residuals", the interviewees were able to identify that the cohort had secured better results in some subjects than others when compared to original predictions, using the graph legend to help them construct their understanding:

> "So it looks like, so this is the whole school data, right? So, so science looks strong because science seems to be biology, chemistry and physics is, has got a plus residual, so they seem to be. So according to that chart, there's some evidence of higher progress."

However, two interviewees needed interviewer explanation to support a more detailed reading and to facilitate discussions about what they might do with this data once they understood it, for example:

> **Interviewer:** "Those ones that have turned green have moved outside of the 95 per cent confidence limit into the higher confidence limit. And so that wasn't as..."
>
> **Interviewee:** "OK."
>
> **Interviewer:** "...They expected a result and so it's turned green because that is some evidence of some higher-than-expected progress made by..."

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Interviewee: "And can I infer from this that, that's, sorry to interrupt you? Sorry. Can I infer from this that say the sciences then have under predicted whereas English is, has, we're not sure."

Discussion

The results from the questionnaire suggest that data literacy is important for all teachers in school regardless of their role, echoing Pierce et al.'s (2014) findings, but essential for SLT and some ML. The difference in the value placed upon it may be linked to the data literacy responsibilities that were associated with the different roles. Classroom teacher survey respondents reported responsibilities related to planning and teaching, aligning with the requirements of the DfE (2011). Although using data may make these tasks more effective, it is not essential for those tasks. However, the data responsibilities listed by ML and SLT (oversight, accountability and strategic purposes) would be difficult to complete without using data, and it is possible that is the reason why the ML and SLT participants considered data literacy to be essential for their role.

Given the trend for data literacy being considered as more important by those in ML and SLT roles, it would be reasonable to expect that some participants wanted to improve their data literacy to move into those roles. However, the majority of respondents wanted to improve while still in their current role, suggesting that the desire to improve was generally not related to their desire for promotion into a role that might demand those skills. Instead, it may reflect a perception that they do not have the data literacy skills that they need.

One way of acquiring data literacy skills is through Mathematics qualifications. All teachers are required to have at least a grade C in GCSE Mathematics (or equivalent), and this was the highest Mathematics qualification held by the majority of our participants. Although statistics is included in GCSE Mathematics, which should mean teachers have data literacy skills such as reading and comparing values and analysing datasets (Pierce & Chick, 2011), it is only one part of the curriculum. Furthermore, it does not give teachers other skills that Mandinach and Gummer (2016) identified as being important for data literacy, such as contextual understanding and critical thinking. Those skills need to be gained in other ways.

It was clear from those surveyed that in many cases educators were either left to develop their own skills, or skills were passed down from senior leaders or other school staff. However, responses from senior leaders showed that they had not had any training in data analysis either. It seemed that senior leaders were more confident with handling data (as Pierce et al. found in 2014), but this may only be true because they needed to analyse data more regularly. Indeed, we had responses that showed that senior leaders were to a certain extent bluffing when analysing data.

Relying on schools having staff members with sufficient data literacy skills to train others may prove problematic. Although secondary schools might be able to provide training or support because of the maths and science teachers who are likely to have those skills, primary schools may not have teachers with subject

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expertise in those areas. Ideally, as one of the participants suggested, it would be provided in initial teacher training to ensure all teachers had the expertise they need. However, this does not seem to be the case, as neither England's Initial Teacher Training and Early Career Framework (DfE, 2024) nor the Teachers' Standards (DfE, 2011) mention data literacy, data analysis or statistics.

The studies we reviewed suggested that teachers may lack the data literacy skills to interpret data accurately (e.g., Chick & Pierce, 2013; Filderman et al., 2021). Our own research suggested that this varied by both interviewee and data representation. Some interviewees were able to analyse all three representations accurately with little or no input from the interviewer, while others needed help, particularly with the school value added chart. The nature of that help varied across the data representations. For the predictions table and the individual student's progress chart, interviewees requested minor clarifications of the assessment results' meaning (e.g., standardised scores, developed ability). However, for the school value added chart they needed explanations of features associated with the assessment results' meaning (the residuals scale) and knowledge associated with analysing data more generally (confidence intervals), and then needed help from the interviewer to accurately interpret what the chart was showing them.

