Pearson

A Level Mathematics

Enter

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Qualification Efficacy Report — May 2021

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Introduction

In 2013, we were the first company to make a commitment to measure our impact on some of the outcomes that matter most to learners, such as academic achievement. But there was no rule book and no model to follow. We've had to carve our own path to define what efficacy looks like in education.

While our approach is rigorous, the concept underlying it is simple: we use evidence and research to design products and solutions to help learners achieve the outcomes that matter to them. Then, we measure the impact of using our products, report that impact in a transparent way, and use what we learn to help learners – and ourselves – continuously improve.

Today, we are taking what we have learned and evolving our approach. We are focusing more on designing products to have a measurable impact, not just during education, but on employability and lifelong learning as well.

We want our commitment to efficacy to be a reason for learners to believe in Pearson, to see us as their trusted guide to a lifetime of learning, as they navigate a changing world of work. Skills that are hard to automate, like communication and critical thinking, are in more demand than ever. And now that the idea of a job for life is gone, people need to continuously grow, demonstrate their skills and adapt their talent to support the development of the key skills people need to thrive today and in the future.

Our efficacy reports help us, and the wider education community, build a better understanding of not just what works, but how, why, and in what context — helping us learn, not guess, about how the design and use of products relates to the achievement of outcomes that matter most.

Efficacy in 2021

Qualifications and assessments are a critical aspect of how Pearson impacts learner outcomes at scale. This report on A Level Mathematics is part of our ongoing commitment to communicate about our impact in a transparent way for our assessment and qualification offerings.

We are pioneering the application of efficacy in education. As such, we are driven by continuous pushing the boundaries of what learners can and should expect from learning experiences. Our commitment to transparency reflects our desire to build public trust in our ability to support learners at all ages and stages to achieve the outcomes that matter to them. In doing so we want to be the trusted guide for learners through a lifetime of learning.

Our commitment to efficacy is on-going and all our 2021 efficacy reports are available **from our website**.

Special thanks

We want to thank all the customers, test-takers, research institutions and organisations we have collaborated with to date. If you are interested in partnering with us on future efficacy research, have feedback or suggestions for how we can improve, or want to discuss your approach to using or researching our assessments, we would love to hear from you at **efficacy@pearson.com**.

Kate Edwards, PhD
SVP Efficacy & Learning, Pearson

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About efficacy reporting at Pearson

Learn more about the processes and principles of efficacy **here**

As part of our commitment to being open and transparent about how we design, develop, and evaluate the impact of use of our products on learning, we produce a range of efficacy publications, including reports and guides. This report is one of our Qualification & Certification Reports.

Technical Research Reports [1-2-4]

These describe a single piece of impact evaluation research into the use of a product, undertaken to meet the standards expected for publication in a peer-reviewed academic journal. Selected statements in our Technical Research Reports are independently assured by PricewaterhouseCoopers (PwC).

Product Guides & Spotlights [3-4]

These explain what the evidence about a single product means for users of that product. They combine research findings with stories from real users to help you replicate best practice with the product and achieve the best outcomes for learners.

Assessment Reports [3-5]

These summarise the evidence about a single assessment's capability to measure a trait or ability in a valid, reliable and fair manner. These reports are not independently assured, because we do not expect assessments to have a direct effect on outcomes for learners.

Product Efficacy Reports [1-3-4]

These summarise all the relevant impact evaluation research related to the use of a single product. This includes research described in Technical Research Reports and learning research that informed the product's design and use. Selected statements in our Product Efficacy Reports are independently assured by PwC.

Qualification & Certification Reports [3-5]

These reports include information about how the design of the qualification or certification was informed by research. They bring in evidence about how the qualification is delivered, and how it supports experience and progression. They summarise relevant Technical Research Reports associated with the assessment of the qualification and impact evaluation research related to learner outcomes.

Key

1. Independently assured by PwC
2. Details a single study
3. Summarises all relevant evidence
4. Evaluates impact on learner outcomes
5. Evaluates assessment quality indicators: validity, reliability, and fairness

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Executive summary

Executive summary

With qualification reform come significant opportunities, but also some challenges. In designing, implementing and assessing a new qualification, there is potential to increase the depth and breadth of student learning and encourage changing pedagogical approaches which support increased engagement with the subject content.

Conversely, it is important to consider the potential negative impacts of change and ensure that rigorous processes can be put in place to mitigate against these. As qualifications move from initial intentions through design and into implementation, they pass through a complex educational landscape which shapes their enactment and impact in the real word.

The five sections that make up this report collectively tell a story that covers three key themes:

1. The initial design process as undertaken by Pearson and the wider policy context that informed this
2. The implementation of the qualification: how it has been enacted in classrooms as well as its implications for students' progression to higher education
3. Assessment of the qualification, including Pearson's rigorous review processes

This report aims to give a window into this journey with a focus on the reformed A Level Mathematics.

The report is based on qualitative feedback from teachers, engagement with students, and discussions with senior examiners and other stakeholders. It is focused on the Summer 2019 exam series, which were the only examinations to take place with a full cohort before the disruption caused by the global COVID-19 pandemic.

Executive summary

At every stage, the focus of the report, as with Pearson's internal processes, will be the student and teacher experiences. Each section has been put together by a different Pearson team, each of which plays a key role in the processes described. This means the report offers detailed insights from those who have been closest to developments in the qualification since its launch.

The first section, **Development of the qualification: opportunities and challenges**, explains how Pearson went about developing the A Level Mathematics qualification.

Next, **How prepared were teachers and students for the reformed A levels in mathematics?** tracks the implementation of the reformed qualification in classrooms from the perspective of teachers and students.

The section on **Higher education institutions' perceptions of the impact of reformed mathematics A levels on preparation for mathematics-intensive degree courses** looks at students' preparation and progression from the perspective of academics.

The fourth section, **Monitoring the performance of assessments: the importance of student experience**, focuses on the review processes that take place after an examination is sat, with a focus on the 2019 A Level Mathematics series.

Finally, **Future assessments in A Level Mathematics** explores ways in which Pearson has been listening to feedback and working to improve future assessments.

We hope that this report offers insight into the work taking place at Pearson to maximise the potential of the reformed A Level Mathematics while mitigating the impact of challenges that arise during enactment.

Our aims in compiling this report are not only to present an overview of the processes involved in the development of the reformed A Level Mathematics, but also to present a snapshot of the journey of the qualification so far. We believe that this information has value for policy makers, teachers and other stakeholders as a tool for the ongoing improvement of A Level Mathematics.

This report does not cover the disruption caused by the global COVID-19 pandemic, which has affected A Level Mathematics in the same way as other General Qualifications. Detailed information about A level grading in Summer 2020 can be found on Ofqual's **blog**. The most up to date information about teacher assessed grades for Summer 2021, including the support available for teachers, is available on the **Pearson website**. Research is under way to better understand the impact of the pandemic on teaching and learning A Level Mathematics and we will report the outcomes when they are available.

At Pearson, we will continue to act on the evidence presented here, as well as continuing to monitor the ongoing enactment of the reformed A Level Mathematics. This puts us in a robust position to ensure that the qualification, as well as its surrounding resources and assessments, are of the highest possible standard. As a consequence of this work, we are able to continuously monitor to what extent we are meeting our core aims, enabling students to develop and demonstrate their mathematical learning in a rewarding context and allowing them to progress to further study or employment.

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About the A Level Mathematics qualification

About the A Level Mathematics qualification

Advanced Level qualifications, or A levels, are subject based qualifications offered mainly in secondary schools, sixth form colleges and further education colleges. The qualifications are defined by the Department for Education and regulated by Ofqual in England, Qualifications Wales in Wales, and CCEA in Northern Ireland. They are usually studied over the course of two years, and lead to qualifications recognised for entrance to higher education institutions in the UK and many others worldwide.

Although they are a UK qualification, schools across the world offer A levels. Most universities and higher education institutions recognise A levels as a suitable entry qualification.

A Level Mathematics provides a framework within which students can continue the subject beyond GCSE level. It is the most popular of all A levels taken in England. As part of a wider reform of A levels, A Level Mathematics was reformed for first teaching in 2017. The changes associated with these reforms are described in greater detail in **Development of the qualification: opportunities and challenges**, and represent a focus throughout this report.

The new qualification builds from GCSE level mathematics, which was reformed in parallel with the A level, and introduces calculus and its applications. It emphasises how mathematical ideas are interconnected and how mathematics can be applied to model situations mathematically, using algebra and other representations, to help make sense of data, understand the physical world and solve problems in a variety of contexts. It prepares students for further study and employment in a wide range of disciplines involving the use of mathematics. For many science, technology, engineering and mathematics (STEM) degree courses, A Level Mathematics is an essential pre-requisite.

Development of the qualification: opportunities and challenges

The introduction of the new reformed linear A Level Mathematics qualification created opportunities for better mathematical learning, but also some uncertainty for both teachers and students who, for more than 20 years, had taught and studied the qualification under a more flexible modular approach.

