

Department for Education consultation

Reformed GCSE and A level subject content consultation: GCE Mathematics and Further Mathematics

September 2014

1. About ACME

The Advisory Committee on Mathematics Education (ACME) is an independent committee, based at the Royal Society and operating under its auspices, that aims to influence mathematics education strategy and policies with a view to improving the outcomes of mathematics teaching and learning in England and so secure a mathematically enabled population.

2. This response

ACME's response to this consultation has been informed by discussions with the mathematics community and ACME's Outer Circle of advisors. ACME has also submitted a range of consultation responses and documentation on A level in recent months.¹ In addition, in August 2014 ACME convened a meeting for learned societies, subject associations and other organisations interested and involved in the development and implementation of GCE Mathematics and Further Mathematics. During this meeting many of the issues set out below were discussed. ACME has also written a response to the Ofqual consultation.²

3. Content

AS/A level Mathematics

3.1 The recommendation from the A level Content Advisory Board (ALCAB) is that the content of both AS and A level Mathematics is 100% prescribed. A common core:

- can support users of the qualifications including Higher Education Institutions (HEIs) and employers by making them aware of the mathematical skills that a student should have learned and therefore provides a helpful basis for progression
- can support students who move from one school to another where a different awarding organisation's qualifications may be taught³
- offers the potential for innovative learning resources to be developed.

3.2 In the current A level system it has often been the case that "choice" of modules has been driven by teachers or schools and depends on what their centre can offer. In addition, learners may not always understand the impact or effects of their choices. However, the introduction of fully prescribed qualifications will require centres to adapt their teaching and resourcing. This will prove especially challenging for many smaller schools and colleges. As is the case with many of the proposals, targeted

¹ <http://www.acme-uk.org/policy-advice/current-areas-of-focus-for-acme/a-level>.

² <http://comment.ofqual.gov.uk/developing-new-qualifications-for-2016/>.

³ <http://www.acme-uk.org/media/11319/positionstatementalevelmay2013.pdf>; <http://www.acme-uk.org/media/10163/acme%20response%20to%20ofqual%20consultation%20on%20a-level%20-%20final%20submitted.pdf>

support for centres and investment in professional development is required to ensure the success of qualifications with fully prescribed content.

3.3 The content of AS/A level qualifications needs to be carefully examined by the Department for Education (DfE) and Ofqual to ensure that fully prescribing such qualifications in mathematics does not lead to too much content in the specification at the expense of depth of knowledge. At the A level roundtable convened by ACME on 28 August, some representatives had concerns about what they saw as too large a qualification at both AS and A level. Other representatives believed that the size of the qualification, in terms of content, was broadly correct. However, as will be noted in more detail below, participants emphasised that greater clarity was required as to how to achieve the aim of encouraging more problem solving and modelling in the learning and teaching of the new specifications.

AS/A level Further Mathematics

3.4 The proposal in the consultation is that a core of pure mathematics is valued at 50% of A level. The argument is that this would allow a coherent body of knowledge to be studied by students taking A level Further Mathematics, but also would leave space for specialisation for learners. It is appropriate that anyone who has obtained a GCE Further Mathematics qualification has covered certain identified content that is not in A level Mathematics. Flexibility in further mathematics qualifications and distinctiveness of options available, with students taking modules useful for their future educational and career paths has been integral to AS/A level Further Mathematics qualifications and the remaining content must provide a range of options for students.

3.5 In the consultation it is stated that leaving material unspecified allows for innovation on the part of awarding organisations in developing the remaining content. However, Ofqual and the DfE should state how awarding organisations will develop the remaining content. They should set out how they intend to ensure that there is consistency across awarding organisations in the AS/A level Further Mathematics qualifications that are offered.

3.6 The proposals for AS Further Mathematics seem unnecessarily complex (Paragraph 7, *Further mathematics - GCE AS and A level subject content* document, see footnote for more detail).⁴ This should be looked at in more detail and potentially simplified. It may make AS Further Mathematics more desirable to end users if 50% were prescribed.

