Assessment of Practical Work in GCSE Science

Regulatory Impact Assessment

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Contents

Introduction

In summer 2018, students in England will take reformed GCSEs in biology, chemistry, physics and combined science (science GCSEs).[1] These will be based on new subject content and requirements for 'working scientifically' that emphasise students' understanding of scientific experiments and their ability to conduct them.

In our role as qualifications regulator we determine how students will be assessed. We ensure qualification standards are appropriate and comparable, both across different exam boards and over time. We emphasise the importance of good educational outcomes and results we can all trust. This regulatory impact assessment considers the costs and benefits of our proposal for the assessment of science GCSEs, compared with the status quo. To do this we have used evidence from a number of sources, including stakeholder feedback, data and information provided by the Department for Education and Ofsted, and a survey commissioned by SCORE.

Students in schools which are required to teach the national curriculum have to study science until the end of Key Stage 4. Students are also required to achieve A* to C in two science GCSEs[2] to satisfy the requirements of the Ebacc. Because of this many students enter one or more science GCSEs. In summer 2014 there were approximately 700,000 entries for science GCSEs,[3] making up around 14 per cent of all GCSE entries.

Current assessment arrangements

Students currently sit examination papers which account, in total, for 75 per cent of their marks for the GCSE qualification. The remaining 25 per cent of the marks is determined by their performance in controlled assessment. This is made up of a report or evaluation of data from a practical activity set by the exam board and carried out in controlled conditions. At a minimum, a student would need to complete only one such activity to achieve a GCSE qualification. There are differences in the controlled assessments across exam boards, but as an illustration, here we describe AQA's arrangements.[4]

[1] The new GCSEs in biology, chemistry and physics will be single awards; the GCSE in combined science will be a double award.

[2] This can include one A* to C pass in computer science.

[3] JCQ, summer 2014, England only.

[4] AQA accounts for around 50 per cent of science entries in GCSE science subjects.

Step 1 − preparation	Once candidates know what the hypothesis is they research it using more than one source to ascertain which method to use. They may make notes on a Candidate Research Note. This element is not assessed.
Step 2 – reporting and planning the research	This is a 45-minute assessment done under exam conditions. Candidates are provided with a question booklet, in which they must answer questions about the experiment they plan to conduct. Responses to these questions are assessed. They are allowed access to the Candidate Research Note which they completed in step 1.
Step 3 − practical work	Candidates use their own method or one provided by AQA to carry out the experiment. They may work in groups, but they must take an active role within the group. This element is not assessed.
Step 4 – processing primary data	Candidates present their data as either a bar chart or graph, which is assessed.
Step 5 – analysis of the data	This is a 50-minute assessment done under exam conditions, and is assessed.

The written elements of the assessment (steps 2, 4 and 5) are then marked by teachers. Exam boards moderate a proportion of each school or college's assessments, and award marks accordingly.

Proposed arrangements

Under the proposed arrangements schools and colleges will still be expected to make sure students undertake experiments, but there will be no element of non-exam assessment that counts towards a student's final grade. Instead, students will be expected to complete a range of practical activities set out in the specification (at least 8 for single science subjects and 16 for combined science), and keep records of these experiments. At least 15 per cent of the marks in the exam paper will be for questions that draw on the knowledge and understanding students have gained from their practical science experience.

Schools will be required to confirm to their exam board that their students have completed the required practical science work before the students take their exams. Students will also be required to keep records of the practical work they have done, which would have to be made available to the exam board on request.

Costs and cost savings of introducing the new approach

Impact on schools and colleges

Because there will no longer be any formal non-exam assessment, with its result contributing significantly to the subject grade, there is likely to be a reduction in teachers' workload as they will not have to plan, oversee and mark a set of high-stakes assessments for all their students. (The accountability context in which these qualifications operate is likely to be having a significant effect on the current assessments).

Having said this, the removal of the non-exam assessment is unlikely to mean any change in total delivery time, as non-exam assessments are carried out in lesson time. Without non-exam assessment it may mean that teachers spend more time completing practical experiments with their students, so there may be no change to science teachers' workload. (This greater time experiencing practical work, however, would be of significant benefit educationally for students.)

It is difficult to predict exactly what the impact of the change will be on the number and range of experiments students undertake. However the minimum number proposed is intentionally greater than the minimum required by current controlled assessments. This is important as if the change in assessment style leads, as intended, to an increase in the range of practical work schools undertake there could be additional costs.