During the initial development of the qualification, the key aspects of its purpose, set out by the Department for Education (DfE), were that it should:

- support the study of AS and A Level Further Mathematics
- enable students to build on their knowledge of GCSE mathematics to understand how mathematical ideas are interconnected and how mathematics can be applied to model situations
- help make sense of data
- provide the flexibility to teach AS Level Mathematics as a separate qualification which consolidates and develops GCSE level mathematics and supports transition to higher education *(Department for Education, 2016, p. 3)*

The reasoning for these changes was to create a qualification that supports students following a broad range of further education options and career paths that require mathematics. The inclusion of new requirements related to problem solving, modelling, mathematical communication and large data sets introduced a layer of difficult concepts and was widely believed to result in an increase in the demand of the qualification.

However, while the purpose and aims of the new qualification quite rightly emphasised the requirement for coherence and connection within mathematics, it was noted that schools were going to be emerging from a long period of a modularised curriculum and were therefore going to be introduced to new territory.

In this section

Designing the qualification

When designing the new A Level Mathematics qualification, Pearson worked with Senior Examiners and teachers with the aim of ensuring we were meeting the learning aims and objectives and subject criteria as set out by the DfE and Ofqual, while at the same time striving to ensure that the qualification was accessible to students with a wide range of abilities and that teachers were able to deliver it. We wanted to try to maintain the spirit of the legacy qualification to make the transition easier, but this was a challenge given the characteristics of a linear qualification model and the demands of the new criteria.

These were the key changes to the criteria introduced in the new A Level Mathematics:

- a linear qualification with examinations taking place at the end of a two-year course
- a greater level of detail applied to the assessment objectives (AOs) with the introduction of 'Strands' and 'Elements' to ensure full coverage of the AOs (see Table 1)
- a greater emphasis on problem solving and modelling (particularly in AO3)
- the inclusion of questions which allow learners to provide extended responses
- the inclusion of questions which allow learners to demonstrate their ability to draw together knowledge and understanding from across the content
- the need for students to be familiar with, and answer questions related to, a large data set
- common core content, with no optional routes

Table 1: *Ofqual guidance on assessment objective coverage and question types*

Subject level guidance		Qualification level conditions and requirements
Strands and elements	**Coverage**	**Question types [GCE5.1]**
AO1 (50%) 1 – select and correctly carry out routine procedures 2 – accurately recall facts, terminology and definitions	No more than 10% of the marks should be allocated solely to strand 2.	Assessments for a GCE Qualification must ensure that, taken together, they include questions or tasks which allow learners to: • provide extended responses • demonstrate their ability to draw together different areas of knowledge and/or understanding from across a full course of study for that qualification
AO2 (25%) 1 – construct rigorous mathematical arguments (including proofs) 2 – make deductions and inferences 3 – assess the validity of mathematical arguments 4 – explain their reasoning 5 – use mathematical language and notation correctly	Strands 1 and 2 should comprise at least 50% of the marks for this assessment objective. No more than 10% of the marks for this assessment objective should be allocated to strand 3. No more than 10% of the marks for this assessment objective should be allocated solely to strand 5.	
AO3 (25%) 1 – translate problems in mathematical and non-mathematical contexts into mathematical processes 2 – interpret solutions to problems in their original context and, where appropriate, evaluate their accuracy and limitations 3 – translate situations in context into mathematical models 4 – use mathematical models 5 – evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them	Taken together, strands 1 and 2 should comprise at least 40% of the marks for this assessment objective. Taken together, strands 3, 4 and 5 should comprise at least 40% of the marks for this assessment objective.	

As part of the initial research to inform the design decisions for the qualification, we carried out a range of activities with stakeholders from higher education, as well as teachers and students.

Higher education stakeholders, such as the A Level Content Advisory Board (ALCAB), were mostly in favour of the new criteria, because they felt the existing content was not covered in enough depth and questions were often too structured. Discussions with teachers often focused on the structure and length of assessments, with preferences expressed for defined paper content to allow for focused preparation, and for maintaining the separation of pure and applied assessments as in the legacy modular qualification.

Concerns were expressed about preparing students for problem solving and modelling questions. Second year A Level Mathematics students who took part in a problem solving trial to test the new-style questions found them very demanding and marks scored were low in comparison with legacy qualification AS Level Mathematics examinations. In interviews, students said they found the questions difficult and often did not know how to get started. It was clear that the skills now required added to the demand of the qualification.

Pearson worked to formulate possible assessment models for the qualification and held a series of focus groups with teachers to discuss them. These were the findings.

Assessment time

6 hours

- It was generally felt that six hours total of assessment time for A Level Mathematics was appropriate, because this was similar to other A level qualifications and the same as the past linear mathematics qualifications.

2 hours

- There should be a two-hour limit for each paper and assessments should not be shorter than 1.5 hours. There was a feeling that one-hour papers would be too rushed, particularly if there were problem solving questions.

Structure

- There was a strong preference for separate papers covering the pure mathematics content and applied content, with statistics and mechanics split out.
- At least two papers would be required to cover the pure mathematics content. Almost all of those consulted wanted this content separately defined in the papers, in line with the legacy modular qualification, to enable focused teaching and revision for examinations (see Table 2).

While we could justify having the applied mathematics content in a separate paper, providing a rationale for splitting out the pure mathematics content was not as straightforward. The interdependency of the different topic areas meant that the only logical approach was to define the content in each of the pure papers by putting all AS level content in Paper 1 and additional A level content in Paper 2. The intention was to give students and teachers a clear indication of what to expect in each paper and allow opportunities for co-teaching AS and A level students.

We did, however, have concerns about how this would impact the demands of the papers and opportunities for demonstrating interconnections between topics, with Paper 1 at a lower level of demand than Paper 2. Therefore, an alternative model that assessed any of the pure mathematics content across both Papers 1 and 2 was also put forward. Both models were debated at length, both within Pearson and with subject experts in schools and higher education.

Drawing on all the feedback collated from the initial design research with internal and external stakeholders, we proposed that the separated pure mathematics content model be put forward for the first submission of the qualification for accreditation.

Table 2: *Assessments for A Level Mathematics*

Paper	1	2	3	
Length (hours)	2	2	2	
Content	AS level pure mathematics	A level pure mathematics	Section A	Section B
			Statistics	Mechanics

Meeting the regulatory requirements

Following the first submission for accreditation, Ofqual carried out a comparative judgement study as part of the review process for all A level mathematics qualifications submitted by awarding organisations. Comparative judgement is a research methodology in which participants compare a series of paired items, after which statistical methods are used to put these in a rank order. This study investigated the consistency of demand across awarding organisations and within papers within each awarding organisation.

Ofqual's expectation was that the demand across the three papers should be comparable. However, the data from the study suggested that this had not been sufficiently achieved in our qualification. The structure of the qualification, with Paper 1 containing content designed for AS level qualifications, put it at a lower level of demand compared to Papers 2 and 3, as mentioned in our discussion of the design phase. This structure also prevented the inclusion of questions which drew upon, and made connections across, the full range of content.

To address this, we moved forward with the alternative model and amended the assessment structure so that Paper 1 and Paper 2 could contain questions on any topics from the pure mathematics content. This ensured that the papers discriminated effectively and provided the balance of demand required.

Delivering the qualification

The final accredited Pearson A Level Mathematics qualification was well received by teachers and has allowed us to continue empowering students to meet their educational goals. Our qualification is unique among our competitors' in that it assesses pure and applied mathematics in separate papers, which helps students focus on the skills required for each. Although we could not define the content in all the papers, having the statistics and mechanics content in a separate paper with separate sections was welcomed. We have also ensured that Pearson is able to offer extensive support to teachers and students.

Following the first full exam series for the qualification in 2019 and feedback from teachers, it has become clear that some of the new skills required have been difficult for students to grasp and a challenge to teach. While we have tried to keep the style of the questions similar to the legacy qualification where possible, so that the teaching and learning of techniques are familiar, mastering problem solving, modelling and communication skills can only come with practice.

We have continued to engage with teachers and mathematics experts to help improve the examination experience for students. Steps taken so far to improve this experience are detailed in **Future assessments in A Level Mathematics**.

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How prepared were teachers and students for the reformed A levels in mathematics?

Pearson

As part of its response to the changing education landscape around A Level Mathematics, Pearson is conducting a study covering four academic years (2017/18–2020/21), in collaboration with the University College London (UCL) Institute of Education. This study is tracking enactment at classroom level and the use and impact of Pearson curriculum resources and A level assessment materials.

The methodology for this study emphasises qualitative, classroom-close data, drawing on termly interactions that include teacher and student interviews, surveys and focus groups, and semi-structured lesson observations. Such longitudinal, classroom-close studies at a reasonable scale are unusual and, since the majority of mathematics A level entries in England are with Pearson, the findings can reasonably be supposed to have wide applicability.

The study draws on teachers and students of mathematics A levels in 13 centres with a range of representative characteristics (for example: socio-economic nature of catchment area, Ofsted category, governance type, size, and student prior attainment). In year 3, for example, it draws on data from 33 Year 13 teachers, 24 classes observed, and 218 Year 13 students. Importantly, the findings help to evidence a grounded understanding of the qualifications, as well as guiding improvements to associated resources and assessments. Data was collected at three stages in the academic year, Autumn, Spring and Summer, to capture evolving teacher and student experiences.