3.7 Some aspects of paragraph 7 quoted below could make the content unworkable as a coherent specification. It is stated that AS Further Mathematics 'must not overlap with, or depend upon, other A level Mathematics content'. Without including some material that is dependent on A level Mathematics, the AS Further Mathematics qualifications are likely to be incoherent. Allowing some such dependency would increase the relevance of the AS Further Mathematics material, for example more mechanics

⁴ Paragraph 7, p. 5 states 'The content of AS Further Mathematics must introduce new content, build from the AS content of A level Mathematics, or a combination of both. It must not overlap with, or depend upon, other A level Mathematics content. A minimum of 30% of the assessment of AS Further Mathematics must address the prescribed core content of the further mathematics A level. Core content that must be included in AS Further Mathematics is indicated in sections A to C in bold text within square brackets, and this must represent 20% of the overall assessment of AS Further Mathematics. In addition, a minimum of 10% of the assessment must address other prescribed core content of the further mathematics A level, which can be selected at the discretion of the awarding organisations.', See:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/330359/Further_mathematics_GCE_-_subject_content_-_final.pdf.

would be helpful to those intending to take engineering at university. The content of AS Further Mathematics must either introduce new content, build from the AS content of A level Mathematics, or ensure a combination of both. At the meeting convened by ACME on 28 August, it was highlighted that the sentence quoted above was not clearly drafted and should be examined more closely and adapted to ensure that its meaning is clearer.

Co-teachability

3.8 It is noted in the ALCAB report that co-teaching of pure mathematics between the single A level and AS level Further Mathematics should be achievable.⁵ ACME believes that the co-teaching of the current applications modules between the qualifications is one of the strongest contributing factors behind the increases in students taking mathematics qualifications, especially AS Further Mathematics. There must be a continuing transferability between AS/A level Mathematics and Further Mathematics, which should enable the gradual extension of students' commitment.⁶

Statistics

3.9 The change in approach to statistics is largely to be welcomed. However, there are a number of resource implications to be borne in mind, including but not limited to the need for investment in professional development. The reorientation of statistics content towards large data sets may prove difficult for teachers and learners. It may be that this aspect needs to be more gradually implemented. Further consideration and subsequently an implementation plan is required before publication of a final draft of the specification.

Decision Mathematics

3.10 The current Decision Mathematics modules differ from other modules in GCE Mathematics. Many of the participants from the 28 August roundtable noted they were content with its removal from AS/A level Mathematics. ACME is supportive of this view. Awarding organisations can take the decision, in consultation with mathematics experts, about whether to include Decision Mathematics in GCE Further Mathematics courses or to adapt it for other subjects beyond mathematics.

4. Emphasising problem solving, interpretation and the testing of understanding

4.1 The emphasis on problem solving and modelling is welcome, as is the emphasis on mathematical argument, language and proof. In the ALCAB report it is stated that content from the current AS/A level specifications in mathematics has been removed so as to make more space for problem solving. This is broadly to be welcomed. However, more clarity is required about the meaning of problem solving and interpretation in this context, and more information is needed about what this would mean in practice in terms of teaching, learning and assessment.

4.2 For teachers, teaching these skills is time consuming. It may also differ significantly from previous practice. There will need to be an investment in professional development for teachers of mathematics, as well as significant investment during initial teacher education to ensure that teachers of mathematics are trained in how to teach these skills.

⁵ <https://alevelcontent.files.wordpress.com/2014/07/alcab-report-on-mathematics-and-further-mathematics-july-2014.pdf>.

⁶ <http://www.acme-uk.org/media/14317/final%20acme%20response%20-%20new%20a%20level%20regulatory%20requirements.pdf>, p. 4.

4.3 For learners, the majority of students will not have previously been taught or learned in a way that would allow them to succeed in this system. Many of the skills, such as problem solving, are aims of the new National Curriculum. However, it will take over a decade for this learning to feed through, if implemented correctly and assessed rigorously through the GCSE examination. It needs to be recognised that incremental change and innovative means of support are required.

4.4 Assessment, rather than the specification, frames the way in which students are taught in the classroom. As ALCAB was limited to looking at content alone, more work is needed to ensure that the goals of integrating problem solving and other skills into the learning and teaching of mathematics are realised in assessment. Ofqual must ensure that the assessment objectives and assessment align with this new content and the emphasis on problem solving and other skills. There must be a sufficient range of assessment instruments to ensure validity of assessment. Awarding organisations must develop examinations which fully assess the content set out in GCE specifications and the skills set out in those specifications.

4.5 Improving the validity of assessment of A level Mathematics is not a short term process and rather requires a much longer timescale, somewhere between five and ten years.