Differences in the difficulty of analysing the data representations related to how familiar interviewees were with them. Interviewees were able to interpret the representations accurately, even complex visualisations such as the school value added chart, when they had previous experience of those representations or similar data. It is reasonable to expect that teachers are experienced in interpreting results tables, particularly given the questionnaire findings which showed almost all respondents read, compared and interpreted data in tables and many constructed their own. Similarly, teachers could be expected to be familiar with line graphs, even though fewer questionnaire respondents reported using them than using tables. However, the complex nature of the information within the school value added chart meant that it was only familiar to teachers who had seen that representation before (the SLT interviewee), or teachers whose subject background was in a discipline where similar data was reported (the science teacher interviewee).

This has implications for analysis and visualisations that assessment organisations provide, and the support provided to accompany them. For analysis and visualisations that are likely to be familiar, a simple explanation of the metrics that are reported might be the only support required. However, more complex visualisations might require training in how to understand them or a detailed commentary including examples of valid and invalid conclusions that can be drawn from the data. It is also important to consider how data is best presented, whether in visualisations, tables or a combination of the two.

A final area of data literacy to be considered is teachers' confidence in handling data. Reported confidence varied among our participants according to the type of data being analysed, the systems they were expected to use for analysis, and their disciplinary background. Although confidence was not an intended focus of the interviews, we observed differences in the way that interviewees

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phrased their interpretations of the data that we thought may be related to the confidence they had in those observations. Interviewees sometimes phrased their interpretation as a question, checked their interpretations with the interviewer or prefaced their interpretation with phrases such as "I assume that". This suggested that interviewees may have been less confident about those interpretations, even when their interpretations were correct. It may also indicate interviewees' perception that they lacked the knowledge to interpret those representations, as Musleh et al. (2025) observed that confidence is impacted by perceived knowledge gaps. Phrasing interpretations in this way could be a useful indication of where more training is required.

On the basis of studies consulted and the insights from our own work, we hypothesise that different personas may exist to describe the data literacy of users, and that these may vary according to how confident and capable teachers are in analysing the data. Figure 8 illustrates this using quotations from our interviews. While one of our interviewees expressed both confidence and capability in their discussions about the data presentations, the majority exhibited signs of low confidence in their verbal responses for one or more of the presentations through their hesitations and questions. Interviewees' observations were mostly accurate, showing a higher level of data literacy capability, but were sometimes inaccurate for the unfamiliar school value added chart, suggesting lower levels of capability for that type of data analysis. We did not experience interviewees appearing confident when showing lower levels of capability, but one interviewee described such behaviours among teachers in their school setting.