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3rd year of the study

13 centres

33 year 13 teachers

24 classes

218 year 13 students

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The study adopts a grounded, institutional ethnographic approach to analysis and interpretation. All data collection was carried out by mathematics subject specialists, ensuring nuanced and subject specific aspects of enactment could be explored in depth.

Although the year 3 study was disrupted by the COVID-19 pandemic, this offered an opportunity to evidence teachers' and students' responses to associated centre strategies, and exposed other issues around teachers' and students' preparedness for final assessments. The study is being extended into a fourth year in order to further evidence the ongoing impact of the pandemic and explore the third full cycle of new A level enactment, while recognising that in the current circumstances, this remains unstable.

Our data suggests that while teachers in the sample were, in principle, supportive of the intentions of the new A levels, they felt under-prepared in terms of their own professional subject knowledge, and perceived that students faced a large jump in demand from GCSE Mathematics. Their concerns were exacerbated by the comparatively late publication of related curriculum resources and sample assessment materials, which was inevitable given the timescales for accreditation.

Over time, many teachers drew on Pearson's and others' curriculum resources, especially digital resources; on collaborative in-centre work; and occasionally on external courses designed to help develop their subject and pedagogical knowledge. Such development became heavily framed by emerging assessment materials, though over the first three years of enactment, teachers and students remained insecure about some aspects of the assessment intentions. Teachers were often uncertain about the perceived demands of emerging assessment material and felt them to be unhelpfully demanding.

Teachers' overall perceptions of the reformed A levels in mathematics

Teachers who participated in the study were almost all persistently positive about the intentions underpinning the new A Level Mathematics. At least half said they enjoyed teaching for the greater depth of engagement with mathematics, and most valued the increased emphasis on problem solving and reasoning. This was also perceived to be potentially more rewarding for students, particularly the higher attainers.

In addition, throughout the study, many teachers felt that the reformed A levels in mathematics had the potential to create better mathematicians.

> *'It's much easier to make those connections … it helps make a better quality of mathematician'*
> – Teacher interview, Autumn, 2017/18

However, almost all participating teachers had serious concerns about enactment and uncertainty was a key theme in teachers' responses. This uncertainty was linked to initial short timelines, experienced across all awarding organisations, in the development and accreditation of the specification, including the timely availability of appropriate curriculum resources and sample assessment materials.

Most teachers were attempting to respond to significantly increased depth and breadth of content in the new specification, while struggling to adapt their subject knowledge and pedagogical skills, and this left them feeling under considerable pressure.

> *'I wanted to be really prepared and even by March, especially for Further Mathematics, there were still lots of unanswered questions … I felt like I must be really behind, people must know everything, and I'm just left behind'*
> – Head of Maths interview, Autumn, 2018/19

This uncertainty diminished somewhat over time, as more resources were published and teachers accrued experience. Lesson observations showed increasing moves towards intended enactments, but uncertainty remained a key theme. This uncertainty was associated with perceived shifts in the style and consequently the demand of questions in terminal assessments.

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Students' preparedness

The reformed mathematics curricula were unusual in that the new mathematics GCSE (first examined in 2017) was aligned in time and intention with the new A levels (first taught from September 2017). Student interview and survey responses evidenced a key theme that curricular preparedness was less of an issue in the transition from GCSE than the jump in the depth and extent of work needed for mathematics A levels – which were often perceived to be more demanding on time and effort than students' other A levels.

> *'It takes about as much time as our other two A levels put together'*
> – Student focus group, Spring, 2018/19

Most teachers suggested mixed perceptions of student preparedness compared with that under the predecessor GCSE. A minority suggested evidence of better preparation for problem solving, but perhaps weaker algebraic fluency, and those themes became slightly more evident through the study. Teachers increasingly attributed limitations in algebraic fluency to emerging low grade boundaries at GCSE, even for top grade students.

> *'Even if you're looking at … higher sets. There's not the incentive to really major on the algebra. You have to … teach as a foundation for A level'*
> – Teacher interview, Spring, 2019/20

In response to challenges faced by students, Pearson has released new **free videos to support the transition from GCSE to A level**.

Pearson also produces **baseline tests** to help assess students' preparedness for A Level Mathematics.

Pedagogical and subject knowledge

Many teachers reported struggling to adapt their subject knowledge and pedagogical skills. This was particularly the case for more experienced teachers with well-established practices closely tied to the previous specification.

Many teachers were required to teach aspects of mathematics that were new to them. These commonly included at least one of the applied strands (statistics or mechanics), but there were also aspects of pure content, such as proof from first principles, that were unfamiliar to teachers at this level. The challenges of delivering a high stakes qualification at the same time as adapting to its more aspirational mathematical requirements were, for some teachers, very stressful.

> *'I just … feel that I'm letting them down … my teaching of this is awful compared to the way I would want to teach it'*
> – Teacher interview, Spring, 2017/18

A few teachers felt it was a 'gentle transition' (Teacher interview, Spring, 2017/18), perhaps reflecting the varying interpretations, support, or knowledge available in different centres, although almost all teachers reported some initial anxiety.

As the study progressed into its third annual cycle, more teachers were beginning to adapt their subject and pedagogical knowledge successfully, with respondents more likely to identify specific areas they still needed to develop. However, the challenge of doing so in parallel with teaching the reformed specification remained a key theme, particularly in relation to large data set work and the increased emphasis on problem solving and reasoning.

Such concerns highlight the importance of targeted and accessible continuing professional development (CPD) to support teachers in their transition. Most teachers in the study said that they had accessed some level of CPD: either external training programs such as **Pearson's**, or formal or informal A level-specific development in-centre, usually with the support of Pearson curriculum and assessment resources. A wide range of resources is also available on **Maths Emporium** and through the **Pearson Edexcel Maths newsletter**.

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Implementation of the reformed qualifications

Central to the reforms is a greater emphasis on problem solving and reasoning. This was often viewed as both an opportunity and a new challenge for students and teachers.

Teachers throughout the study largely valued the related depth of engagement with mathematics that this encouraged.

> *'I think it's difficult … and it's meant to be. I think the problem solving element makes the first year much more interesting … Because you've always got those questions that are really making them think'*
> – Teacher interview, Spring, 2019/20

However, teachers also reflected that there was a related need for a substantial shift in pedagogical approach, with many teachers feeling under-prepared. This was particularly true given the increased content of the specification, the parallel demands of increased content and the greater target depth of mathematics understanding. This resulted in an increased pace of teaching and learning, with related pressure and increased expectations for independent learning.

Some students also reflected on the increased depth of mathematical engagement required of them, in particular the focus on mathematical problem solving and reasoning, suggesting they enjoyed the additional challenge that came with this. Many students, however, struggled with this element of the course.

> *'The methods themselves aren't too bad … but it's figuring out when to use what'*
> – Student focus group, Spring, 2019/20

This was reflected in teachers' comments, noting that increased problem solving and reasoning creates real challenges for weaker students, and that supporting teachers to adapt pedagogy may be central to allowing these weaker students to succeed.

The large data set (LDS) work required not only new pedagogical approaches, but also technological skills and pedagogy that participating teachers were often not equipped with.

> *'I think I'm very much at a loss to know really what I should be doing with the LDS, or the technology – I'm not a technology teacher'*
> – Teacher interview, Autumn, 2017/18

Implementation of the reformed qualifications

Students throughout the study were often ill-prepared in terms of experience with data analytics software. Both students and teachers expressed sustained uncertainty about how this element would be assessed and what they would need to know.

> *'They just say be familiar with it, but what does that mean?'*
> – Student focus group, Spring, 2018/19

Critique of emerging assessment of this work was widespread, with about half the centres responding by sidelining this element, given the small amount of direct credit for it.

To support students and teachers with the large data set, Pearson has published a range of activities, including teachers' notes and student worksheets. To support the teaching of the large data set, the following resources and graphs are available:

- large data set presentation
- summary statistics
- large data set graphs
- statistics starter for 10

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Resources

Teachers and students were very positive about A Level Mathematics resources published by Pearson. Consequently, over the first year, all centres in the study moved to them.

Tight timelines experienced across all awarding organisations meant that Pearson textbooks were published after first teaching had commenced. However, teachers felt these textbooks were well designed to support both structuring the scheme of work and planning lessons. Pearson textbooks were also seen to support alignment of teachers' subject knowledge with the reformed specification.

> *'I am confident that I can develop my subject knowledge and pedagogical knowledge through working through the textbooks to revise content I have previously covered'*
> – Teacher interview, Autumn, 2018/19

Students enjoyed learning from both printed and digital textbooks and considered them well developed for learning, both in class and independently. Knowing that the textbooks had been designed with the specification and associated assessments in mind gave students confidence that they were covering all the appropriate content.

