SHORT UPDATE

AS and A levels in Mathematics and Further Mathematics are changing - are you ready?

Paul Glaister[i], Department of Mathematics and Statistics, University of Reading, Reading, UK.
Email: p.glaister@reading.ac.uk

Abstract

The purpose of this article is to give an overview of the reforms to AS and A levels in Mathematics and Further Mathematics, with links to relevant sources of information and resources, to assist colleagues in HEIs with their planning for curricula etc for new entrants in Autumn 2019. The article begins with a brief history of the reforms and their rationale, together with details of the final subject content and nature of the assessment regime in which these sit. The specific details of the eight major changes to Mathematics and Further Mathematics AS and A levels are included. The article concludes with some details on the related specifications and assessment materials provided by the Awarding Oganisations: AQA, OCR, and Pearson/Edexcel.

Keywords: mathematics education, AS/A level reforms, mathematics, further mathematics.

1. AS/A level reforms: history, timeline and rationale

The most recent reform of AS and A levels in Mathematics and Further Mathematics, with first teaching of the new qualifications about start in September 2017, began as far back at 2010 with the publication by the Department for Education (DfE) of the Schools White Paper 'The Importance of Teaching' (DfE, 2010), stating that:

> 'A levels are a crucial way that universities select candidates for their courses, so it is important that these qualifications meet the needs of higher education institutions. To ensure that they support progression to further education, higher education or employment, we are working with Ofqual, the awarding organisations and higher education institutions to ensure universities and learned bodies can be fully involved in their development.'

It wasn't until 2013 that any significant progress began, following the Secretary of State for Education's letter (DfE, 2013a) to the Chief Executive of The Office of Qualifications and Examinations Regulation (Ofqual) saying:

> 'I believe that the primary purpose of A levels is to prepare students for degree-level study. All students should have access to qualifications that are highly respected and valued by leading universities. Current A levels do not always provide the solid foundation that students need to prepare them for degree-level study and for vocational education. The modular nature of the qualification and repeated assessment windows have contributed to many students not developing deep understanding or the necessary skills to make connections between topics. Many leading universities are concerned about current A levels, and nearly three-quarters of lecturers say that they have had to adapt their teaching approaches for underprepared first year undergraduates. As you have found, there is support for much greater higher education involvement in A levels.
>
> There is clear dissatisfaction among leading university academics about the preparation of A level pupils for advanced studies. Mathematicians are concerned that current A level questions

are overly structured and encourage a formulaic approach, instead of using more open-ended questions that require advanced problem-solving.

It is of paramount importance that new A levels command the respect of leading universities. I am delighted that the Russell Group is planning to create an organisation to provide advice to Ofqual on the content of A levels. The advisory body will focus on those A levels which are most commonly required for entry to our leading universities and will seek the views of universities outside of the Russell Group, as well as engaging with relevant learned societies and others. The involvement of respected academics will help to ensure that the qualifications are designed to equip students for university. It will be critical that new qualifications are reviewed each year to ensure that they are delivering the rigorous and high quality education that is needed.'

As a consequence, all AS and A levels have been included as part of the reform process, with consequential changes in subject content, assessment, and particularly the assessment regime, including a change to 'decoupling' AS from A levels, and making A levels 'linear' (see Section 4 for further details). In three subject areas: mathematics, further mathematics; modern foreign and classical languages; and geography, these reforms have been more wide-ranging, and involved a much lengthier and detailed review, with an A Level Content Advisory Board (ALCAB) for each of these (ALCAB, 2013). (See also Smith, 2014, relating to recommendations for review of AS and A level subjects.) The A Level Content Advisory Board (ALCAB) for mathematics and further mathematics was then set up by the Russell Group in June 2013 (ALCAB, 2013) with support from the DfE and Ofqual (DfE, 2013b,c,d,e) to:

'… advise on subject content … and play a lead role in an annual post-A level review'.

