

Assessing new mathematics curricula 16-18 – lessons from developing Core Maths and A level Maths qualifications

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Abstract

Mathematics in Education and Industry (MEI) is a charitable organisation which engages in innovative curriculum development work. They have developed new qualification specifications for both Core Maths (entitled Quantitative Reasoning and Quantitative Problem Solving) and AS/A level Mathematics/Further Mathematics. The OCR Awarding Organisation are responsible for administering the examinations for the accredited MEI qualifications.

Core Maths qualifications had their first examinations in 2016 (taken largely by students from schools and colleges who were early adopters). AS and A levels in Mathematics and Further Mathematics are being redeveloped for first teaching from September 2017.

In this paper a number of key questions, challenges and pedagogical considerations are discussed, including:

- How do assessments in Core Maths differ from GCSE?
- How will questions in the new A levels reflect the new emphases?
- How can problem solving be assessed in examinations?

Conclusions consider the wider curriculum development cycle and praise the extensive support that has been made available, particularly in mathematics, to help teachers to deliver the new qualifications.

1. Background

MEI's involvement in curriculum development includes working on funded exploratory projects such as Integrating Mathematical Problem Solving (Dudzic and Stripp, 2012) and Critical Maths (Dawson and Lee, 2015), as well as developing specifications for national qualifications (OCR, 2017). This gives MEI a unique insight into the process of mathematics curriculum development at a national level.

Here, a brief background of Core Maths and the new mathematics AS/A level qualifications is given before a number of key questions, challenges and pedagogical considerations are discussed. These include incorporation of mathematical problem solving and the assessment of the qualifications.

1.1. What is Core Maths?

The intention of Core Maths qualifications is to provide a pathway for students who have succeeded at GCSE Mathematics but for whom AS or A level Mathematics is not appropriate.

The qualifications offer progression from GCSE Mathematics, developing understanding and skills in the application of mathematics to real problems. Some of the mathematical content is common with GCSE Mathematics but at least 20% has to go beyond GCSE. Students are expected to apply their knowledge in authentic contexts and to be able to think, reason and communicate mathematically.

All students who took Core Maths in 2016 were assessed by timed written examinations at the end of the course.

1.2. New mathematics AS/A levels for September 2017

The new, linear, A levels will have a greater emphasis on mathematical reasoning, problem solving and modelling. The use of technology is expected to permeate teaching and learning of the new AS and A levels and students are expected to work with specific large data sets during the course (Glaister, 2017).

The qualifications will be assessed by timed written examinations at the end of the course and the assessments will reflect the new emphases, but there is no intention that the qualifications should be harder than at present.

2. The aims of Core Maths qualifications

The Core Maths Technical Guidance (DfE, 2015) indicated that the purpose for Core Maths qualifications was to:

“...consolidate and build on students’ mathematical understanding and develop further mathematical understanding and skills in the application of maths to authentic problems, thereby offering progression from GCSE mathematics. Qualifications should provide a sound basis for the mathematical demands that students will face at university and within employment across a broad range of academic, professional and technical fields.”

The mathematical content of the qualifications can overlap with GCSE content but the intention is that students address authentic situations and problems in Core Maths – this is appropriate both in terms of the greater maturity of the students at 18 and in terms of preparing them to be able to use mathematics for further study or work.

2.1. How does the assessment of Core Maths differ from GCSE?

Core Maths assessment items are set in a variety of realistic contexts. To ensure that students are equally familiar with the contexts some qualifications make use of pre-release material which enables the candidates to encounter the context before the examination.

For GCSE Mathematics, marks in examinations must be assigned to assessment objectives with the following weightings over the qualification as a whole at Higher Tier (Ofqual, 2017):

- AO1: Use and apply standard techniques - **40%**
- AO2: Reason, interpret and communicate mathematically - **30%**
- AO3: Solve problems within mathematics and in other contexts - **30%**

There are no nationally defined assessment objectives for Core Maths but there are three qualification objectives with a requirement that objectives 2 and 3 should each have a greater weighting than objective 1:

- Objective 1: Deepen competence in the selection and use of mathematical methods and techniques.
- Objective 2: Develop confidence in representing and analysing authentic situations mathematically and in applying mathematics to address related questions and issues.
- Objective 3: Build skills in mathematical thinking, reasoning and communication.