> *'The textbook covers everything'*
> – Student focus group, Spring, 2018/19

Over time, though, there was concern that questions in textbooks that students were using did not fully reflect the style or demand of those in emerging assessment materials – and that there were insufficient assessment materials to compensate for that. This appeared to affect both teacher and student confidence.

In response, Pearson has published **A Level Mathematics Practice Books**, which are rich in problem solving content. These have been well received, albeit with widespread requests for a digital version, which is in development and will be released in the first half of 2021.

Additionally, an external reviewer has compared the 2019 A Level Mathematics examinations with the textbooks to ensure that the content is fully appropriate. As a result, paper textbooks were reprinted and digital versions updated.

The latest sample assessment materials were published in January 2020 and reflect the changes to assessments discussed in **Future assessments in A Level Mathematics**.

Teacher and student perceptions of live assessments

Teachers and students perceived the Summer 2019 A Level Mathematics assessments to be long and unexpectedly difficult. Prior to grades being issued, many teachers reported perceived under-performance by students. This undermined teachers' confidence.

A large proportion of questions for A Level Mathematics, and in some other emerging materials, were felt to be highly challenging, particularly where they were complex, relatively unstructured and demanded greater problem solving and reasoning skills.

Papers were seen by most teachers and many students as privileging confidence and flair, while not always giving the opportunity for less able students to demonstrate their learning.

> *'A lot of questions I can do most of, if I find the right way in. But in exam conditions I can't reliably do that, so I don't get a chance to show what I can do. The system seems to favour the ultra-confident students'*
> – Student survey, 2019/20

There was also concern that time-pressured and overly aspirational assessments might have repercussions for some students' future relationship with mathematics.

> *'We want all our students leaving their … exams feeling positively about maths'*
> – Teacher survey, 2019/20

These concerns, and changes made to future assessments as a consequence, are explored in greater depth in **Monitoring the performance of assessments: the importance of student experience** and **Future assessments in A Level Mathematics**.

In 2020, the COVID-19 pandemic brought a new set of challenges to the learning and assessment of mathematics A levels. Summer 2020 research questions were adapted to gather evidence of students' and teachers' resulting experiences. More information about grades in summer 2020 can be found on Ofqual's blog.

This data collection took place before grades were issued. At that point, students and teachers felt that the use of centre assessment grades was an adequate approach given the challenging circumstances, although some teachers found the process of grading and ranking students stressful.

Questions also explored the impact of disruptions to teaching. Most Year 13 and 11 students were expected to do little structured work during remote learning, with obvious impacts on their completion and synthesis of the A level and GCSE courses, and thus on their foundations for progression. Year 12, in contrast, were usually expected to engage at scale, though with variable response.

Conclusions and next steps

While teachers and students remain challenged by the new qualifications, they have considerable loyalty to, and trust in, Pearson assessments and resources. This loyalty is linked to the support given by Maths Emporium and the Subject Advisor team.

While recognising the opportunities created by the deeper engagement with mathematics required by the new qualifications, teachers and students also perceived them as time-pressured and perhaps overly aspirational.

The fourth year of the study will explore more consequences of the pandemic and of teachers' increasing confidence with specifications, and will also evidence higher education institution perceptions of students' preparedness for mathematics-intense and mathematics-using university courses, in progression from the new A levels.

In this section

Pearson

Higher education institutions' perceptions of the impact of reformed mathematics A levels on preparation for mathematics-intensive degree courses

The higher education institution (HEI)-focused body driving the direction of reforms to mathematics A levels, the A Level Content Advisory Board (ALCAB), conceived a principal purpose of A Level Mathematics: to prepare students for calculus-using study at university. It similarly conceived a principal purpose of A Level Further Mathematics as being to prepare students for the study of mathematics at university *(ALCAB, 2014)*.

Pearson's Intended Learner Outcomes for A Level Mathematics include that 'Learners have the knowledge and skills to progress to the route of their choice (higher education, further education, employment)'.

Evidence of the extent to which these aspirations are being achieved necessarily comes from beyond 16–18 education. Complementing Pearson's longitudinal A Level Mathematics efficacy study 2017–21, Pearson and University College London (UCL) conducted a small qualitative study in late autumn 2020. This study focused on HEI academics' perceptions of the new mathematics A levels and of their impact on student preparedness for mathematics or mathematics-intensive courses at university. Such perceptions were based on academics' experiences of students in the first two full cohorts who had taken the reformed A levels.

These students' pre-university mathematics experiences will not have been typical of those available once the reformed A levels are established. It is well known that the first enactment of a new qualification is fairly idiosyncratic (for example, *Ofqual, 2016*), and indeed, our broader study shows how challenging it was initially for teachers to adapt their practice to the significant changes intended (for example, *Golding et al., 2020*).

Challenges around enactment are explored in **How prepared were teachers and students for the reformed A levels in Mathematics?**

In this section

In this section

We showed that the second full cohort studying for these new A levels benefited from greater teacher confidence and familiarity – but they were then heavily impacted by the closure of centres to most students from mid-March 2020 because of the pandemic. The students took no examinations, but were awarded centre assessment grades (CAGs), and their experience of synthesis and consolidation of mathematics learning post-March was certainly atypical. Our evidence showed that most centres prioritised other year groups, offering their Year 13 students limited remote input or interaction, at least once the specification had been 'covered'.

Teachers anticipated these experiences having a significant impact on students' readiness for university study. Some students appeared to have engaged very little once it became clear that examinations would not take place, though a small proportion of apparently well motivated and self-disciplined students we surveyed said they felt they had benefited from the flexibility and extended high quality time available to them for synthesis of learning. This range of student responses is likely to have resulted in a greater than usual spread of student preparedness to use mathematics in their university studies, and there was some evidence of that from academics.

Our work with academics draws on two main data sources. First and predominantly, it cites data from 34 responses to a survey purposively targeted at selected academics engaging with first year undergraduates in mathematics or mathematics-intensive courses across a range of 30 universities in England, carried out in December 2020. Second, it draws on transcripts of nine interviews and two surveys from 11 academics at eight fairly competitive English universities, conducted for another study carried out in Spring 2020 *(Golding, 2020)*.

Together, this data emanates from 34 different universities in England (16 of them the most selective Russell Group universities); 31 academics working with first year undergraduate mathematics; and 13 academics whose work includes first year applications of mathematics (mathematical economics, physics, engineering, and study support for the range of mathematics users).

While not fully representative of English HEIs, and drawing on individual academics' views rather than negotiated departmental positions, the views do reflect a wide range of academic backgrounds and student destinations. The data does not relate exclusively to Pearson A levels, since academics are typically unaware of which awarding organisation is the source of students' credentials, but Pearson provides a sizeable majority of such mathematics qualifications.

34 responses

30 universities in England *December 2020*

9 interviews

2 surveys

8 competitive universities in England *Spring 2020*

Academics' overall perceptions of the reformed A levels in mathematics

First, it is important to note that without exception, participants were supportive of the intended changes, although those in more competitive departments often felt A levels still under-serve the most mathematical students. Respondents commonly thought that when taught in depth, the new A levels have the potential to provide well for a wide range of students, including those achieving at less advanced levels, particularly if reasonably high grade boundaries can be achieved.

However, participants continued to show concern about grade boundaries:

'GCSE and AL grades, even Further Maths grades, confuse me because some students with high grades sometimes cannot think – and that's still true'
– Academic interview

'They really need to have mastered the A levels, and the grade boundaries are so low you don't know what they can do, and often it seems to be not the bits that we need to build on in uni. No change there'
– Academic interview

'If an A grade demands only 50% of the marks, that's up to 50% missing, possibly parts of all aspects of the syllabus, so there's very little they're mastering. It'll be different for each of them, but it's not a robust foundation. So either the syllabus or the assessment, or possibly the teaching, need addressing'
– Academic interview

Academics' perceptions of the impact of the new A levels on the first two cohorts varied, but there was limited evidence that the new specifications were yet supporting significant improvements in students' mathematical preparedness for university. While the new A Level Mathematics syllabus has included the additional content required for a smooth transition to higher education, and this has been well received by institutions, there is still a gap in terms of students consistently being able to access and demonstrate their understanding of this content. This has become compounded by the impact of the pandemic on teaching and learning.

Grade boundaries are addressed in **Monitoring the performance of assessments: the importance of student experience**.

Student preparedness for 2019 HEI entry

Participants suggested the mathematical foundations of the 2019 entry cohort had not been markedly different from their predecessors', except that the new common experience of applied strands in A Level Mathematics was valued.

Respondents expressed the greatest relative confidence in students' knowledge – and application in their study area – of basic mathematical facts and core standard processes. Endorsement of these was still variable, however: usually 'adequate' or 'strong' and only rarely 'very strong'.