Following six months of intensive work during the first half of 2014, ALCAB's first report was published (ALCAB, 2014a), along with an executive summary (ALCAB, 2014b), comprising details of ALCAB's work and recommendations. Additional advice was published at the same time in a letter from Professor Richard Craster, Chair of the Mathematics and Further Mathematics ALCAB Panel (ALCAB, 2014c), along with the highlighting of some issues that needed further consideration on:

'**Continuing Professional Development**. The suggested changes to content and style of A level mathematics may present challenges to existing teachers of mathematics and we strongly advise that continuing professional development courses in mathematics are adequately resourced so as to ensure that all teachers are equipped with the skills they need. The Further Mathematics Support Programme (FMSP) has done a magnificent job: the situation would have been far worse without its influence, and it is important that it is both supported and extended.

Monitoring and future development. The panel views the continued scrutiny of A level Mathematics as essential in order to prevent a recurrence of the problems highlighted in our main report and to see through the implementation of these proposals. It is also important to allow examinations to develop in response to technological changes and also to developments in the subject itself. It is not desirable to have content fossilised at this point in time. There is therefore a need for continuing development to refine and improve the specifications and assessment. There is, for instance, value in having at least one developmental A level specification which has more innovative approaches to content and assessment and tests pedagogy that can later become mainstream (more embedded use of technology, discrete

> mathematics, etc). I have noted that the recently-published Royal Society "Vision for science and mathematics education" (RS, 2014) states that "new, independent, expert bodies that draw on the wider STEM professional community need to be created in England and Wales to determine curricula and assessment in STEM subjects". The ALCAB panel which I have chaired would like to see arrangements of that kind made for mathematics, as in our view it is essential for the matters raised in this letter to be kept under continuous review.'

The Royal Society's Advisory Committee on Mathematics Education (ACME) advises on '3-19 mathematics education policy in England', and with recent changes being made to ACME, (ACME, 2017a,b,c), the Committee will be well-placed to continue to provide this much-needed expert, independent advice to Government.

The final advice ahead of publication of the Subject Content for Mathematics and Further Mathematics can be found in (ALCAB, 2014d,e), with the response from the Secretary of State (ALCAB, 2014f) stating:

> 'I share your desire to see that ALCAB's intentions for these subjects are followed through into practice, generating significant rewards for students and others, not least universities.
>
> ALCAB's work has represented a major part of our commitment to working with universities on A level reform, and we will continue to pursue this commitment with some vigour.'

2. Reformed Subject Content and Assessment

ALCAB's recommendations for Subject Content were accepted in full by the DfE in December 2014, and published at that time (DfE, 2014a,b). It is only over the last few months, however, that teachers in schools and colleges have been finding out more about the implications for teaching and learning, and, of course, assessment. This might be of concern given that the direction of travel was made clear in the Subject Content documents (DfE, 2014a,b), but there is good reason for this. These implications would only become truly apparent once the associated Specifications and Sample Assessment Materials (SAMs) offered by the various Awarding Organisations (AOs, and also known as 'examination boards') had been approved by Ofqual as part of their accreditation process. For a variety of reasons it is only very recently that the AOs have had their Specifications and SAMs accredited, which now gives teachers a much fuller picture of what is expected, and for this reason it is only now that, for many teachers, the intentions and implications of the reforms are being fully understood.

As we are all too well aware in HE, whether we like it or not, assessment drives much of teaching and learning, and in schools and colleges the accountability measures are such that this is inevitable there too, not to mention the pressure on learners to perform well to be able to gain entry to their choice of university and programme. A significant amount of CPD is needed to realise these reforms, and much of this is being provided by the FMSP (FMSP, 2017a,b), often in partnership with the Maths Hubs (Maths Hubs, 2017).

3. Implications for HE

If one asks lecturers in HEIs the question in the title, however, there will be mixed responses, but the response will more than likely be something along the lines: "Changes? What changes?". Given that it will not be until Autumn 2019 when HEIs will admit the first group of students who have studied the reformed AS/A levels, there is ample time for teaching staff to find out more about

the reforms, consider the implications for their programmes and the important school/college-university transition, and to take appropriate steps.