5. Other comments on the Department for Education consultation documents

Use of technology

5.1 It is specified that students can use calculators in examinations to enable them to compute summary statistics and access probabilities from standard statistical distributions. This clarification should enable more up to date teaching and assessment. However, there needs to be recognition that an increased use of technology will make increased demands on resources, which will stretch some centres in teaching and potentially assessment. More clarity is needed about the place of technology in learning and assessment in mathematics and the investment that there would be in ensuring that technology is used effectively.

5.2 There must be coherence across the DfE and Ofqual consultations about the place that will be given to technology in the assessment of mathematics.

Initial teacher education and professional development

5.3 The changes that are proposed have the potential to improve the mathematical education of young people. ACME supports the work the work on professional development being undertaken by the Maths Hubs and work of the Further Mathematics Support Programme. It is clear that for the proposals to be achieved, significant further investment in initial teacher education and professional development is required.

Participation in GCE Mathematics

5.4 In recent years, participation in AS/A level has been a success story.⁷ Reform that aims to realise the potential of students of mathematics is to be encouraged. However, as has been well documented,

⁷ ACME has highlighted its concerns about potential detrimental effects for the uptake of AS/ A level Mathematics and Further Mathematics. In recent years AS/A level Mathematics and Further Mathematics are growth subjects. In 2014, 89,497 students took A level Mathematics and 14,484 students took A level Further Mathematics, a rise of 0.4% and 2.6% respectively from 2013 entries. AS Mathematics and Further Mathematics had entries of 16,200 and 24,402, rises of 7.1% and 9.3% on the previous year.

mathematics uptake can be vulnerable to changes in the system, with an enormous decline in uptake following the 'Curriculum 2000' reforms. Reform needs to be undertaken carefully and in a staged manner.

5.5 ACME has expressed concern about the potential negative impact of a 'best 3 A level measures' on the provision of mathematics for 16-19 students.⁸ As A level Further Mathematics is often taken as a fourth A level, ACME welcomes that from 2016 students that study four A levels and large TechBacc programmes will receive around £400 more per year than their basic funding. Those studying five or more A levels and the full International Baccalaureate will receive around £800 more. However, the funding is directed to 'stretch [the] brightest state students' and therefore will depend on the student achieving at least grade Bs, or equivalent, in all their subjects.⁹ This payment will also be paid in arrears, which may affect centres' and students' decisions.

5.6 The funding decision, combined with the decision for performance measures to be based on a student's "best 3" A levels may affect participation.¹⁰ The new arrangements will not fund learners to start on four AS courses and then drop to three A level courses, which could be particularly harmful for AS/A level Further Mathematics participation. If the 3 A level measure is retained, funding must be provided to centres for all students taking AS/A level Mathematics and Further Mathematics in addition to their three A levels, i.e. the funding should not be just for "bright students", that is those who achieve at least a Grade B.

5.7 In addition, other funding models must be considered so that funding is not only allocated on the completion of the qualification. This works against the idea of students taking more mathematics over time. The AS/A levels system has worked well in recent years as students had clear stepping stones between qualifications and had the potential to study more mathematics as their confidence grew. AS/A level Mathematics and Further Mathematics all serve different purposes. Students begin by taking the components that make up the AS level qualification, but can then build upon this foundation and undertake the full A level if they find that they are coping well with the demand of the subject.

5.8 In implementing new qualifications with separate AS and A level qualifications, the DfE and Ofqual need to provide clarity on the possibilities for progression within this system.

5.8 ALCAB suggested that there is a staged linear approach in which papers taken in Year 12 and Year 13 should count towards both AS and A level Further Mathematics. This needs to be considered carefully. Other options also need be considered. Monitoring and evaluation is required of the implementation of new qualifications is required and there needs to be the possibility for adaptations to be made if a decline in uptake is recorded.

⁸ <http://www.acme-uk.org/media/14031/acme1619accountability.pdf>;
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/337867/DfE_consultation_response_16-19_Accountability_final.pdf.

⁹ <https://www.gov.uk/government/news/government-pledges-funding-to-stretch-brightest-state-students>.

¹⁰ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/337867/DfE_consultation_response_16-19_Accountability_final.pdf ; <http://www.acme-uk.org/media/14031/acme1619accountability.pdf>.