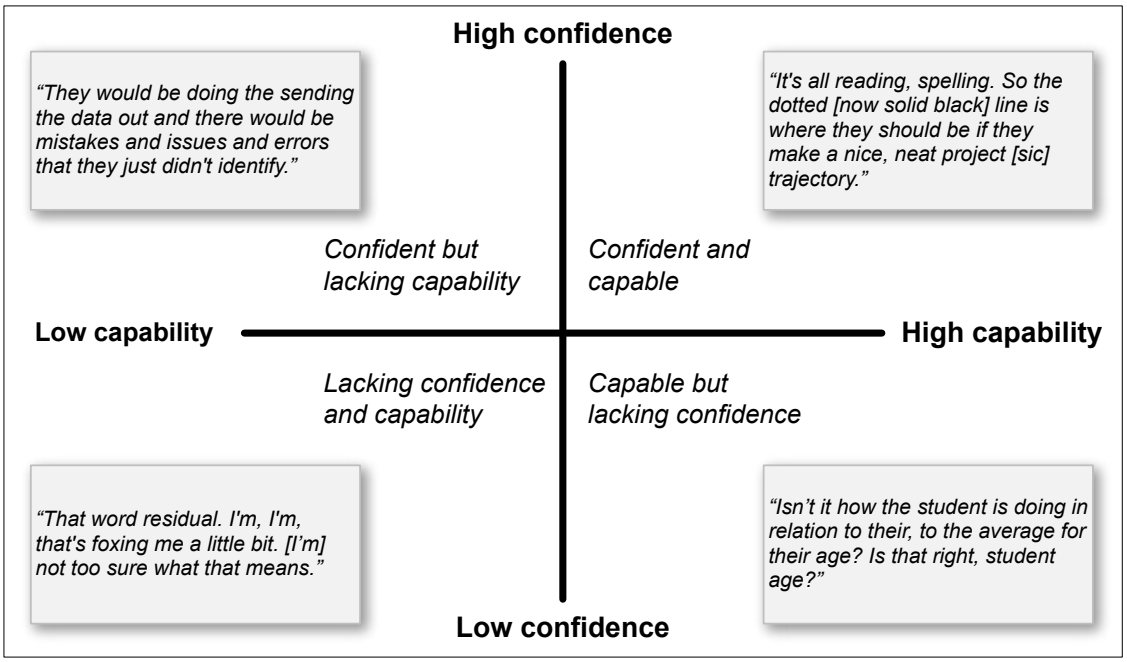

Figure 8: Hypothesised structure of data user personas

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Limitations

The study sample was small, with 40 respondents for the questionnaire and six interviewees. The sample was also self-selecting, with respondents volunteering to take part by responding to social media posts or email communications. The final sample of teachers was not necessarily representative of teachers in secondary schools.

The bias towards humanities teaching specialisms and classroom teachers holding no additional responsibilities in school may mean that teachers in our sample had less familiarity with data analysis tasks in a school context than might be the case for a representative sample of teachers. Classroom teachers are largely confined to data analysis associated with their own classes and assessments, as opposed to larger datasets for entire cohorts (as ML are expected to manage) and the wider school (as SLT are expected to manage). Similarly, humanities subjects require less mathematical or statistical background and prior knowledge for teaching, so it could reasonably be assumed that a humanities specialist has less recent knowledge and application of the statistical skills required for data literacy tasks.

Because of the small numbers of teachers interviewed, we cannot make strong generalisations from the interview data, particularly given that two of our interviewees did not complete all of the data interpretation tasks due to unforeseen circumstances, and the AI tool used to transcribe the audio may have led to small inaccuracies in the transcribed text. However, the aim for this section of the study was to gain more detailed insights into the ways in which teachers interact with different types of data representations, and the interviews did provide useful insights in this respect, including in terms of variations between teachers. The effects of inaccurate AI audio transcriptions were reduced, as obvious errors were checked against the audio and the interviewers coded the transcriptions to identify patterns and trends, minimising the risk of the analysis inaccurately reflecting what was said.

It is also important to note that interviewees' data literacy may have been impacted by the nature of the task. Interviewees were asked to interact with unfamiliar data presented by an unknown researcher and were not able to manipulate the data. Their observed ability to interact with the data may not represent their ability to interact with similar data in a familiar context.

While our research suggested there may be different data literacy personas, this was not the focus of our study and arose incidentally. Therefore, more detailed research, utilising a broader sample that is more generalisable, is needed to provide evidence for this hypothesis.

Conclusions

This study aimed to investigate teachers' data literacy, and related to this, how they interacted with assessment data. Although it is not possible to generalise from the findings due to the sample size and subject specialisms of the participants, the study has provided some valuable insights relating to teachers' data literacy.

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Our research shows that teachers in our sample routinely engaged with data and often had responsibilities in school relating to data, particularly if they were in ML or SLT roles. This suggests that data literacy is important for teachers, but possibly more so for ML and SLT. However, the desire to improve data literacy skills was strong across the sample, which suggests that not all teachers feel that they have the data literacy skills they need. The nature of the training needed may vary by role, the type of data they encounter and the type of data analysis they need to conduct. Classroom teachers are mostly likely to analyse data for individual students and classes, while ML and SLT may need to analyse data across cohorts or the whole school, to consider changes in the data over multiple years, and possibly to engage with more complex metrics such as the average residuals seen in the school value added chart.

The findings led us to suggest that data literacy skills may be affected by confidence as well as capability, and that the levels of confidence and capability are likely to vary according to the data analysis task. However, the interaction between confidence and capability to create data personas is currently a hypothesis that needs to be investigated further in future research.

Our results suggest several implications for schools and assessment organisations in terms of training and guidance:

- There is a desire among teachers to improve data literacy skills and an appetite for data literacy training.
- It would be helpful for schools to know their teachers' data literacy skill level across different types of data so that they can plan appropriate training for individual teachers and across the school more widely.
- If identifiable data personas exist, it may be useful for schools to consider them when identifying teachers who would benefit from further training, and for assessment organisations to consider them when developing training and / or guidance.
- Assessment organisations should consider the format in which they provide assessment data and the support that users need to enable accurate interpretation of it. That support may need to vary according to the complexity of the data.