Data handling and mathematical problem solving and reasoning within students' study area were typically considered 'adequate', while students' ability to model mathematical situations, to engage with unfamiliar mathematical situations, to reason more abstractly, and to communicate mathematically, remained areas for concern, on average considered less than adequate – 'weak' or 'very weak':

> *'Ask them to use logical reasoning, ask them to think outside the box, ask them to *think* about a problem they haven't seen before, and they go to pieces. This is the same every year'*
> – Academic survey

> *'Adapting to novel mathematical situations and reasoning about them directly (as opposed to applying pre-rehearsed method). Ability to communicate mathematical argument. Students have always struggled with these, but this year was perhaps … slightly weaker'*
> – Academic survey

Responses were somewhat less encouraging from those institutions typically admitting students with A grades in A Level Mathematics, rather than A*, and perhaps unsurprisingly, much less encouraging from those typically admitting students with B grades or less. There was a significant unease about limitations in GCSE and very basic A Level Mathematics, notably core algebraic and trigonometric functioning:

> *'GCSE content far too weak – remembering basic facts about trigonometry, basic algebraic manipulations'*
> – Academic survey

> *'They seemed to understand typical A level content but were slightly weaker these last two years on what would be considered GCSE content'*
> – Academic survey

Emerging strengths were usually described in terms of persisting patterns rather than recent improvements. It is worth asking how realistic the depth of some expectations is in the English system and context, especially in less competitive universities which are not able to attract relatively high performing students.

Changes for 2020 HEI entry

In this section

In comparison, perceptions of the mathematical foundations of the 2020 entry cohort varied, but were perceived on average to be markedly weaker than in 2019 – across all categories of mathematical preparedness probed, and for all levels of typical student A level attainment. Concerns about basic weaknesses persisted, especially from students entering with less than an A* in A Level Mathematics.

However, such findings might have been somewhat skewed by the inclusion of seven support academics in the sample of 34 surveyed. We have cited evidence that the conditions under which the 2020 intake completed their A levels might well have led to a wider range of preparedness than usual, and support academics typically see a range of students skewed towards the weaker end. However, there was a little more evidence from academics to support this view.

The unprecedented experiences of this cohort were widely seen to result in lower confidence and greater incidence of unresolved 'imposter syndrome' – partly as a result of the absence of examination-earned A level results. The latter also underlay perceptions that many were ill-equipped to cope with the pressures of university assessments. Some were felt to have a less solid repertoire of well known facts and procedures on which to draw, possibly as a result of variable degrees of consolidation and synthesis of A level learning prior to university during the pandemic.

> *'In 2019 when students lacked confidence or had "imposter syndrome" we could point to their exam results and say that they deserved to be here. This year, there is no such concrete reinforcement of their abilities (in their opinion)'*
> – Academic survey

> *'They are wholly incapable of coping with the stress around university exams because they have no reference point. They lack resourcefulness, initiative and are much more needy than previous years'*
> – Academic survey

On the other hand, there were small and contingent signs that students might be benefiting from their online and then blended mode of experiences, perhaps in terms of independent approaches to the learning of less structured parts of university courses, such as coursework.

> *'I think they were a little more rusty on the recalling facts/ procedures, that traditionally most new students are good at – they didn't have to synthesise their learning to the same extent in the summer. But … their coursework submissions have been at a higher standard than other years (although this could be due to the blended learning approach due to COVID and the introduction of a new marking rubric that is shared with students)'*
> – Academic survey

HEI priorities for further development

Going forward, participants commonly considered that despite the clear aspirations of the new mathematics A levels, many students still needed a more robust repertoire of core mathematics knowledge to bring to university.

> *'They haven't learnt the basics properly. We may as well be starting from scratch with them'*
> – Academic survey

> *'Elementary operations (which are covered at GCSE level), rationalising fractions, manipulating logarithms etc.'*
> – Academic survey

Beyond that, academics prioritised further development of mathematical reasoning, communication, and confidence to engage in novel mathematical situations in their 'wish-lists'.

> *'Logical reasoning; applying maths to the real world; confidence in trying to solve something they have never seen before'*
> – Academic survey

> *'An emphasis on presenting solutions coherently, as well as just getting the right answer. Also, more emphasis on using what you know creatively rather than using standard tools "off the shelf"'*
> – Academic survey

Some thought these skills could be better achieved via a more coherent, discursive experience of school mathematics, with students supported to develop the discussion and problematisation of mathematical concepts, knowledge and processes, and of putative solutions to problems.

> *'It would be better if all students (not just the top end) had incentives to discuss the subject, get used to talking about it, rather than just solving exercises'*
> – Academic survey

There sometimes remained a considerable divide between conceptualisations of mathematics apparently received by students at school and those needed at university.

> *'The majority of our incoming students do not seem to know what maths is. They have little or no familiarity with abstraction, logic, theorems, proof, sets, functions, etc. … The A level syllabus (is still) … excessively fixated on calculus, and devoid of any meaningful exploration of mathematical thinking. Worst of all, A level students are expected to accept mathematical facts unquestioningly. This is the opposite of maths'*
> – Academic survey

It is by no means clear that thorough enactment of the intentions of the new specifications would fully meet this mismatch, so there are also persistent questions for universities about how they address such issues over the transition.

Conclusions and next steps

It is widely known that significant curriculum changes, such as those targeted by the new mathematics A levels, are not achieved quickly or without a variety of robust support. The effects of the initial pandemic hiatus have clearly further impacted students' mathematical preparation for 2020 university entry. The disruption to teaching and learning severely undermines attempts to move towards the widely valued aspirations of these qualifications, and is likely to do so for at least the next three cohorts: students currently in Year 11 have experienced significant challenges to their intended curriculum, and as yet we know little about the mathematics-specific impact of that, positive or negative.

There seems, as yet, little evidence in universities of realisation of the new A levels' aspirations, with widespread concerns about the robustness of basic mathematical functioning from GCSE onward. Academics point to a need for a thorough grasp of the mathematics that students do bring to university, and to the tensions between achieving that and low grade boundaries at A level.

There are tensions also between the mathematical needs of different A level students and their espoused mathematical pathways. Academics would value enhanced mathematical reasoning, rigour, communication, and confidence to engage with new mathematical situations.

Such disjunctures between school and university mathematics practices and expectations are widespread globally, with shifts expected in organisation for learning, forms and purposes of curriculum, pedagogy and assessment, rigour, and formalisation and abstractedness of mathematical knowledge *(Hufton & Elliott, 2000)*. Necessary shifts vary also between different mathematics-using disciplines and across different universities and jurisdictions *(Gueudet, 2008)*.

There is probably a continuing need for university mathematics-using departments to recognise and respond to students' available mathematical functioning, and to support continued growth towards departments' own mathematical aspirations for those students.

Although there is still some way to go in preparing students to confidently progress from A Level Mathematics into university mathematical study, steps have been put into place by awarding organisations to support this work. Within Pearson, support has been provided to meet a number of the issues outlined in this section. Comprehensive transition materials have been provided to help fill gaps in skills and knowledge caused by the pandemic and allow students to be A level ready. In addition, a comprehensive series of training events – including support for online teaching, content exemplification and teacher guides – have helped to ensure both teachers and students were able to engage with the content.

The next steps are to gather thorough feedback in terms of how useful students and teachers have found this support in 2020 and to work with the mathematics teaching community to ensure that support is provided to alleviate the difficulties outlined in this section.

Pearson

Monitoring the performance of assessments: the importance of student experience

It is an important feature of the UK examinations system that examinations are designed to allow students to show themselves to the best of their ability. Part of this is ensuring that when candidates take their examinations, they have a 'good assessment experience'. This means that as they leave the examination hall, students feel like they were able to meet their own performance expectations and that the questions were clear and related to things they had studied, whether or not they remembered it well enough to have come up with the right answers. It is the responsibility of awarding organisations setting those assessments to ensure that the examinations they place in front of students provide those expected experiences.

This section explores how the way A level assessments are created means it is difficult to predict how students will experience them. It then goes on to look at three key points in the review process, which is in place to ensure that high standards are maintained.

Although examples in this section refer to Summer 2019 A Level Mathematics, the processes and review points described apply equally to all General Qualifications assessments taken throughout the whole of Pearson.

There is a more detailed description of the process and the changes made as a result of the assessment performance review in **Future assessments in A Level Mathematics**.

In this section

To ensure the security of assessments in the UK, examinations related to General Qualifications are not pre-tested. This means that the cohort of students being graded sees the examination questions for the first time on the day of the examination. This contrasts with assessment formats used in some other jurisdictions, where items are tested for their performance before being used to determine the grades of students.

In the UK, much relies on the judgement of question paper writers: subject experts who are charged with creating assessments that can differentiate across the full grade range expected. This is very difficult to do because of the complex variables which influence how students understand and engage with questions.

For example, if a unit is designed to cover the basic introductory principles of a subject, it may be filled with more accessible content, and therefore more people will score well on it. Consequently, the grade boundaries are likely to be higher. The difficulty of these estimations is increased when qualifications undergo redevelopment, as A Level Mathematics has, because it is more difficult to consider new questions in the light of past performance on similar items.

Each assessment for General Qualifications by Pearson will have the same lifecycle, shown in Figure 1. First the assessment is designed when the qualification is developed. Each individual assessment will then be written and reviewed by subject experts to meet that design. After the paper is taken, markers go through standardisation, so that they all understand the requirements of the mark scheme and can apply it consistently with each other. Once marking has been completed, the grade boundaries are then set, informed by a range of statistics about both the question paper's performance and the ability of the cohort of students who have taken the examination. Finally, after results, a review process takes place, considering both data from marking and feedback from markers and centres, so that improvements can be made for future assessments.

