SCORE
SCIENCE COMMUNITY REPRESENTING EDUCATION

REPORT

GCSE SCIENCE 2008 EXAMINATIONS

BACKGROUND

A new set of specifications for GCSE science was introduced in 2006 and the first cohort of students completed their studies in 2008. There were many changes to the structure and assessment of GCSE science with the introduction of a wider range of qualifications, different routes through the courses and a broader range of assessment styles. The new specifications also required more varied teaching styles. The set of examinations sat in June 2008 provided an opportunity to undertake an initial appraisal of the first examination papers assessing the new specifications.

The SCORE partnership, made up of key players in the science education community, therefore undertook to conduct a review of the 2008 GCSE Core and Additional Science examinations across the unitary awarding bodies in England and Wales. This project represents the first stage in a longer process of SCORE's engagement with examinations.

AIMS

SCORE's overall objective of this strand of work was to provide reliable information on the fitness for purpose of GCSE science examination papers, focusing on how the examination papers assess particular aspects of GCSE science. This is a complex area and in order to focus the study the scope of this work was deliberately kept narrow, covering:

1. **Accuracy of the science:** whether the science in the exam questions and mark schemes was accurate,
2. **Mathematics:** the extent and type of mathematics needed, and whether this was the same across the awarding bodies,
3. **How Science Works:** the way in which How Science Works (HSW) was assessed,
4. **Question type:** the balance between question/response types in the examination papers,
5. **Knowledge required:** whether any knowledge of science or How Science Works was required to answer the questions.

This project was concerned with looking at the performance of the assessments. It does not provide any evidence on the performance of the students. The assessment of coursework was outside the scope of this project.

METHODOLOGY

A panel of 15 expert biology, chemistry and physics teachers, examiners and scientists analysed the June 2008 papers of AQA, Edexcel, OCR and WJEC in science and Additional Science at a two-day workshop. In total, 79 examination papers were analysed. Most of the teachers taking part had previously been involved in the assessment process. Both foundation and higher tier examination papers were considered.

An analysis 'grid' was devised to capture data about each examination paper – the grids reflected those used by awarding bodies in the setting of examination papers. Following the workshop, the data and comments from all the grids were collated to provide a summary for each examination within each specification.

KEY FINDINGS OF THIS STUDY

1. Accuracy of the science

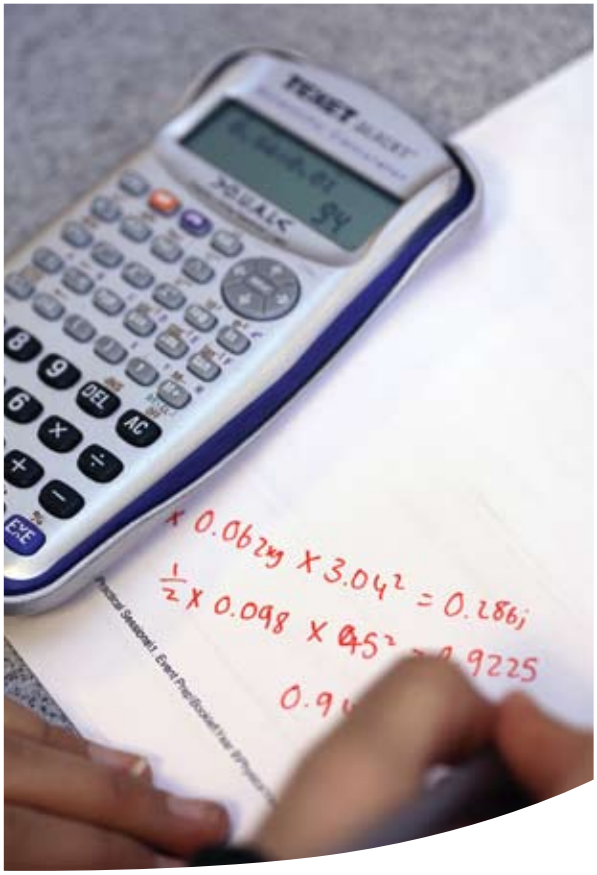
Previously, concerns have been raised over the accuracy of the science in GCSE examination papers. In this project it was found that in the vast majority of questions the science in the examination papers was correct at the level examined. Where inaccuracies were identified, they were generally poorly worded or edited questions, rather than inaccurate science.

