SCIENCE COMMUNITY REPRESENTING EDUCATION

Reformed GCSE subject content

SCORE's response to the Department for Education consultation

20 August 2013

Introduction

1. 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.
2. In summary:
    a. SCORE supports the principle of reforming GCSEs, particularly if the opportunity is taken to ensure that appropriate qualifications are available in the sciences for the entire cohort, both those continuing to further study in the sciences and those not doing so.
    b. However, SCORE is concerned that the criteria outlined in the consultation are written only for those progressing to further study, who have a choice of routes: a double award and separate sciences. There will therefore be no suitable qualifications for a large part of the cohort.
    c. The proposed criteria define too much content, over too great a breadth, and much at too high a level, for GCSE students to understand deeply, which will lead to superficial learning. Increased rigour and challenge come from improving assessment schemes and assessment items rather than from increasing the amount or level of the specified content.
    d. Given that the criteria specify the entire proposed content of the GCSEs, it is difficult to see an argument in favour of the existing model of competing awarding organisations, since there will be little room for variation between their specifications.
    e. SCORE has produced guidelines[1] for key stage 4 that outline recommended content for biology, chemistry and physics (plus earth science). These are structured around 'big ideas' for each of the sciences, and it is hoped that they may prove useful for those tasked with revising qualifications and curriculum for this educational stage.
    f. SCORE is pleased that there will continue to be direct assessment of practical work. It is important that the central role of hands-on practical experience in education in the sciences is emphasised and recognised within qualifications.
    g. SCORE is also pleased about the emphasis throughout the criteria on the use of mathematics, but has some suggestions about how this content could be presented within the document.
    h. It is important that there is a clear progression of content from key stage 3 to key stage 4, and on to key stage 5 for those who wish to study further. However, the process used to determine the content of programmes of study at these different stages, with separate consultations and a restricted timeframe, means that it is very difficult to ascertain whether content is included appropriately.

[1] Available at http://score-education.org/media/12525/ks4%20guidelines%20final%20version.pdf

General comments

3. SCORE has provided subject-specific feedback on the criteria in appendices; the comments that follow below relate to all three sciences. SCORE is also responding to the Ofqual consultation on GCSE reform, and our response to that consultation will be available on 3 September 2013.
4. SCORE supports the principle of reforming GCSEs, and hopes that the opportunity can be taken to design qualifications appropriate to the needs, interests and aptitudes of all students at key stage 4.
5. Studying science is a core requirement at key stage 4. Qualifications should provide a useful and engaging experience for all 16 year olds, including those who will not become scientists or take science A-levels. At the same time, there is a need to prepare some students with the specific knowledge and skills they will require for further study in science subjects. There is a tension between these two requirements.
6. The review process has not addressed this tension. There has been no discussion about the needs of the majority of the cohort – i.e. those who will not become scientists. Consequently, there has also been no discussion about how to accommodate those needs at the same time as preparing some students for A-levels in the sciences.
7. The published criteria have been designed primarily for qualifications aimed at those students intending to continue studying the sciences beyond 16. Whilst this approach seems appropriate for the separate GCSEs in physics, chemistry and biology, it is not necessarily appropriate as the main driver for the double award in science.

Double award in combined science

8. SCORE is pleased that there will continue to be a combined science GCSE. It provides some reassurance that all students have the option of achieving a qualification in all three sciences at key stage 4, particularly since SCORE is not confident that the current accountability measures will protect the core sciences in a balanced way.
9. We do not believe, however, that the double award, as it is currently envisaged, meets the needs outlined above. We understand that the Government's primary aim for the double award is the same as that for the separate sciences: to prepare students for further study in the sciences, predominantly A-levels. However, this leaves a large part of the cohort without a course of study in the sciences that fits their needs.
10. Some students not intending to progress to further study in the sciences will still find either the separate sciences or the double award suitable, but there are significant numbers of students for whom that is not the case. SCORE would like to see further consideration of high quality alternative provision in the sciences being made for these students. The detailed prescription within the criteria does not allow the development of a range of appropriate courses for all student aspirations and aptitudes.
11. Whatever its stated purpose, the double award in science needs to be designed as a coherent programme, with the appropriate content and rigour. The double award as it is currently specified does not meet these aims, since it appears as though the content has been devised by removing, in some cases, more challenging aspects of topics, while

retaining the full range of content. The amount of content retained in the double award will present considerable staffing and timetabling challenges.

12. SCORE would like to see a consultation that leads to a clear statement about the purposes of science education up to 16 and how the needs of all students can be addressed. Therefore, our comments about content pertain to the separate sciences. Comments about the style and structure of the criteria statements will apply to double science as well.
13. SCORE is planning to carry out research into appropriate routes in the sciences for students at key stage 4, and will make the findings available when the research is completed.