With the reforms as laid out by ALCAB, DfE, (ALCAB, 2014a,b), (DfE, 2014a,b), Ofqual's publication of Subject Level Conditions and Requirements (Ofqual, 2016a,b), Guidance (Ofqual, 2016c,d), and further exemplification (Ofqual, 2015), and publication of Specifications and the all-important SAMs (either accredited, or with accreditation pending) ahead of Autumn 2017, HEIs have much more time ahead of Autumn 2019 to plan than teachers in schools and colleges have had to prepare for first teaching in Autumn 2017.

4. Details of the changes: the 'big eight'

The changes that have taken place and which colleagues will need to become familiar with are eight-fold, and we outline the key points and links to further information and resources for each. We conclude, in Section 6, with links to the relevant specifications from the AOs, and the all-important SAMs, all of which will give those responsible for curricula in departments in HEIs a clearer idea of what students are expected to achieve, and through that a perspective on the changes in the knowledge, skills, and understanding new entrants will have from 2019 onwards, including an appreciation of the fresh approach they will have to learning mathematics, and the way in which they have been taught mathematics. (Note that the first three below, (i)-(iii) apply to all reformed AS and A levels and not just those in mathematics and further mathematics.)

i. **Linearity**. All A levels, including Mathematics and Further Mathematics, are now 'linear', which means that the final grade achieved is based solely on a series of papers (typically 3 two-hour papers for Mathematics, and potentially slightly more, shorter papers for Further Mathematics depending on which AO's specification is being followed) taken at the end of the course of study, typically two years in length, and assessing the *whole* of the Suject Content.

ii. **Decoupled**. AS qualifications continue, but the results from an AS qualification will not contribute to the corresponding A level qualification, be that Mathematics or Further Mathematics.

iii. **Synoptic**. With both AS and A levels being linear, each qualification is intended to be synoptic, with any examination question being able to draw from across the whole of the content in the relevant qualification. While there are no options within Mathematics (see iv.), Further Mathematics retains some optionality, but again within each qualification, regardless of the various strands that are combined to form the qualification, the intention is that this is also synoptic in the sense that examination questions will be able to draw from across the whole of the relevant content.

iv. **100% prescribed content, including mechanics and statistics**. ALCAB's primary aim was: '… to provide modern A levels that: contain the necessary material; will be interesting to learn and teach; will serve HE and employment'.

    That last part is crucial and acknowledged the very wide group of end-users of both AS and A level Mathematics and Further Mathematics. While wishing to ensure that the new AS/A levels would be 'fit for purpose' and serve the undergraduate mathematics community well, particularly at leading universities, ALCAB also wanted to ensure that the current increase in numbers taking AS and A level Mathematics was sustained, and that the success of AS

and A level Further Mathematics, much of which is down to the success of the FMSP, continues.

ALCAB sought to develop AS/A levels whose main aims are to:

a. build from GCSE;
b. introduce calculus and its applications;
c. emphasise how mathematical ideas are interconnected;
d. show how mathematics can be applied to model situations mathematically;
e. make sense of data;
f. understand the physical world;
g. solve problems in a variety of contexts;
h. and, above all, prepare students for further study and employment in a wide range of disciplines.

To achieve these aims ALCAB recommended that the content of the single Mathematics AS and A level be fully prescribed. This would ensure all students had covered the same content, from which they could build upon with some degree of reliability in HE or employment.

It was also essential to go into considerable detail with the recommended content, which was lacking in the previous AS/A levels. The content would also need to ensure that co-teaching of pure mathematics between the single A level in Mathematics and AS level Further Mathematics can be achieved.

As AS/A level Mathematics 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; to understand the physical world; and to solve problems in a variety of contexts, including social sciences and business. It prepares students for further study and employment in a wide range of disciplines involving the use of mathematics. As such the reformed A levels now include compulsory, prescribed content in the two core applications of the pure mathematics at this level: mechanics and statistics.

v. **Use of data in statistics**. A significant change in the reformed AS and A levels is in the requirement that, as part of their study of statistics, students:

a. become familiar with one or more specific large data set(s) in advance of the final assessment (these data must be real and sufficiently rich to enable the concepts and skills of data presentation and interpretation in the specification to be explored);
b. use technology such as spreadsheets or specialist statistical packages to explore the data set(s);
c. interpret real data presented in summary or graphical form;
d. use data to investigate questions arising in real contexts.