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Jackie White (Research Division)

The following reports and articles have been published since *Research Matters*, Issue 41:

Journal articles and other publications

Johnson, M., & Oates, T. (2026). Eğitim modeli olarak Bauhaus: Kalıcı tasarım ve güçlü bilgi [The Bauhaus as education model: Enduring design and powerful knowledge] (F. Cizrelioğlu Karaer, Trans.). *Marmara Üniversitesi Sanat Ve Tasarım Dergisi, 17*(1), 197–216.

Johnson, M., & Oates, T. (2026). The Bauhaus as education model: Enduring design and powerful knowledge. *International Journal of Arts & Design Education, 45*(2), 325–341.

Morley, F., Walland, E., & Vidal Rodeiro, C. L. (2026). Auto-marking short answer questions in science: The foundational years of transformer-based models from BERT to GPT-4. *International Journal of Artificial Intelligence in Education, 36*(1–2).

Research and statistics reports on our website

Gill, T. (2026). *Provision of GCE A level subjects in 2025*. Statistics Report Series No. 150

Gill, T. (2026). *Provision of GCSE subjects 2025.* Statistics Report Series No. 152

Gill, T. (2026). *Uptake of GCE A level subjects 2025.* Statistics Report Series No. 149

Gill, T. (2026). *Uptake of GCSE subjects 2025.* Statistics Report Series No. 151

Jin, C., Constantinou, F., Majewska, D., & Greatorex, J. (2026). *What influences curriculum developers' decisions during the curriculum-making process?*

Miranda, A. (2026). *Post-16 qualification pathways in England: Combinations of Level 3 academic and vocational qualifications uptake by students' backgrounds*.

Miranda, A. (2026). *Post-16 qualification pathways in England: Uptake of Level 2 and Level 3 academic and vocational qualifications by students' backgrounds*.

Walland, E., & Benton, T. (2026). *Multiple marking methods as alternatives to single marker analytical essay marking: Exploring pairwise comparative judgement, rank ordering and levels-only*.

Data Bytes

A series of data graphics from Cambridge's Research Division, designed to bring the latest trends and research in educational assessment to a wide audience. Topics are often chosen to coincide with contemporary news or recent Cambridge research outputs.

How do digital activities affect young people's wellbeing? (June 2026).

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The heat is on: How temperatures during exam sessions have changed since the first GCSEs. (September 2026).

Conference presentations

Johnson, M., Rodrigues, A., & Brady, J. (2026, March 25–27). *Community and collaborative learning in online schools: Students' and teachers' perspectives* [Paper presentation]. European Association for Research on Learning and Instruction (EARLI) SIG 10, 17, 21, & 25 Conference, University of Augsburg, Germany.

Klement, S., Greatorex, J., & Albayrak Sari, A. (2026, September 8–10). *Climate change education and the knowledge-action gap* [Paper presentation]. British Educational Research Association annual conference, Manchester, UK.

Rushton, N., & Morrish, D. (2026, September 8–10). *Using a conceptual framework to describe structural features of system-level curriculum frameworks* [Paper presentation]. British Educational Research Association annual conference, Manchester, UK.

Vidal Rodeiro, C. L., Lieber, E., & Majewska, D. (2026, September 8–10). *Motivations behind A-level subject choice: Evidence from a large-scale survey of students in England* [Paper presentation]. British Educational Research Association annual conference, Manchester, UK.

Sharing our research

We aim to make our research as widely available as possible. Listed below are links to the places where you can find our research online:

Journal papers and book chapters

Research reports

Statistical reports

Conference papers

Blogs

Research Matters (in full and as PDFs of individual articles)

You can also learn more about our recent activities from Facebook, Instagram, LinkedIn and X (formerly Twitter).

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Contents / Issue 42 / November 2026

4 **Foreword:** Jane Mann

5 **Editorial:** Victoria Crisp

6 **In This Issue:** Victoria Crisp

9 **Learning theories unpacked: A discussion of the findings from three Research Division studies:** Dominika Majewska and Jo Ireland

20 **"Post-traumatic growth" in education: How crises can spark positive change:** Filio Constantinou

39 **Gaps in foundation mathematics understanding among 16-year-olds in England:** Alejandra Miranda

65 **Progression and earnings of students who leave post-16 education with low grades in their A Level qualifications:** Carmen L. Vidal Rodeiro and Tim Gill

84 **Data literacy: Exploring secondary school teachers' perspectives and skills:** Annie Vincent, Nicky Rushton and Chris Jellis

108 **Research News:** Jackie White

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