Criteria for the separate sciences

14. SCORE supports the intention of the Government to provide GCSE courses that are challenging for all, including the most able, and to ensure that qualifications are rigorous and well-respected. However, increased rigour and challenge come from improving assessment schemes and assessment items rather than from increasing the amount or level of the specified content.
15. The proposals define too much content, over too great a breadth, and much at too high a level, for GCSE students to understand deeply. It is preferable to have a smaller number of ideas that are studied and assessed in depth than to have a large number of ideas that are studied and examined superficially.
16. SCORE has produced guidelines for key stage 4 qualifications[2] that outline recommended content for biology, chemistry and physics (plus earth science). These are structured around 'big ideas' for each of the sciences, and it is hoped that they may prove useful for those tasked with revising qualifications and curriculum for this educational stage.
17. SCORE has concerns about the use of command words in the criteria. Their inclusion will have a narrowing effect on what can be specified, assessed and taught. Additionally, in many cases there has been an inappropriate choice and number of command words used. If command words are to be used, they should 'earn their place', in other words should only be used when they are necessary to be precise about what students need to be able to do, and only those commonly used by the awarding organisations should be included, and their use should be consistent across the three sciences. It may be helpful to include a glossary defining each one.
18. The criteria document should be addressed to awarding organisations and what they are expected to do when preparing their specifications and assessment, rather than stating what students should be required to do.
19. The subject content outlined in the consultation for all three of the sciences is highly specified, stating that they represent the 'full range of content' for the qualifications, which we take to mean that they define a complete programme of study. This will leave little room for the development of variation between specifications designed by awarding

[2] http://score-education.org/media/12525/ks4%20guidelines%20final%20version.pdf

organisations. This raises the question of whether there is any benefit in having a market in qualifications with competing awarding organisations. There are a number of drawbacks associated with this existing model:

a. A market for qualifications forces competition on price and outcome (in the form of exam results) for schools, rather than the quality of assessment, which has contributed to a race to the bottom;

b. It entails mechanisms to ensure inter-board comparability, which distort decisions about areas such as grading;

c. The costs of examinations take up an increasing part of schools' budgets, which has an impact on the resources available for other aspects of learning, as SCORE's research into the resourcing of practical work has shown[3].

20. This also highlights difficulties with the processes used for the reform of the National Curriculum programmes of study for key stages 1 to 3, the criteria for GCSEs and the programme of study for key stage 4. The use of three separate processes has made it very difficult to ensure progression between key stages, and SCORE is concerned that there will be insufficient time before the publication of the key stages 1 to 3 programmes of study to ensure that content is aligned. This is of particular concern since there are areas of content currently included in the key stage 4 programme of study (for example, classification in biology) that are not included in the revised GCSE criteria.

21. An audit is needed to establish whether the amount of content specified in the criteria represents a manageable programme of study for students at key stage 4, both for the three sciences and the broader curriculum. This audit should also look at whether the content is apportioned appropriately between the four assessment objectives according to their weighting. There is also poor correlation between 'subject aims and learning outcomes' and the subject content that follows, and this should be addressed.

22. SCORE is concerned that the assessment objectives are unbalanced, with AO2 covering too many skills and too much of the assessment. This has the potential to lead to imbalanced assessments since it could lead to awarding organisations focusing on too narrow a range of skills within the assessment objective.

Working scientifically

23. The exemplification of working scientifically within the three science disciplines is a welcome addition. However, significant work needs to be carried out to ensure that the examples given are much more representative of each subject, to ensure that they do not become the de facto entire working scientifically content of GCSE courses. It may also help for them to be included alongside the content in the same way as the mathematical content is currently specified.

24. Further work is needed to exemplify working scientifically for the double award combined science course, as some of the examples given relate to the content specified for the separate sciences, for example nanoparticulate materials.

[3] SCORE's research is available at http://score-education.org/policy/curriculum/practical-work-in-science

25. The use of current terminology such as repeatability and reproducibility is welcome. This needs to be carried into the assessment objectives, so that words like ‘unreliability’ are removed.

26. There are opportunities for working scientifically to present a more current range of scientific techniques and approaches rather than continuing the restricted and outmoded view of scientific endeavour presented in the national curriculum.

Practical work

27. SCORE is pleased that the subject criteria continue to reflect the central place that practical work has in the learning of the sciences, and that practical work will continue to be assessed directly, and contribute to students’ final grades. However, further exemplification and explanation of the types and purposes of practical work are required, including a revision of assessment objective 4.

28. Practical work in science serves a number of purposes, including the provision of first-hand experiences to support the learning of science content. This aspect can be assured through a set of core practical activities that have to be carried out and signed off by the head teacher.

