



Consultation on proposed GCE AS and A Level Subject Content for Biology, Chemistry, Physics and Psychology

SCORE's response to the Department for Education consultation.

A separate response will follow concerning the Ofqual consultation.

20 December 2013

SCORE is a partnership of organisations, which aims to improve science education in UK schools and colleges by supporting the development and implementation of effective education policy. The partnership is currently chaired by Professor Julia Buckingham and comprises the Association for Science Education, Institute of Physics, Royal Society, Royal Society of Chemistry and Society of Biology.

Timescale for reform

SCORE has supported the desire to review and reform A-levels since the initiation of this process¹. However, we have raised serious concerns regarding the process and pace of reform².

The issues that we outline in this consultation, and those that we raise in our response to the Ofqual consultation, are mainly rooted in shortcomings of the reform process. SCORE strongly recommends that the introduction of new science A-levels is postponed for at least one year for the reasons set out below.

In summary, reform should be delayed for these reasons:

- A-levels must provide progression from GCSEs. GCSEs in the sciences are currently being reformed for introduction to schools in 2016. It is our understanding that the new A-levels are intended to provide progression from the reformed GCSEs, which are still under development. It is only possible to ensure that A-levels achieve coherent progression by basing them on finalised GCSE criteria. This will not be possible with the current timetable.
- Mathematics A-level is currently being reformed to a different timetable and a different process, making cross-subject coherence impossible to achieve (see page 4 below). A-level mathematics requirements for the three sciences must be thoughtfully mapped against the development of AS- and A-level content in mathematics. We recommend that the reform of science AS- and A-levels is delayed in line with the reform of mathematics AS- and A-levels.
- Additionally, the student cohort taking their GCSEs in 2015 and 2016 will progress to the new A-levels but will have studied the existing GCSE courses (in both mathematics and the sciences). Those who start their A-levels in 2017 will have taken the new mathematics GCSE and the existing science GCSEs. All three year-groups, and particularly the first two, will be markedly disadvantaged compared with later cohorts of students taking the reformed GCSEs, which place a greater emphasis on the development of quantitative skills in science.

Therefore, SCORE proposes:

- Reformed A-levels are piloted in schools from 2016, for national rollout in 2018. This would allow for research into concerns outlined below; give Ofqual an opportunity to test new reporting procedures; give schools the chance to get used to new qualifications; and finally, ensure that the first cohort studying new GCSE and A-level qualifications are not a test case for reform.

¹ SCORE's response to Ofqual's A-level reform consultation 2012; <http://score-education.org/media/11200/alevel.pdf>

² Letter to Professor Mark Smith, Reform of Biology, Chemistry and Physics A-Levels; June 2013 <http://score-education.org/media/13440/letter%20to%20mark%20smith%2024june13%20final.pdf>; Letter to Joint Council for Qualifications, Review of A-level subject content, September 2013 <http://score-education.org/media/12310/20130516%20score%20to%20aqs%20re%20al%20reform.pdf>;

Practical science and assessment

Practical work in the science subjects is not an additional component of teaching and learning; it sits within thinking and working scientifically and is intrinsic to a full learning experience for students. Any change to the assessment of practical work must consider the necessity to uphold the status of practical work in schools and in content criteria.

SCORE defines practical work as follows:

Practical work in science is a 'hands-on' experience which prompts thinking about the world in which we live. It is made up of a core of two activity types:

- *scientific techniques and procedures, both in the laboratory or the field, and;*
- *scientific enquiries and investigations.*

Each of these core activities not only supports the physical development of skills but also helps shape the understanding of scientific concepts and phenomena. The hands-on approach offered by practical work often challenges students' preconceived ideas and as a result deepens their scientific understanding. In addition, teacher demonstrations are a valuable experience of practical work in science experience. They allow, for example, students to gain firsthand experience of more spectacular experiments. Demonstrations are also useful for modelling scientific procedure, thus enabling students to develop their own skills.

We have serious concerns about the proposal that the direct assessment of practical skills will be reported separately to A-level grades. This will be further explained in SCORE's response to the Ofqual consultation. It is vital that the stakeholders involved in using students' grades are directly consulted on their perspective towards the new reporting procedures.