In this section

Qualification and assessment design

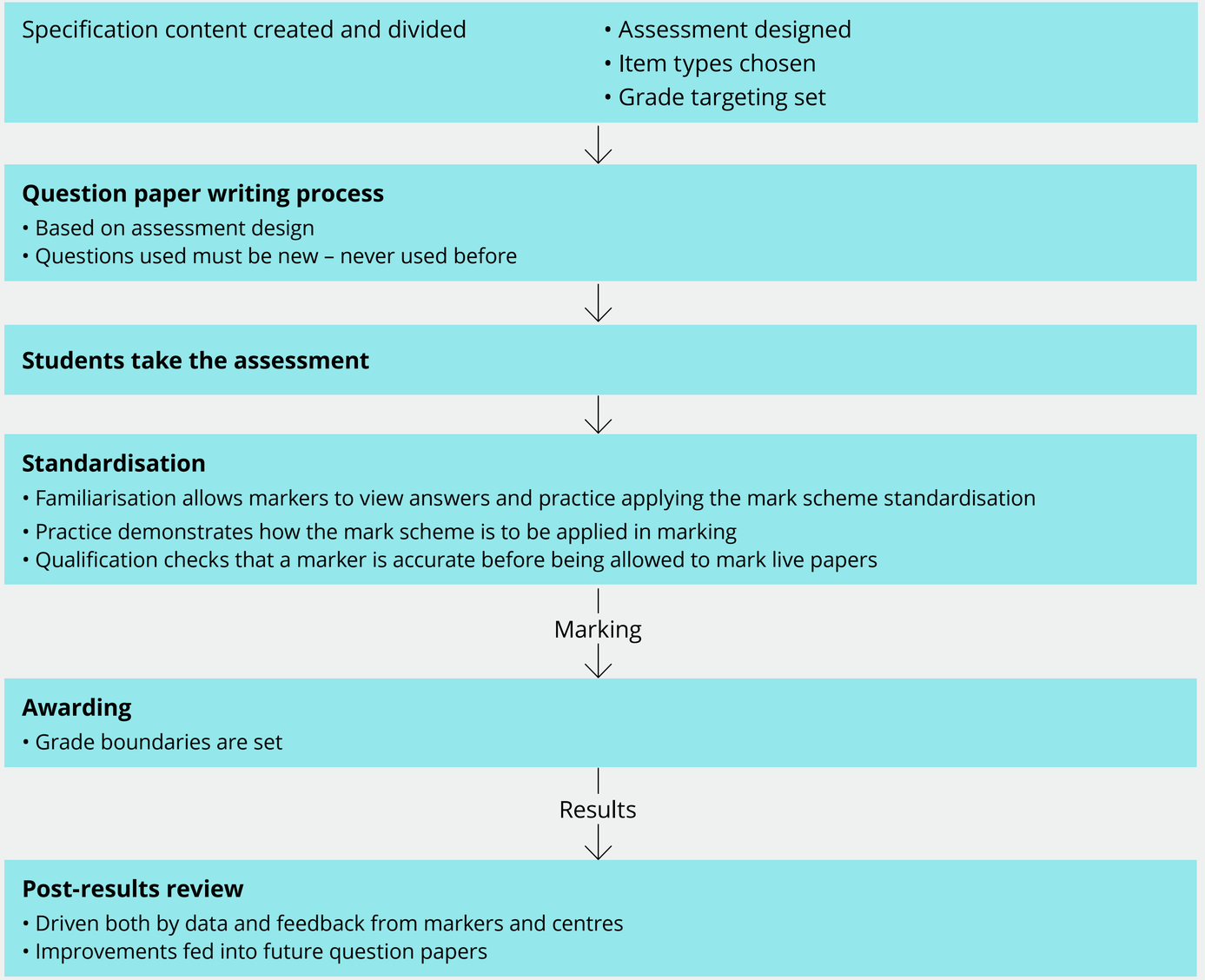


Figure 1
The life of a General Qualifications assessment

In this section

Review points for assessment performance

Familiarisation

Without pre-testing, the earliest opportunity to evaluate the performance of any assessment is after the paper is sat, when markers get the opportunity to look at and reflect on students' answers.

Answers are scanned and made available online to all the subject expert markers prior to the standardisation process. The markers are required to undertake a 'familiarisation' exercise, where they look through the answers in conjunction with the mark scheme. This process has three purposes.

The first is to ensure they come to the standardisation prepared, they have seen the mark scheme, and they begin to understand how to apply it. In short, markers can identify any areas of doubt they may have so that these can be clarified before marking starts.

The second purpose is to test the mark scheme and identify any common answers that have not been included. This means that the mark scheme document, which is used throughout marking and later published with results, is complete and clear.

The final purpose is to start to gain insight into how students have approached and understood certain questions: for example, whether a phrase used in relation to a particular context was understood. Sometimes questions that had been thought to be accessible when they were written over a year earlier actually turned out to be very difficult, or vice versa.

This early stage of review gives an important holistic picture of how an assessment is performing. Evidence gathered at this stage is qualitative and often based on a small sample size, but it provides valuable clues when looking at some of the data available later in the summer.

There are usually only a few days between the answers being made available for familiarisation and the start of the standardisation process. In this time, markers may pass comments to their supervisors, such as 'I was surprised at how good the answers to question eight were', or 'I saw lots of students struggle with question two, where there was a common misunderstanding of the requirements of the question'.

Question difficulty is difficult to reliably establish in advance because of a range of complex variables, and so there are often one or two questions that prove to be more or less accessible than intended. However, these often balance out across the whole assessment, and the question paper is usually at the intended level of demand overall. Consequently, misbehaving items are not usually a cause for concern.

However, for A Level Mathematics in Summer 2019, this was the first point at which evidence began to emerge that students found these papers more demanding overall. Markers noticed a number of items that appeared to be more demanding than intended, and few that proved to be more accessible.

At this stage, the only course of action available to the senior examiners was to review the answers seen against the mark scheme, to make sure that the expectations were not too high, and that good maths was being rewarded at the appropriate level.

Awarding

After marking is complete, but before results can be published, grade boundaries must be set. Setting the grade boundaries every year means that adjustments can be made to ensure that if question papers vary in difficulty from series to series, even by just a mark or two, the boundaries can be adjusted to maintain standards over time.

A wide range of evidence is collected and weighed to inform the grade setting process, including details about the student cohort and their ability, as well as the marks awarded, for every item, every paper, and across the whole qualification.

This is the first time that the full mark distribution can be analysed and considered, and it becomes possible to see how successful the writer was at estimating the performance of their assessment. Question level distributions are also reviewed here to see if the questions performed as expected, whether the anecdotal evidence from the familiarisation exercise was seen in the mark distributions after all items had been marked, or whether mitigations that were built into the mark scheme at standardisation were successful.

If a paper has not performed as well as expected, this is mitigated by the placement of the grade boundaries. This ensures that the students who have been able to demonstrate ability worthy of a grade in their assessments receive that grade and are not advantaged or disadvantaged because of natural variations in the demand of the assessment.

In 2019's A Level Mathematics Paper 1, the mark distribution for Question 13(b) shows that many students were awarded no marks for this part of the question (Figure 2). Those who had managed to understand how to achieve that first mark tended to go on and score well, obtaining most of the available marks. This phenomenon has since been investigated further, and steps taken to address it are covered in Future assessments in A Level Mathematics.

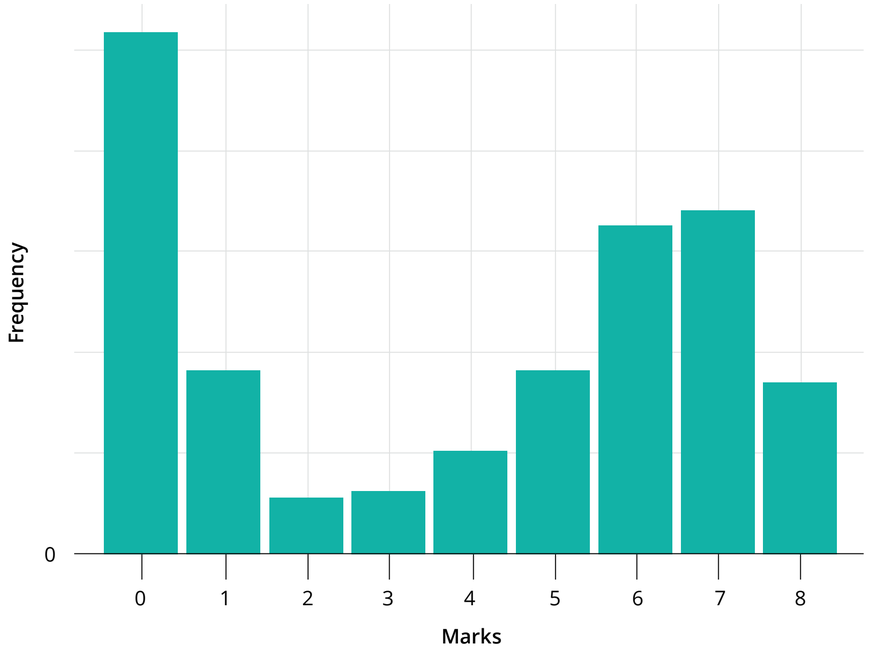


Figure 2

Item mark distribution for A Level Mathematics Paper, 1 Question 13(b) in 2019

In this section

Pearson is committed to continuing improvement in all its assessments. The experience of the students will always be central to this process, and questions such as 13(b) were analysed extensively.