29. We also expect students to develop good procedural understanding of how to plan, carry out and evaluate aspects of practical work and analyse results. These aspects can be assessed through the written examination in such a way that students are likely to perform better if they have acquired that procedural knowledge through doing practicals. It is up to the awarding organisations to set good questions to ensure that happens.

30. In addition, students should be expected to be proficient in a number of practical and manipulative techniques. Being proficient in these techniques is part of what it means to be a good scientist and it would be preferable if they were assessed.

31. It is hard to see how these techniques would be assessed indirectly, so there needs to be some form of direct assessment. Any such assessment must be valid and robust. If the assessment is designed to provide differentiation, then the differentiation must be reliable with a wide spread of marks. However, consideration should also be given to a model where direct assessment is not intended to provide differentiation, but rather to check whether or not a student is competent in a given practical skill.

32. However, there is currently no good suggestion for how to do this. SCORE recommends that the DfE commission some work to find a way of assessing technical and manipulative skills. Furthermore, any new assessment method needs to be piloted. There are possibilities that can be explored – for example, making part of the assessment a competency test of hands-on skills – that could reconcile these different priorities.

33. Whatever assessment scheme is proposed (for all aspects of practical work), it needs to be taken up by all awarding organisations. They should not compete on their practical assessment scheme.

34. There is no reference made in the criteria to fieldwork. This is a serious omission and SCORE would like to see explicit reference to the importance of fieldwork as part of any qualification in a science.

35. In the draft criteria, practical work now accounts for 20% of the overall assessment marks. However, practical work accounts for 25% of the marks in the current GCSEs, so the reduction could be taken by some as a downgrading of its importance. SCORE would like to see further protection for ensuring that students do carry out practical work in the classroom. More significant than the specific weighting is the importance of ensuring that all students continue to have a proper experience of practical work, and that its central place in learning science is recognised in the assessment and certification of qualifications in the sciences.

36. It is also important that all students have a level playing field to acquire the skills described above, and the research conducted by SCORE[4] into the resourcing of practical work indicates that this may not be the case. The Department for Education needs to ensure that schools apportion adequate resources, so that students are not disadvantaged.

Use of mathematics

37. SCORE is pleased to see the emphasis on the use of mathematics throughout the criteria, and that the mathematics is presented in terms of its scientific context, to an extent.

38. SCORE has some concerns that, given the sciences will continue to be tiered, it is not clear whether all of the mathematical content is expected to be accessible to students taking all tiers. It is likely that some students, particularly those taking the lower tier (whichever model of tiering is chosen), may struggle with some of the mathematical content included in the criteria, and it is important that this does not limit their ability to access the scientific content. We argue in our response to the Ofqual consultation that difference between tiers should primarily be achieved through assessment rather than content.

39. The mathematical content needs to be clearly specified with the mathematical requirements for biology, chemistry and physics separately listed. There should be specific scientific contexts within each subject section detailing the relevant mathematical processes and terminology to be used.

40. It would also be useful to include a list of the terminology used to describe quantities within the criteria, to ensure a common approach across specifications. Similarly, there needs to be consistency in the use of language used to describe measurement[5].

Alignment between the sciences

41. The criteria for the different subjects are written in quite different styles, with the criteria for physics and chemistry appearing more highly specified than those for biology

[4] The research can be found at http://score-education.org/policy/curriculum/practical-work-in-science

[5] See ed. Peter Campbell, *The Language of Measurement*, (Hatfield: ASE Publications on behalf of ASE-Nuffield, 2010)

42. The content is also not always aligned; level of demand of the same topic is not always comparable (for example, DNA knowledge of nucleotides in biology and chemistry), and there is duplication (for example, atomic structure is covered in both physics and chemistry).

Progression between stages of study

43. It is very important that the GCSE subject criteria allow students to build on the knowledge they have acquired at key stage 3, while enabling those who wish to do so to progress to further study in the sciences at key stage 5.
44. However, it is not always clear how content in the GCSE criteria build on existing knowledge acquired at previous key stages, and whether that existing knowledge can also be assessed. For example, photosynthesis appears at both key stage 3 and in the proposed GCSE criteria, but the published statements in the GCSE criteria do not currently make it clear how students should come to a deeper understanding of the ideas.
45. It is also important that, if the sciences are tiered, all tiers should incorporate content to allow for progression. In other words that differentiation should be on the basis of more challenging assessment, rather than increased content.
46. In addition, without agreed subject criteria for A-levels in the sciences, it is very difficult to judge whether there will be coherence between GCSEs and A-levels. There are instances of content having been moved down from key stage 5 to key stage 4, which emphasises the need for a coherent approach to content reform across the various key stages. For example, this applies to elements of genomics in biology.
47. It is important that language is consistent between GCSE and A-level. For example, at present the GCSE criteria include modern genetics terminology, while the current A-level criteria do not.