This means that the emphasis of Core Maths qualifications should be more to do with mathematical problem solving and reasoning than it is to do with using standard techniques. For

the reformed GCSEs, there is a greater number of marks for using and applying standard techniques than there is for either of mathematical problem solving or reasoning.

3. Changes to AS and A levels in Mathematics and Further Mathematics for 2017

Mathematics and Further Mathematics AS and A levels are changing for first teaching from September 2017. In addition to becoming linear qualifications, with all the assessment at the end of the course, there is 100% specified content for Mathematics A level including statistics and mechanics. For Further Mathematics A level, 50% of the content is specified and common to all specifications from different awarding organisations.

It is not intended that the reformed qualifications should be any more difficult than the legacy Mathematics and Further Mathematics AS and A levels which the new qualifications are replacing. However, the new qualifications should have an increased emphasis on mathematical modelling, reasoning and problem solving. The use of technology should permeate the teaching and learning of the new qualifications. Mathematics AS and A levels include working with large data sets for the statistics element.

3.1. How will AS and A level assessment reflect the new emphases?

The development of new qualifications is governed by rules concerning content and assessment. The assessment objectives for A level Mathematics are similar to those for GCSE Mathematics, with the following weightings (Ofqual, 2016):

- AO1: Use and apply standard techniques - **50%**
- AO2: Reason, interpret and communicate mathematically - **25%**
- AO3: Solve problems within mathematics and in other contexts - **25%**

The larger weighting for AO1 at A level, in comparison to GCSE, reflects the new techniques that are being learnt at A level and the need to assess facility with these along with the intention that the new A levels should not be more difficult than legacy qualifications.

Consideration of the proposals for assessment objectives made it clear that reducing the weighting for AO1 from 50% would run the risk of AS and A level Mathematics examinations being suitable for only a minority of the current cohort.

Ofqual called a working group to consider the appropriate assessment of problem solving and modelling in the new A levels. This group produced exemplification and commentary on questions assessing problem solving and modelling at this level (Ofqual, 2015).

3.2. The challenges for teachers

There are a number of challenges for teachers in the change to the new A levels.

The legacy A levels have been unchanged since 2004 (with the only change from 2000 being a reduction in overall content). This means that some teachers have never taught a different course at A level for Mathematics and some teachers were taught the same course as they are currently teaching so they have no other experience. Teachers who feel expert at teaching the legacy AS and A levels may feel deskilled as they face teaching the new courses. Other teachers are positive about the likely benefits to teaching and learning of the new courses.

The long-standing modular nature means that it is quite some time since teachers had to consider how to ensure that students remember all their A level work at the end of a

course. The AS assessment that has been common at the end of the first year of A levels has motivated students to work in the first year of the A level course as they have faced real examinations with results which will form part of their university applications. Schools and colleges have differing policies for the new A levels with some continuing with AS entry after one year to enable monitoring of student progress and others not allowing AS entry. Several reasons have been cited for this, including: to prevent interruption of the teaching for examinations and the extra costs for entering students into additional examinations (AS levels) that will no longer contribute to their A level grade (at a time of change to post-16 funding overall).

The compulsory mechanics and statistics content at A level together with the new emphasis on statistical interpretation and working with large data sets will be new to teachers with some schools not having anyone who has taught mechanics and many teachers of statistics feeling concern about the new requirements.

More rigorous GCSEs in Mathematics will be assessed in summer 2017 with the first cohort of students through the new GCSEs also being the first cohort taking the new AS and A levels. There are reports of students finding the new GCSEs difficult (TES, 2017) with a consequent reduction in numbers expressing an interest in taking A level in some schools and colleges. The changes at both GCSE and A level may also result in teachers feeling less certain about how to advise students about progression in their learning.