Specifications should require students to:

e. explore the data set(s), and associated contexts, during their course of study to enable them to perform tasks that assume familiarity with the contexts, the main features of the data and the ways in which technology can help explore the data;
f. demonstrate the ability to analyse a subset or features of the data using a calculator with standard statistical functions.

The intention is that, rather than students focussing on performing routine calculations to determine summary statistics, they should use technology to do this and then focus on the understanding and interpretation of these statistics.

vi. **Overarching themes**. This is a fundamental part of the reforms. Having stated the aims of the new AS/A levels:

   a. understand mathematics and mathematical processes in a way that promotes confidence, fosters enjoyment and provides a strong foundation for progress to further study;
   b. extend their range of mathematical skills and techniques;
   c. understand coherence and progression in mathematics and how different areas of mathematics are connected;
   d. apply mathematics in other fields of study and be aware of the relevance of mathematics to the world of work and to situations in society in general;
   e. use their mathematical knowledge to make logical and reasoned decisions in solving problems both within pure mathematics and in a variety of contexts, and communicate the mathematical rationale for these decisions clearly;
   f. reason logically and recognise incorrect reasoning;
   g. generalise mathematically;
   h. construct mathematical proofs;
   i. use their mathematical skills and techniques to solve challenging problems which require them to decide on the solution strategy;
   j. recognise when mathematics can be used to analyse and solve a problem in context;
   k. represent situations mathematically and understand the relationship between problems in context and mathematical models that may be applied to solve them;
   l. draw diagrams and sketch graphs to help explore mathematical situations and interpret solutions;
   m. make deductions and inferences and draw conclusions by using mathematical reasoning;
   n. interpret solutions and communicate their interpretation effectively in the context of the problem;
   o. read and comprehend mathematical arguments, including justifications of methods and formulae, and communicate their understanding;
   p. read and comprehend articles concerning applications of mathematics and communicate their understanding;
   q. use technology such as calculators and computers effectively and recognise when such use may be inappropriate;
   r. take increasing responsibility for their own learning and the evaluation of their own mathematical development;

ALCAB wanted to make clear that merely providing a list of detailed Subject Content was not enough to bring about the changes required to make AS/A levels reflect the nature of mathematics at this level. This was achieved by introducing three ‘Overarching Themes’ (OTs) into the Subject Content that encapsulate the knowledge and skills that students should be required to demonstrate:

   I. OT1 Mathematical argument, language and proof
   II. OT2 Mathematical problem solving
   III. OT3 Mathematical modelling

and that these must be applied, along with associated mathematical thinking and understanding, across the whole of the detailed content.

It is important for undergraduate programmes in mathematics, but also for the wider group of end-users in HE, that mathematics is not just seen as a collection of techniques to be mastered. The OTs should permeate the teaching of the subject content, so that 'the whole is more than the sum of its parts'. ALCAB had no remit over assessment, but it hoped that assessments would reflect these wider intentions. Indeed, it identified a number of issues with the current A levels which are intrinsically connected to assessment (ALCAB, 2014a).

vii. **Use of technology**. The use of technology, in particular mathematical and statistical graphing tools and spreadsheets, must permeate the study of AS and A level Mathematics.

viii. **Further mathematics**. The structure of Further Mathematics has changed significantly. The aims remain broadly the same as Mathematics, and is designed for students with an enthusiasm for mathematics, many of whom will go on to degrees in mathematics, engineering, the sciences and economics. The qualification is both deeper and broader than A level Mathematics.

AS and A level Further Mathematics build from GCSE level and AS and A level Mathematics. As well as building on algebra and calculus introduced in A level Mathematics, the A level Further Mathematics core content introduces complex numbers and matrices, fundamental mathematical ideas with wide applications in mathematics, engineering, physical sciences and computing.