SCORE believes that direct assessment can form part of the final grade in the A-level sciences, and would like to see more work done in this area to explore ways in which to do so.³ SCORE and other organisations have plans in place to contribute to this process by comparing and analysing the efficacy of models currently used in practical assessment and identifying a list of practical skills necessary to have had an authentic experience in each science subject.

The introduction of fieldwork to A-levels in Geography indicates that Ofqual has the means to develop new methods of, and regulate, direct assessment in other subjects. SCORE believes that by isolating the sciences as subjects in which direct assessment cannot form part of a final grade, Ofqual is sidestepping the important question of what best practice in practical work looks like.

SCORE also notes that at GCSE level it has been deemed appropriate and feasible to report practical science assessment as part of the overall grade, despite the larger cohort size at GCSE; this further calls into question the approach being proposed at A-level.

SCORE recommends:

- Some elements of practical work are assessed directly and practical work is included in the main A-level grade rather than being reported separately.

³ Recent research demonstrates possibilities: Ian Abrahams, Michael J. Reiss & Rachael M. Sharpe (2013) The assessment of practical work in school science, *Studies in Science Education*, 49:2, 209-251, <http://dx.doi.org/10.1080/03057267.2013.858496>

- Different models of direct assessment of practical work should be compared and analysed in order to make an informed decision on the most appropriate form of assessment that is best able to differentiate student abilities and create a stimulating and representative experience of the subject in the classroom.
- Stakeholders that use science grades (employers, industries, Higher and Further Education) should be consulted directly on the new reporting procedure proposed for practical skills, whereby marks for practical skills will be published separately on student certificates.
- The proposed reporting procedure should be thoroughly modelled and tested in order to understand any unintended consequences that it may stimulate.

Curriculum Committees

The SCORE member organisations are in an advantageous position to convene cross-sector expertise in the science subjects across school levels from 5-19. We have worked with the Department for Education in a positive manner to advise on the reform of GCSEs and the National Curriculum. However, SCORE expertise has not been drawn on in the reform of A-level content or assessment. The professional bodies – Society of Biology, Institute of Physics and Royal Society of Chemistry – are establishing Curriculum Committees which will be responsible for developing a comprehensive view of an appropriate school science curriculum, from primary to university entrance, on behalf of each society. This will include:

- developing content criteria for biology, chemistry and physics qualifications;
- providing guidance information on appropriate assessment models for biology, chemistry and physics qualifications;
- defining the essential skills needed for successful progression to higher education in biology, chemistry and physics – including the practical, mathematical and computational skills required.

The Curriculum Committees are in process of being established. However, given the very limited window available for the A level reforms in science, their work will not be completed within the timeframe for this consultation. Instead, the Committee will undertake this work in parallel to the reforms, and publish its findings in the Autumn term 2014.

SCORE recommends:

- Curriculum Committees are involved in the reform process and the Committees' expertise taken into account in the development of new science A-levels.

Content and assessment

SCORE is mindful that the Department for Education and Ofqual have occasionally consulted together on related activities. However, on the whole during this reform process, assessment has been divorced from content drafting. SCORE believes that it is impossible to separate content from assessment, where both define the ways in which students learn. Conducting reform of content and assessment in parallel rather than in unison has had a

negative impact on the reform of A-levels. These negative impacts will be highlighted further in SCORE's response to the Ofqual consultation.

Furthermore, the reform of A-levels has occurred in isolation from the reform of GCSEs, therefore coherence across key stages has not been retained and there is a risk that subject content will either be needlessly repeated or lost entirely at A-level.

SCORE supports the aim to design content and assessment in order to develop students' knowledge and skills. Current reform to GCSEs indicates that the double award in science will remain a major route through which students progress to A-level sciences, therefore content and assessment design at A-level must be based on double award content criteria at GCSE in order to be accessible to the majority. We are concerned that subject content requirements for A-level have been defined in relation to current GCSE criteria in *each science* (paragraph 3 of the proposed content requirements). This implies that new A-levels will be developed on pre-reform GCSEs and that only students who have taken triple science at GCSE will have access to all the content contained in the new A-level sciences.

Ideas within and across the science disciplines are interlinked and part of a consistent and coherent interpretation of the world. It is essential that interrelated ideas across biology, chemistry and physics are properly addressed in criteria for awarding organisations. An exercise of this kind needs to ensure that students studying only one science will acquire a core understanding of that subject, while also ensuring that those students taking two or all three science subjects are not faced with too much overlapping content.