At this point in 2019, it became clear that the A Level Mathematics assessments had not allowed able students to attain as many marks as would be expected. Our research showed that this contributed to student anxiety for those who felt they had not been able to perform well in their examinations. Those worried about achieving a pass will probably only have felt confident about being able to answer 10–15% of the questions, with a few guesses here and there. Their more able classmates, equally reliant on grades for university places, may have felt able to answer around half the paper.

Grade boundaries for this series can be seen in Figure 3. They were selected to ensure students are not disadvantaged by the difficulty of the assessments. Both the A and E boundaries are lower than would be seen in a better performing assessment.

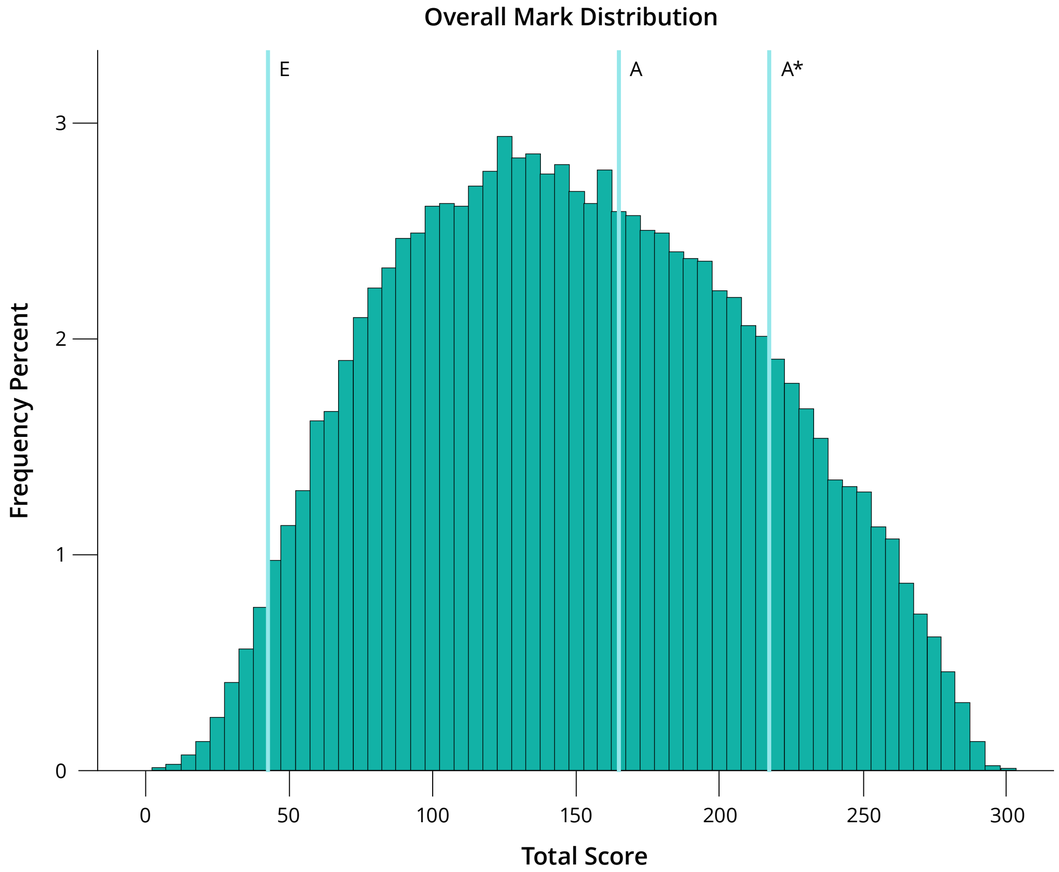


Figure 3

Overall mark distribution in 2019 for A Level Mathematics

In this section

In this section

Post-results

The final point at which examinations are reviewed for their performance is around six months after they were sat by students. At this point, any reviews of marking and appeals have been completed and the results data set is final. Alongside this, feedback from centres and reflections from senior examiners have also been gathered to help contextualise and guide analysis of the data.

An 'assessment functioning report' is produced at this point. This report gives insight into the performance of each examination overall, as well as helping identify which items tended to differentiate students of different abilities – which questions A-grade students tended to get right, but B-grade students did not, for example.

The report is used for two purposes. The first looks back on the previous series and identifies lessons learned for the future. The second informs the writers of future assessments so that they can better target their questions, get a good spread of marks and differentiate across the cohort ability range.

Questions that did not perform as intended, either because they were more or less accessible than expected, are identified and reviewed. With all the evidence available, it is possible to formulate reasons why those questions did not perform as intended.

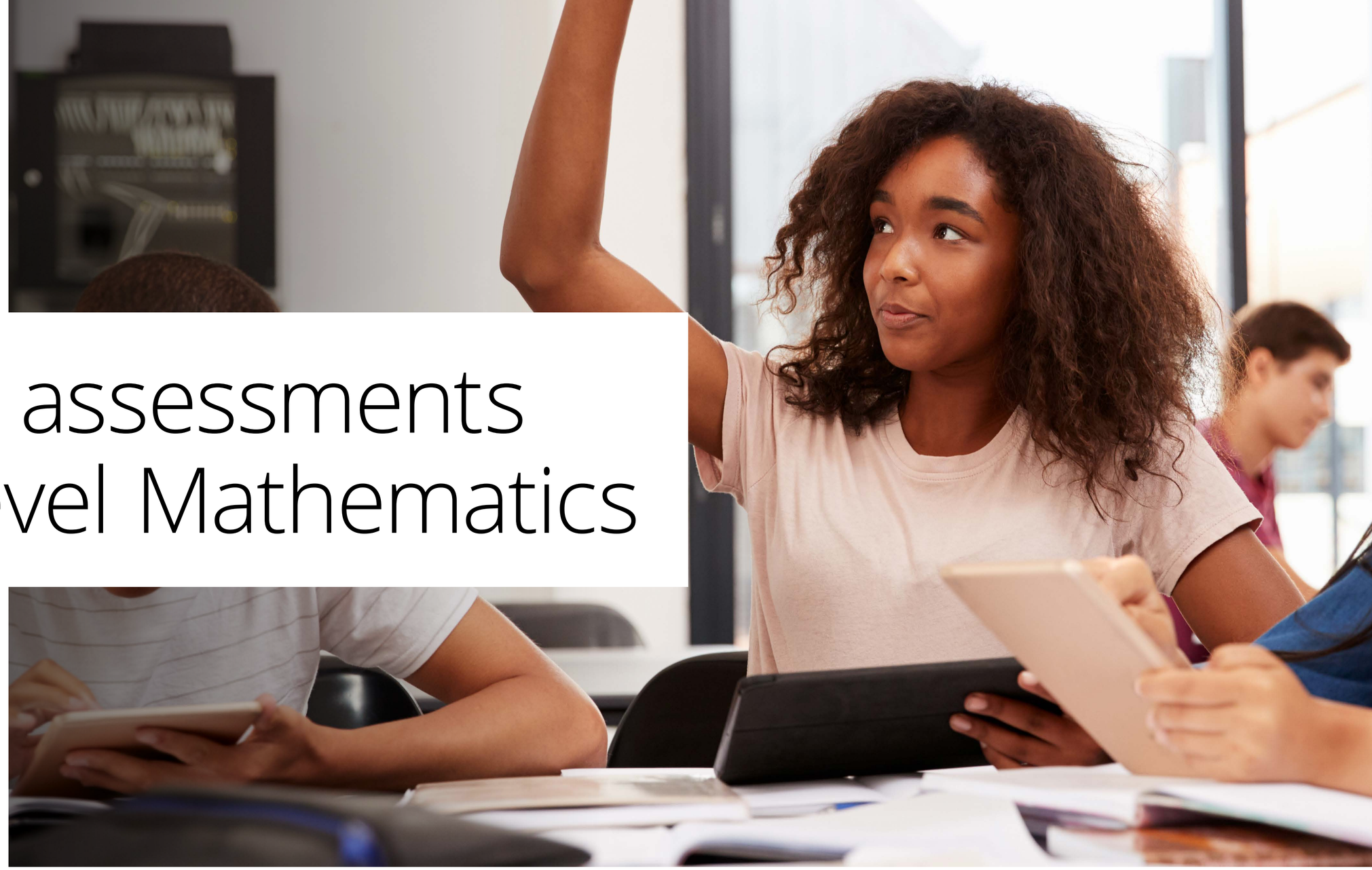
Writers will revisit and update the assumptions behind the grade targeting, amending it for the future. The purpose of this is to focus solely on the functioning of the assessment after the dust has settled, allowing Pearson and the senior examining team to produce better qualifications in future series.