Workshop participants also looked at the science in the mark schemes. Mark schemes include a range of allowable answers. The workshop participants expressed concerns that in some cases some of the allowable answers given in mark schemes did not reflect correct science. This is of particular importance as teachers and students have access to online mark schemes, and if these indicate that marks can be gained for answers that are not strictly correct, students (and non-specialist science teachers) could become confused over what is the most accurate answer.

2. Mathematics

Science is a quantitative subject, and so one of the areas we considered was the type and the quantity of mathematics tested in the examinations. The number of marks in each examination question for the use and understanding of mathematics was recorded. This provided data about the extent of mathematics being assessed. Also, participants commented about the type of mathematics in the examination papers. In order to assess what was, or wasn't, a mark relating to mathematics participants used the information provided in the specifications from each awarding body.

- There was a wide variation in the amount of mathematics accessed across disciplines and specifications. There was clear evidence that the amount of mathematics required in questions relating to physics was higher than those relating to biology and chemistry. While it may be expected that physics questions require more mathematics than biology or chemistry, the mathematical requirements given in the separate GCSEs in biology, chemistry and physics specifications are the same.



- There were some indications that the proportion of marks available for mathematics was greater for the Additional Science papers than for the Core Science papers. This is interesting as the specifications state that the mathematical requirements for both Core and Additional awards are the same.
- There were no clear differences between the percentage of marks related to mathematics in the foundation tier and higher tier papers. However, some of the specifications do have different mathematical requirements for foundation and higher tier papers, with higher tier papers requiring the use of a greater range of mathematics. This project did not examine whether the type of mathematics used in the examinations varied between different examination papers.
- There were indications that the demand and type of the mathematics within the papers was limited. Some awarding bodies set out in their specifications what mathematics could be examined, and in some cases this did not correspond with the mathematics found in the examination papers. In particular, the more advanced mathematics detailed in the specifications was not present in the examination papers.
- Out of the 79 papers reviewed, there were several papers (or sections within papers where biology, chemistry and physics were within one paper) with no mathematics marks: 3 biology papers/sections; 4 chemistry papers/sections.

These results give preliminary indications that the use of mathematics within the context of science was examined in a very limited way. It was limited in terms of the type of mathematics required by students: the full range of mathematics skills/techniques included within the specifications was not examined. It was also limited in terms of quantity: the percentage of questions requiring mathematical knowledge was low. As this project considered only the examinations themselves and not the internal assessment/coursework, this could account for discrepancies between awarding bodies.

3. How Science Works

In 2006, the Key Stage 4 programme of study introduced the concept of How Science Works. As How Science Works was a new approach to teaching and learning science, this project aimed to investigate how and where it was being assessed within the examinations.

Participants were asked to identify the number of marks relating to How Science Works in each examination paper. In order to aid their decision making, participants were provided with the relevant section of the criteria and were also reminded to consult the specifications to see how each awarding body understood How Science Works.

- There were significant differences between awarding bodies regarding the amount of How Science Works in examination papers, with a range of 0% to 26% identified.
- Wide variations in the amount of How Science Works were found when comparing foundation tier papers across awarding bodies, and also when comparing higher tier papers across awarding bodies. These variations suggest that there is a lack of parity between awarding bodies in terms of the requirement for students to demonstrate knowledge and understanding of How Science Works within the written examination papers. However, it could be that the differing amounts of How Science Works between examinations issued by the awarding bodies is due to some awarding bodies testing How Science Works elsewhere, for example in coursework.
- How Science Works was mainly present in the Core Science papers – accounting for an average of 22% of marks, rather than in Additional Science papers, where it accounted for an average of 7% of marks. There is little difference between the proportion of marks stated by the awarding bodies for Assessment Objective 1 (Knowledge and Understanding of Science and How Science Works) for Core and Additional Science. The Ofqual report comments generally on the differences between specifications in terms of How Science Works. The criteria for GCSE science state that specifications with the title GCSE science should consist of the skills, knowledge and understanding of How Science Works and apply these skills to the given content. The criteria also state that at least half of each specification with the title GCSE Additional Science should set the How Science Works skills, knowledge and understanding in the context of the content covered.