SCORE is concerned that paragraph 8 in the subject content document contains statements that are vague or difficult to assess (Appendix 1). It is essential that any statements of student competency and knowledge must be clear, precise and indicate how in which the expectation would be assessed. The wording of this paragraph should be reconsidered as a definition of Working Scientifically, this proposal is explained below, page 8.

SCORE recommends:

- A-level content and assessment reform must be considered holistically.
- A-level content should be reviewed and mapped against the reformed GCSE content to ensure progression from key stage 4 to 5, from both the double award and triple award science qualifications.
- The subject criteria should stipulate that A-levels in the sciences must be accessible to those who take double award science at GCSE.
- Paragraph 8 needs further work on wording and clarification of how students would show whether they have achieved what is expected in the general sections (Appendix 1).

AS-level content

Given that AS-levels are being decoupled from A-levels more attention also needs to be paid to the choice of content and division of content, between the two qualifications in order to ensure that those students only taking AS-levels in the sciences still experience a representative breadth of the subject at that level.

Given that AS- and A-levels are going to be co-taught, there is a concern that content and mathematical requirements in the sciences have not yet been carefully chosen and divided

across the two years. AS-level students must experience extended investigation, synoptic questions and study key content in the sciences and we propose that expectations of AS-level competencies be given due consideration in the development of content criteria.

SCORE recommends:

- The content contained in AS-level qualifications is reconsidered, and division of content clarified.

Mathematical skills in A-level sciences

It is essential that mathematics in the A-level sciences is embedded effectively in A-levels in order to demonstrate that mathematics is integral to the process of *doing* science. SCORE is pleased to see that exemplification of mathematical skills has been included in the proposed subject content document. Exemplification is a positive inclusion that indicates the type of mathematical skill applied in the sciences. However, SCORE believes further work is needed to ensure that coherence is retained across the science subjects.

For example, the mathematical skills exemplified in biology appear to be at a lower level than those in the other sciences. In addition there are some mathematical requirements contained in the content for the other sciences that are relevant to biology but have not been included in biology requirements (Appendix 3).

Currently, the difference in weighting of mathematical skills across the three sciences is unsupported by evidence. It may be the case that awarding organisations have conducted studies on best practice in weighting mathematical content in the sciences; however it has not been made available. A consistent approach to the inclusion of mathematics across the sciences, based on evidence and a robust rationale, would enhance the overall aim to ensure that students are confidently applying mathematical skills to science investigation.

This year, the Department for Education released plans for a core mathematics qualification that is intended to encourage more students to study mathematics post-16, particularly those with a B or C at GCSE. SCORE believes that those students studying the sciences who do not take AS- or A-level mathematics are in need of some version of post-16 support in mathematics. In 2009, the percentages of students taking A-levels in the sciences without A-level mathematics were as follows: Biology, 62%; Chemistry, 41%; Physics 22%.

With its emphasis on statistics, probability, and modelling, SCORE feels that some of the content contained in the core mathematics qualification is also suitable for those students studying the sciences who do not take mathematics AS- or A-level. It is perverse that a cohort of non-science students will be expected to take a core mathematics qualification, while students with A grades in GCSE mathematics will be able to continue to study science subjects at A-level without taking either AS-, A-level or core mathematics qualifications.

There is currently no mechanism for ensuring that students studying any of the sciences also continue with a post-16 mathematics qualification. This impacts negatively on mathematics requirements in the science criteria, as criteria cannot be based on any mathematics that builds further than GCSE level requirements. It is important that current reforms take into account these limitations on levels in mathematical requirements in A-level science criteria. SCORE proposes that students studying the sciences at A-level should be expected to

continue some form of post-16 mathematics study, either AS-level mathematics or in a related or similar vein to the core mathematics qualifications.

SCORE recommends:

- The evidence used to decide mathematics weightings in the sciences is made available.
- Exemplification of mathematical skills is further refined to reflect consistency of mathematical requirement and topic across subjects.
- Particular attention is paid to the mathematics exemplification contained in the biology content.
- The new core mathematics qualification is developed alongside reforms to ensure that there can be coherent and mutually supportive package of mathematics and any (or all) of the sciences up to A-level.
- The Department for Education take this opportunity of reform to coherently develop core mathematics qualifications, alongside AS- and A-level mathematics and science qualifications, to provide a complete range of mutually supportive and appropriate qualifications for students studying the sciences.