Usually, this would be the final word on a series, as thoughts and preparations move onto the following summer, armed with the knowledge of what has come before. However, following the review of the performance of A Level Mathematics examinations in 2019, and the feedback received from students and teachers supported by the evidence of the data, a thorough investigation and review process took place from late 2019 through the first half of 2020.

This process was unusual and was a response to the performance issues we have identified. How it was conducted, and the outcomes and improvements made to assessments, can be seen in **Future assessments in A Level Mathematics**.

As noted, it is important to ensure that students leave their assessments feeling good about how they did. This section has identified several points at which an assessment's performance is reviewed and considered, with the steps that can be taken to mitigate any issues that emerge. These reviews are built into the question paper writing and marking process for all Pearson General Qualification assessments and are designed to ensure that the student and their final grades are kept at the centre of the qualification.

Pearson



Future assessments in A Level Mathematics

Pearson has been listening to feedback from teachers, students and parents about the A Level Mathematics examinations in Summer 2019, and we have been working to address the issues raised. We have also conducted our own analysis of students' examination performance and explored ways of improving the papers.

We have now made substantial progress towards ensuring that, moving forward, the A Level Mathematics examinations will be accessible to the full range of students.

In this section

How did we first respond to feedback?

Shortly after the Summer 2019 series, we made three key changes, which focused on:

- **ensuring early questions are accessible to all** and then steadily ramping the demand of the questions to increase students' engagement and confidence with them
- **dividing questions into parts** so students are clear where marks can be achieved and can manage their exam timings accordingly
- **using clear, concise language** to better enable all students to access the questions and understand the type of response expected

All questions have now been written with these three principles in mind. Responses from students to the October 2020 paper on the Student Room forum (accessed October 2020) suggest that these changes have already had a positive impact on accessibility.

'This paper was levels easier than last year'
– Student forum post

'Up to like Q6 or 7 I found it really easy but then it got harder'
– Student forum post

What input did examiners have?

Next, we asked our experienced senior examiners to look at the performance data from the summer examinations in a series of workshops. They reported some important findings regarding the accessibility of the papers.

- **The change from modular to linear:** although some effect was anticipated from this, it has had an even greater impact than expected. Candidates must now retain far more information for each assessment. Unlike in modular qualifications, they can no longer narrow their focus to a sixth of the content for each assessment. They must now retain all of it ahead of examinations.
- **Accessibility of new assessment objective (AO) strands:** candidates were finding the new strands – AO2 (communication) and AO3 (problem solving and modelling) – particularly challenging.
- **The large data set:** marks allocated to the large data set were having a negative impact on accessibility, although only a few marks are awarded for this.

In the workshops we discussed what these findings mean for assessing A Level Mathematics in the future. A key takeaway is that, although the way A Level Mathematics is assessed has changed, prior attainment data suggests that the ability of the candidates has remained the same. Therefore it is important that going forward, writers and revisers respond to the performance of candidates under the new assessment model, rather than expecting candidates to behave as they did when they sat the legacy qualification.

We were very pleased that the workshops were so constructive. We received positive feedback from the examiners after the workshops.

> *'One of the best training seminars that I have been on! The attitude of everyone was excellent. The determination and desire to achieve was there. We were all on the same team'*
> – Examiner workshop

> *'So pleased to be a part of this team. Also, so good to be able to talk with people from Pearson, who were approachable and definitely singing from the same song sheet as everyone else. Huge thanks!'*
> – Examiner workshop

In this section

What changes did we make after the workshops?

Changing the number of marks allocated to AOs

The key changes made to address the above points are:

- reducing the number of marks allocated to less accessible assessment objectives
- increasing the number of marks allocated to more accessible assessment objectives

It was interesting to see that some of the AO elements were less accessible in the pure mathematics papers but more accessible in the applied mathematics papers. This may be because on the applied papers, students have historically been asked to interact with models, and they recognise the calculations and the standard scenarios used. Students and teachers may therefore be less surprised by these questions and the level of demand, and be familiar with the type of response required. That is why we have increased the number of marks allocated to these questions.

However, before we could make the changes, the Chair of Examiners needed to analyse the regulatory constraints on each AO strand and on each element within them. The analysis included an examination of the range of marks for each element. This work was important because it demonstrated that there could be some flexibility for writers to increase or decrease the frequency of certain elements, while keeping within the Ofqual regulations.

For future series, we will continue to monitor whether the same elements remain less and more accessible, since it is critical that this insight is fed into the paper writing. We are also committed to making more changes to the papers where necessary in response to new information about students' responses to these elements.

A new approach to assessing standard techniques (AO1)

After much discussion in the workshops about how we should assess standard techniques, we decided to make the following changes:

- increase the number of questions assessing AO1
- release 'trapped' AO1 marks

As we have reduced the number of marks allocated to less accessible AOs, we were able to use some of the remaining marks to increase the number of questions assessing AO1. We were keen to ensure these AO1 marks are assessed in isolation, as this element echoes questions from the legacy qualification that candidates found both routine and accessible.

Another way of creating more items that assess AO1 in isolation was to release some of the AO1 marks that were tied into questions assessing other, more difficult assessment objectives. By reducing the number of 'trapped' marks, we were able to redefine some scenarios and techniques such as problem solving. This enabled us to allocate marks to other assessment objectives, such as AO3.1, and consequently reduce the demand of this assessment objective.

In this section

Helping candidates get off to a good start

We have put more questions that students perform well on at the start of the paper to give them confidence as they start the assessment. We have been able to do this because we now have more knowledge about which questions students find more accessible and more clarity about our high, medium and low demand targets.

Providing more restart opportunities

One of our early improvements was to divide questions into parts. The workshops have enabled us to go further with this by restricting ourselves, where possible, to writing questions worth a maximum of five marks.

However, we recognise that this approach is not suitable for every candidate, so we do not apply this rule for every question. This is why we also give students opportunities to approach the solution in the way they are most comfortable with, rather than it being scaffolded down a particular path.

Some questions had previously been broken into steps in an attempt to guide a candidate through their answer. This had an unintended consequence: where a candidate made a mistake in an early step, it became more difficult to gain marks in later steps. Where the topic allows, this has been changed either to remove the reliance of later question parts on earlier ones, or to ask the question as a single large entity. The approach taken in each case is informed by the topic of the question and on past assessment performance.

Language and reading

A priority has been to ensure that all language used in A Level Mathematics papers is accessible. Our appointed language specialist, who attends key meetings about question setting, led on this.

The language specialist looks at the papers from a non-mathematical perspective and identifies wording that could pose a barrier for some students.

Improvements from this work included the following.

- Employ concise, **clear and straightforward language** to describe simple, age-appropriate scenarios.
- Make more use of **bullet points** to reduce the number of words and to separate key pieces of information.
- **Reduce the reading time** required for each question, where appropriate.
- Remove questions where the reading time outweighed the available marks and replace them with **questions containing simple sentence structures.**

Feedback from students on the October 2020 examination, received from a teacher on Twitter, shows that this approach to the use of language in mathematics assessment has been well received.

'Your mechanics team made a real effort to simplify the language demands this year and keep the challenge about right'
– Teacher's feedback

Use of contexts

In questions that are assessed through context, we now ensure they meet three principles.

- Familiar contexts are described clearly, concisely and in straightforward language.
- There is sufficient variety of contexts so questions are not predictable.
- Questions are still robust mathematically.

Using clear contexts in pure mathematics and mechanics is more challenging than in statistics, owing to the content. The statistics content allows us to use a wide variety of contexts, which can lead to some longer questions. However, as candidates are also answering mechanics questions in the same paper, the time needed to comprehend the contexts in statistics is recovered in mechanics.

In this section

Summary of changes

The Chair of Examiners compared the new papers written for the now cancelled 2021 series to the papers from previous exam series in order to quantify the accessibility measures we have introduced.

In summary, teachers and students will notice:

- an increase in the accessibility of the earlier items
- more short and snappy items (no context, quick to read)
- more items assessing standard techniques
- more starting and (restarting) points
- an increase in the number of shorter questions
- more questions written in a clear, concise manner
- more questions written with short sentences and/or bullet points
- a decrease in the reading time required in non-contextual questions
- a decrease in the number of longer questions

To support teachers and students, we have published **a detailed guide to the changes**. This guide shows what these improvements look like in practice and what can be expected in future examinations.

In addition to this, in light of cancelled examinations in Summer 2021, the latest support and information for teachers deciding the teacher assessed grades can be found on the **Pearson website**.

However, our work does not stop with the changes to assessments identified in this report. We will continue to look for ways to improve our assessments as the A Level Mathematics qualification and the changing educational landscape evolve. In order to do this, we will continue to listen to feedback from teachers, students and parents, and to carefully and regularly monitor question paper performance data.

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