The non-core content includes different options that can enable students to specialise in areas of mathematics that are particularly relevant to their interests and future aspirations. A level Further Mathematics prepares students for further study and employment in highly mathematical disciplines that require knowledge and understanding of sophisticated mathematical ideas and techniques.

AS Further Mathematics, which can be co-taught with A level Further Mathematics as a separate qualification and which can be taught alongside AS or A level Mathematics, is a very useful qualification in its own right. It broadens and reinforces the content of AS and A level Mathematics, introduces complex numbers and matrices, and gives students the opportunity to extend their knowledge in applied mathematics and logical reasoning. This breadth and depth of study is very valuable for supporting the transition to degree level work and employment in mathematical disciplines.

In terms of structure and content:

a. A level Further Mathematics has a prescribed core which must comprise approximately 50% of its content. For the remaining 50% of the content, different options are available. The content of these options is not prescribed and will be defined within the different AOs' Specifications; these options could build from the applied content in A level Mathematics, they could introduce new applications, or they could extend further the core content, or they could involve some combination of these. Any optional content must be at the same level of demand as the prescribed core.
b. In any AS Further Mathematics specification, at least one route must be available to allow the qualification to be taught alongside AS Mathematics: the content of the

components that make up this route may either be new, or may build on the content of AS Mathematics, but must not significantly overlap with or depend upon other A level Mathematics content.

c. At least 30% (approximately) of the content of any AS Further Mathematics specification must be taken from the prescribed core content of A level Further Mathematics, and 20% (approximately) of the overall content of AS Further Mathematics is prescribed. AOs must select other content from the remainder of the core content of A level Further Mathematics to be in their AS Further Mathematics specifications; this should represent a minimum of 10% (approximately) of the AS Further Mathematics content.

It is worth noting that Professor Sir Adrian Smith's groundbreaking report published in 2004: 'Making Mathematics Count' (Smith, 2004), identified many of the failings of the curriculum for mathematics at the time, much of which have prevailed until the current reforms:

> 'It is the consensus view that far too much time is devoted to examinations and preparing for examinations – "teaching to the test" – and that this is at the expense of the understanding of the subject itself. Many identify the problem as the splitting of the subject matter of A-level mathematics into six separately examined modules. This is seen as having the effect of splintering the unity and connectedness of the mathematics to be learned at this level. It is felt that this fragmented presentation makes it virtually impossible to set genuinely thought-provoking examination questions that assess the full range of mathematical skills. It is also felt that the style of short examination papers results in a race against the clock that adversely affects weaker candidates.'

The Smith report also includes reference to the Advanced Extension Award (AEA) (Pearson, 2017a) which is an *additional* entry qualification (to A level) favoured by some universities. It is both interesting and reassuring to note that the AEA has some of the key features that ALCAB placed great importance on, in terms of the Overarching Themes and other aspects highlighted in (i)-(viii) above. (AEA is by no means the only *additional* qualification (to A level) favoured, or indeed required, for entry to some of the 'top universities', including many in the Russell Group. See also MEI, 2016.) As stated in the Smith report, AEA:

> 'aims to enable students to:
>
> - demonstrate their depth of mathematical understanding;
> - draw connections from across the subject;
> - engage with proof to a much greater extent than is required in A-level mathematics.
>
> Questions on the AEA paper are much longer and less structured than those in the modular papers. They require a greater level of understanding than for GCE A-level as well as the ability to think critically at a higher level. The AEA is not expected to require the teaching of additional content, but requires exposure to deeper forms of reasoning and rigour, and a less compartmentalised approach to problem solving. Students are awarded additional marks for their ability to develop creative, and perhaps unexpected, solutions to problems.'

It is therefore to be hoped (and expected) that some of the positive attributes of the AEA will feature in the reformed A levels in Mathematics (and Further Mathematics).