4. Question type

This project examined the balance between question types in the examination papers. Question types were divided into: multiple choice/very short answer; short response (one sentence); and extended response (more than one sentence).

- There were clear differences in the proportion of marks associated with multiple choice/very short answer questions between the foundation and higher tier papers, with significantly more of these at foundation tier.
- The number of marks awarded for short responses was roughly equal between foundation and higher papers.
- Higher papers awarded more marks for extended responses than foundation papers – this was true across awarding bodies.
- There was little difference in the balance between the three question types when comparing Core Science and Additional Science papers.

In the written, structured, papers, the two tiers clearly each had a different mixture of question type. Foundation papers had mainly multiple choice/very short answers and short response answers. Higher papers had fewer very short answers but more extended responses. This is particularly of note regarding the comparability of candidates on the border of the two papers.

The fact that there were clear differences in the proportion of marks associated with multiple choice/very short answer questions between the foundation and higher tier papers could suggest that examiners and awarding bodies believe that this question type is more suitable for lower demand questions. It was also noted that very short answers and short responses could be marked by clerical or non-expert markers.

There were substantial variations between awarding bodies with some specifications having as few as 2% or 9% of marks available through extended response questions on structured papers. This is of importance as extended response questions provide an opportunity for pupils to demonstrate the full extent of their understanding and ability in a deeper sense than is possible in multiple choice or short response questions. This issue was also raised in Ofqual's March 2009 report.

It was also noted that many of the questions that required mathematics required single-step mathematics, and so were classed as 'multiple choice/very short answer' questions. [Questions that required multi-step mathematics would have been classed as a 'short response' or 'extended response' question.]

A final point relating to question type is that for some specifications, the examiners used some regular key command words – these are words that tell candidates what type of answer (short/extended/single word) they are looking for. It was noted that the choice of command words in a question did not always correspond to the type of answer required (for example 'discuss' or 'explain' was used when the accepted answer was one or two key words).

5. Knowledge required

There were a few instances where neither knowledge of science nor of How Science Works was needed to answer some parts of some questions. Of particular concern were questions which appeared to be general knowledge. However it was noted that there can be a 'grey area' between what is considered to be general knowledge and what is considered to be scientific knowledge or understanding. In some cases, to candidates of differing abilities, the same question could be interpreted as being either general knowledge or as one that requires some scientific knowledge.

A related finding was that some multiple choice questions had poorly constructed incorrect answers. In some cases only the correct answer made grammatical sense, and therefore the incorrect answers were unlikely to be selected by the student simply on the basis of grammar.

RECOMMENDATIONS

SCORE welcomes the conclusions of the Ofqual report published in March 2009. Many of the findings of this SCORE project support Ofqual's findings. SCORE encourages the Government to ensure that the conclusions of both reports are acted on.

SCORE recommends that QCA, Ofqual and awarding bodies develop a process to ensure that:

1. All GCSE science questions must require knowledge of science or How Science Works to answer them.
2. There is more and higher level mathematics in examination papers.
3. There is more extended writing in examination papers.
4. Multiple choice questions are pre-tested to ensure they are fit for purpose.

Additionally, SCORE recommends that:

5. There should be less emphasis on recall, and more emphasis on demonstrating understanding.
6. Awarding bodies are required to publish ideal answers alongside, or instead of, the current mark schemes.

And, in terms of Initial Teacher Education (ITE) and teacher Continuing Professional Development (CPD):

7. Stakeholders involved in ITE and CPD for teachers should investigate the benefits to teaching and learning of involving more teachers in the examination process.
8. There should be a consideration of the possibility of developing a national archive of examination papers, mark schemes and setting grids at the National STEM Resource Centre.

As a consequence of this work:

1. SCORE will begin a project looking at the use, type and extent of mathematics within GCSE science qualifications and their assessment.
2. SCORE will work with stakeholders in order to better clarify and define How Science Works, and how this definition is interpreted, so that all involved in GCSE have a clear idea about what it is and how it should be assessed.
3. SCORE will discuss the variations of question type with Ofqual, QCA and the awarding bodies and in particular how consistency across and within specifications is established and maintained.

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