Drafting and ownership of subject criteria

It has come to our attention that awarding organisations were heavily involved in the drafting of the subject content criteria in the sciences. This represents a clear conflict of interest. The criteria will be used by Ofqual to judge whether awarding organisations' specifications meet appropriate Conditions of Recognition. It is clearly inappropriate for those criteria to be written by the awarding organisations themselves. Awarding organisations operate in a competitive market driven by commercial interests and the motive to attract school and college custom. In addition, there is no guarantee that awarding organisations are able to consult with a full range of stakeholders on content or that awarding organisation subject experts are entirely neutral in the approach to criteria drafting.

Although it appears that Ofqual will own the subject content criteria once they are finalised, this has not been made obvious. The heavy involvement by the Department for Education and awarding organisations in this process has highlighted a vacuum in regulation within the education system. All subjects will require review and renewal of content over time; without clear guidelines for ownership and a regulation strategy there is a risk that content will not be reviewed effectively.

SCORE recommends:

- The question of subject content ownership must be clarified as soon as possible and the regulation strategy for monitoring content over time is published.

Awarding organisation requirements

SCORE supports the principle that subject criteria should define a proportion of the content required for awarding organisation specifications, and is happy with the stipulated sixty per

cent. However, we would like to see some requirements about how awarding organisations can make use of the remaining forty per cent.

It is likely that awarding organisations will use this flexibility in order to differentiate their specifications from each other, which is a positive step if it provides schools and colleges with genuinely innovative approaches to learning the sciences. However, we would want to see the space within the specifications being used appropriately: to ensure that students are given opportunities to deepen their understanding of the subject, and that ways of thinking scientifically and doing practical work are integrated. It can also be used to provide engaging and contemporary contexts for the subject content.

Given that the content in the remaining forty per cent will be decided and developed by the awarding organisations, it is essential that suitably qualified subject experts from a range of backgrounds are involved in the accreditation of the specifications, to ensure accuracy and appropriateness of the content included. Awarding organisations should also consult closely with end users while developing their qualifications, to ensure that content matches their needs. We note that Ofqual is currently recruiting for these roles. Involving subject experts will mitigate these mistakes.

Curriculum Committees (as above) comprise a full range of expertise from teachers, academic subject experts, education researchers, higher education, and curriculum developers required in the accreditation process. The Committees should be considered as qualified experts in the accreditation of specifications.

SCORE recommends:

- The content requirements section is re-drafted to contain clear guidance on ways in which awarding organisations can use the forty per cent of unspecified subject content.
- Suitably qualified subject experts are involved in the accreditation of the specification and example assessment items.
- The professional bodies in the sciences are commissioned to provide the subject expertise required in the accreditation process as per the role defined in Ofqual's recruitment circular.

Working scientifically

SCORE is concerned that there are two different interpretations of working scientifically contained in the document. The requirements bullet pointed on page four are a good description of ways in which students must be able to think and work scientifically; however, the skills and behaviours listed in Appendix 5 on page 22 are inaccurate as a definition of what working scientifically entails, acting rather as a description of approaches to, and expectations of, the experience of doing practical work. It is also not clear for what purpose the Working Scientifically appendix has been included. Many of the qualities described are not assessable, therefore it is not possible to relate these to assessment objectives proposed in the Ofqual consultation.

SCORE recommends:

- Paragraph 8 on *skills, knowledge, and understanding* on page four should be re-drafted as an explicit statement on working scientifically.

- Appendix 5 is redefined so that it is linked to skills that will be assessed, its purpose clarified, and its heading re-titled so that it avoids confusing the phrase ‘working scientifically’.

Big Ideas in the sciences

SCORE is pleased to see that the big ideas in science have been successfully incorporated into the reformed GCSE subject content criteria for the sciences. SCORE proposes that the big ideas are carried over into A-level sciences too, in order to guarantee that the main principles in the sciences are cross-referenced throughout and ensure that A-level students and teachers are aware of these principles.

The ability to understand and make synoptic connections across the big ideas in each science is an essential competency for any student entering higher education to study science, therefore students must be introduced to a deeper understanding of the big ideas during their AS- and A-level studies building on the GCSE criteria.

SCORE recommends:

- Including a statement on the big ideas in A-level science in the final subject content document.