5. Assessment

The next crucial step to releasing the full potential of these recommendations is then placed in the hands of the AOs offering the qualifications, together with the regulator, Ofqual, who, in turn, is responsible for scrutinising the Specifications and Sample Assessment Materials provided by the AOs to establish whether or not these meet the relevant criteria. Ofqual make this assessment through extensive use of a highly-experienced External Panel of Subject Experts.

But what are these criteria?

In the main these comprise Assessment Objectives, since, ultimately, students will sit examinations and these must reflect the purpose of the qualification and, in this case, ALCAB's intentions as set out above, including the all-important Overarching Themes. Ofqual achieve this, in part, by setting out Subject Level Conditions and Requirements (Ofqual, 2016a,b), together with Guidance (Ofqual, 2016c,d).

The Assessment Objectives for AS/A level Mathematics, against which marking schemes for assessments are reviewed and which these must be compliant with, are shown in the table below.

	Objective	Weighting (AS level)	Weighting (A level)
AO1	**Use and apply standard techniques** Learners should be able to: • select and correctly carry out routine procedures; and • accurately recall facts, terminology and definitions	60%	50%
AO2	**Reason, interpret and communicate mathematically** Learners should be able to: • construct rigorous mathematical arguments (including proofs); • make deductions and inferences; • assess the validity of mathematical arguments; • explain their reasoning; and • use mathematical language and notation correctly. *Where questions/tasks targeting this assessment objective will also credit Learners for the ability to 'use and apply standard techniques' (AO1) and/or to 'solve problems within mathematics and in other contexts' (AO3) an appropriate proportion of the marks for the question/task must be attributed to the corresponding assessment objective(s).*	20%	25%
AO3	**Solve problems within mathematics and in other contexts** Learners should be able to: • translate problems in mathematical and non-mathematical contexts into mathematical processes; • interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations; • translate situations in context into mathematical models; • use mathematical models; and • evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them. *Where questions/tasks targeting this assessment objective will also credit Learners for the ability to 'use and apply standard techniques' (AO1) and/or to 'reason, interpret and communicate mathematically' (AO2) an appropriate proportion of the marks for the question/task must be attributed to the corresponding assessment objective(s).*	20%	25%

Each of the Assessment Objectives are subdivided into Strands, and each Strand is also subdivided into Elements (Ofqual, 2016c,d). It is these, together with further exemplification provided by Ofqual in these regulatory documents, that an AO's Specifications and SAMs must be compliant for the associated qualifications offered by them to receive accreditation, and thence candidates for these to be awarded an AS or A level qualification in Mathematics. Similar Conditions, Requirements, and Guidance, with variation to allow for the optional component, apply to Further Mathematics (Ofqual, 2016b,d).

Clearly AO2 and AO3 map onto, respectively, OT1 and OT2, and additional exemplification of the Guidelines for the Awarding Organisations, particularly in respect of mathematical problem solving, modelling, and the use of large datasets, all of which are integral to these reforms, have also been provided (Ofqual, 2015), each of which can be summarised as follows:

I. **Mathematical problem solving**

> 'Mathematical problem solving is a key feature of GCSE and AS/A level Mathematics. It is clear from the subject-content documents for these qualifications that mathematical problem solving is not just for the highest-achieving candidates: it is a core part of mathematics that can and should be accessible to the full range of candidates. For AS and A level Mathematics and Further Mathematics, mathematical problem solving is described in OT2. These OTs are a set of descriptions intended to inform and shape the teaching and learning of AS and A level Mathematics and Further Mathematics.
>
> One way to explore how best to assess problem solving is to consider the possible attributes of assessment of problem solving tasks. (Problem solving tasks in this context are understood to mean a set of requirements focusing on one problem. These tasks may be broken down into a number of steps or parts (that is, items), but this should not undermine the expectation for AS/A level candidates to demonstrate their ability to solve problems as a coherent process.)
>
> The following list contains examples of some of these attributes. These would be expected to be present in tasks that focus primarily on the assessment of problem solving, but may also arise in questions designed primarily to assess other aspects of the detailed subject content and that contain a problem solving element. It is not necessary for every problem solving task to exhibit all of the following attributes, although at least one attribute should apply for a task to be regarded as problem solving:
>
> A. Tasks have little or no scaffolding: there is little guidance given to the candidate beyond a start point and a finish point. Questions do not explicitly state the mathematical process(es) required for the solution.
> B. Tasks provide for multiple representations, such as the use of a sketch or a diagram as well as calculations.
> C. The information is not given in mathematical form or in mathematical language; or there is a need for the results to be interpreted or methods evaluated, for example, in a real-world context.
> D. Tasks have a variety of techniques that could be used.
> E. The solution requires understanding of the processes involved rather than just application of the techniques.
> F. The task requires two or more mathematical processes or may require different parts of mathematics to be brought together to reach a solution.'