4. Assessing problem solving

An increased emphasis on problem solving has been a common feature of the reformed GCSEs and AS/A level in Mathematics and the new Core Maths qualifications. The Advisory Committee on Mathematics Education identified characteristics of questions to assess problem solving (ACME, 2016) and proposed the following implications for assessment and test design when assessing problem solving:

- Avoiding predictability
- Building in choices
- Drawing conclusions
- Probing mathematical thinking

Assessing problem solving in timed written examinations poses different challenges to the incorporation of problem solving activities in teaching. When using problem solving activities in teaching, support is available from the teacher, from reference materials and from discussion with classmates; none of these are available in examinations. Examination tasks must allow students to make a start on the problem independently and should not have methods of solution that are very different in the time taken to implement them.

5. In summary – mathematics curriculum development at a national level

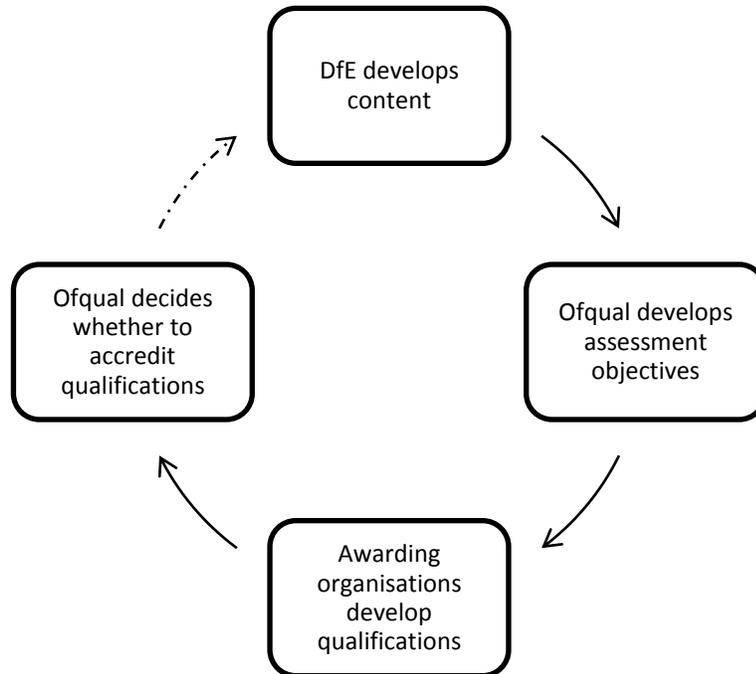
This paper has discussed a number of national mathematics qualifications that have recently been developed. Detail of the aims and emphasis for each was considered, with the assessment objectives and their attributes being seen as a fundamental part in the formation of the qualifications.

The qualifications share similar assessment objectives, which ensure that there is a commonality in the approach and emphasis of assessments, valuing the skills of problem solving and reasoning in mathematics. There are differences in the weightings given to these skills in the assessment of each qualification, ensuring that it has the appropriate emphasis.

An emphasis being placed upon developing mathematical thinking across the qualifications is very welcome. However, it is evident that to assess problem solving is a challenging exercise. Students and teachers will no doubt feel concerned about the lack of predictability of such questions, particularly in the early years for new qualifications.

5.1. The inherent difficulty of the overarching curriculum development cycle

The qualification development system in England has a division of responsibility between the DfE, who are responsible for content and Ofqual who are responsible for assessment and ensuring that qualifications meet required standards. Development takes place in stages.



There is communication between the stakeholders at each stage of the cycle but no possibility of review of content or assessment rules once development of qualifications has started; the only possibility for adjusting qualifications is to start the cycle again by developing new content and rules for assessment and developing new qualifications. Evidently this is a time-consuming and intensive process, but one which the awarding organisations need to adhere to, in order to have their qualifications accredited.

Assessment is the mechanism by which students demonstrate their understanding of a qualification and upon which they are graded. Teachers delivering these new qualifications to the students need to be prepared, and need to be confident in the content and its assessment. It is pleasing to see that awarding organisations and curriculum developers, such as MEI, have been offering considerable support during this period of change.

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