(Note that: not all of these attributes would be required within a single task to establish it as problem solving; neither does the presence of one or more attributes within a task automatically imply problem solving is taking place.)

II. **Modelling**

'Mathematical modelling is covered comprehensively in the Subject Content in a variety of different contexts. For the purposes of assessment, modelling is currently included in the same Assessment Objective (AO3) as problem solving. As with problem solving, modelling is encapsulated within the Overarching Themes in the Mathematics and Further Mathematics Subject Content documents, as OT3.

The content requires candidates to construct their own models, as well as to use known and given models and assumptions, reflecting on the potential impact of their modelling assumptions.'

III. **Large data sets in statistics**

'The subject content for A level Mathematics requires candidates to be familiar with one or more specific large data sets, to use technology to explore the data set(s) and associated contexts, to interpret real data presented in summary or graphical form, and to use data to investigate questions arising in real contexts. This requirement reflects a desire to change the way in which statistics is taught, and this has implications for assessment.'

6. Specifications and Sample Assessment Materials (SAMs)

The first part of reforms is therefore almost complete, with accredited Specifications and SAMs available for first teaching in September 2017. The next part will be soon underway with students embarking on the new AS/A levels, and so we conclude with links to the relevant Specifications and SAMs for the different providers of qualifications that are on offer, with an AS/A level Mathematics and AS/A level Further Mathematics available for each.

The ones that are on offer are:

- AQA - AS and A level Mathematics and Further Mathematics (AQA, 2017) and available via http://www.aqa.org.uk/subjects/mathematics/as-and-a-level.
- Pearson - AS and A level Mathematics and Further Mathematics (Pearson, 2017b) and available via https://qualifications.pearson.com/en/qualifications/edexcel-a-levels/mathematics-2017.html.
- OCR A - AS and A level Mathematics and Further Mathematics (OCR, 2017a) and available via http://www.ocr.org.uk/qualifications/by-subject/mathematics/as-a-level-maths-from-2017/.
- OCR B (MEI) - AS and A level Mathematics and Further Mathematics (OCR, 2017b) and available via http://www.ocr.org.uk/qualifications/by-subject/mathematics/as-a-level-maths-from-2017.

We encourage teaching staff, and programme and module leads, to review all of these. They will give those responsible for curricula in departments in HEIs a clearer idea of what students are expected to achieve, and through that a perspective on changes: in the knowledge, skills and understanding new entrants will have from 2019 onwards; their approach to learning mathematics; and the way in which they have been taught mathematics.

7. Summary

In concusion, we believe it important that all colleagues should be made aware of the substantive changes here: mechanics and statistics becoming compulsory; the change in emphasis for statistics, including the use of large data sets, particularly to inform teaching; the importance of the Overarching Themes: Mathematical argument, language and proof; Mathematical problem solving; and most importantly the removal of scaffolding in some questions compared with current practice.

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[i] The author is in the unique position of having been the only person involved in all aspects of this process through being a member of the: A Level Content Advisory Board (ALCAB); Ofqual External Subject Expert Panel on Conditions and Requirements, and Guidance; Ofqual Working Group on Mathematical Problem Solving, Modelling and the Use of Large Data Sets in Statistics; Ofqual External Subject Expert Panel (as the Overarching Reviewer) for the accreditation of all AS and A Levels in Mathematics and Further Mathematics.