In our consultation[5] we set out a suggested list of equipment and techniques that all students will be expected to be able to use and demonstrate. Although every effort was taken to ensure that this list was reasonable, we have been made aware that not all schools have sufficient equipment which could be a cost in introducing the reformed qualifications.[6]

A report carried out by Pye Tait[7] on behalf of SCORE identified that the average state-funded school in England had just 70 per cent of the equipment and consumables currently required to teach science. For example, around 50 per cent of schools surveyed said that they had enough water baths in working order for group

[5] See pages 26 to 28 www.gov.uk/government/consultations/assessing-practical-work-in-gcse-science

[6] A number of respondents to our consultation highlighted apparatus and equipment which schools may not already have. In particular it was suggested that it may be particularly costly for schools without a sixth form, as they were less likely to already have the required apparatus.

[7] Pye Tait, Under the microscope, http://score-education.org/media/11775/pyetait_under-the-microscope_secondary-report_final.pdf

work in pre-16 biology. A water bath is included within the equipment list and can cost around £300 (excluding VAT).[8] Depending on how many additional water baths were required by each school or college, this could add up to a significant cost.

One way to assess what the total increased expenditure on science by schools could be, is to compare the current average expenditure per pupil on science, with the average budget at those schools that feel they have enough resources. Pye Tait found that the average annual budget for science per student was £8.81. This compares with an average of £16.95 per head where schools were very satisfied with the amount of spending on science in the academic year 2011/12. This is a difference of £8.14 per candidate. After adjusting for inflation,[9] and multiplying by the number of students in the state-funded cohort,[10] this gives an extra cost of £4.9 million per cohort. This includes all costs incurred annually, for example purchasing chemicals, as well as apparatus that needs to be replaced through normal wear and tear.

As indicated below, and as some stakeholders have responded, there is also a risk that the policy will not have the intended effects and that the reduction in assessment of practical elements of science will lead to students doing fewer practical experiments. In considering this statement it has to be remembered that there is no direct assessment of practical skills in GCSE science qualifications at the moment. All the assessment is indirect, that is, the assessment is based on the written product with an assumption of the exercise of the relevant skills lying behind the data and/or report produced. Also, the current controlled assessments tend to require, as a minimum, only one or two underpinning experiments.

Impacts on exam boards

Exam boards will no longer have to set or moderate non-exam assessment in science GCSE qualifications. This will mean savings for the exam boards, particularly through reduced moderation costs. Having said this, in order to fully examine the new, larger content in the exam, exam boards may choose to increase examination time. This would lead to slightly increased costs for the exam boards as they would

[8] See for example www.philipharris.co.uk/product/Water-Bath-Unstirred-Thermostatic-25l230-x-130-x-100370-x-165-x-200250W-B8F65532 and www.betterequipped.co.uk/catalogsearch/result/?q=water+bath

[9] Using HM Treasury deflators available at www.gov.uk/government/collections/gdp-deflators-at-market-prices-and-money-gdp

[10] This was calculated using Department for Education data taking a cohort as those aged 15 in maintained schools in the UK in 2014. This was then adjusted to represent England by applying the proportion of all those in the maintained sector in England. Data can be found at www.gov.uk/government/statistics/education-and-training-statistics-for-the-uk-2014

have to pay more for the scripts to be marked. The costs could increase further if additional long response questions were added.

We may also require exam boards to monitor the school and student experiment records. This would inevitably involve a cost for the exam board, although the details of our approach have not yet been decided. During the development of these important details we will take into account the burden this places on exam boards and schools.

Wider impacts

Impact on practical science skills

It is widely acknowledged that carrying out practical science experiments benefits students. It helps students to further their learning, understand science and how scientific ideas are developed.[11] If improved science skills did lead to more students studying science at a higher level, then it is possible there could be a positive overall impact on the economy.[12]

We reported in our Review of Controlled Assessment in GCSEs views that[13] the current system "makes teachers focus on a narrow range of externally-set practicals" (the Gatsby Charitable Foundation and the Wellcome Trust), and that it is "time consuming, prescriptive and repetitive… [and] encourage[s] 'teaching to the test'" ('59 Club).[14] The way the current controlled assessments work – with a narrow focus and often not being integrated with the course as a whole – means that the potential benefits of students undertaking practical work is significantly reduced.

Under the proposed arrangements for practical work in GCSE science it is anticipated that the range and number of experiments that students undertake will increase, and that students will benefit through increased understanding of the

[11] See for example, Gatsby, Policy Note: *Assessment of Practical Work in Science*, at: www.gatsby.org.uk/~/media/Files/Education/Practical%20Science%20Policy%20Note.ashx and Watt, Andrew (2013) The assessment of Practical Science: a literature review, at: www.cambridgeassessment.org.uk/Images/135793-the-assessment-of-practical-science-a-literature-review.pdf .

[12] In 2012, the Lords Science and Technology Committee identified the important role STEM postgraduates play in economic growth: www.parliament.uk/business/committees/committees-a-z/lords-select/science-and-technology-committee/news/stem-report-published .

[13] Ofqual, Review of Controlled Assessment in GCSEs, page 22, at: www.gov.uk/government/publications/review-of-controlled-assessment-in-gcses

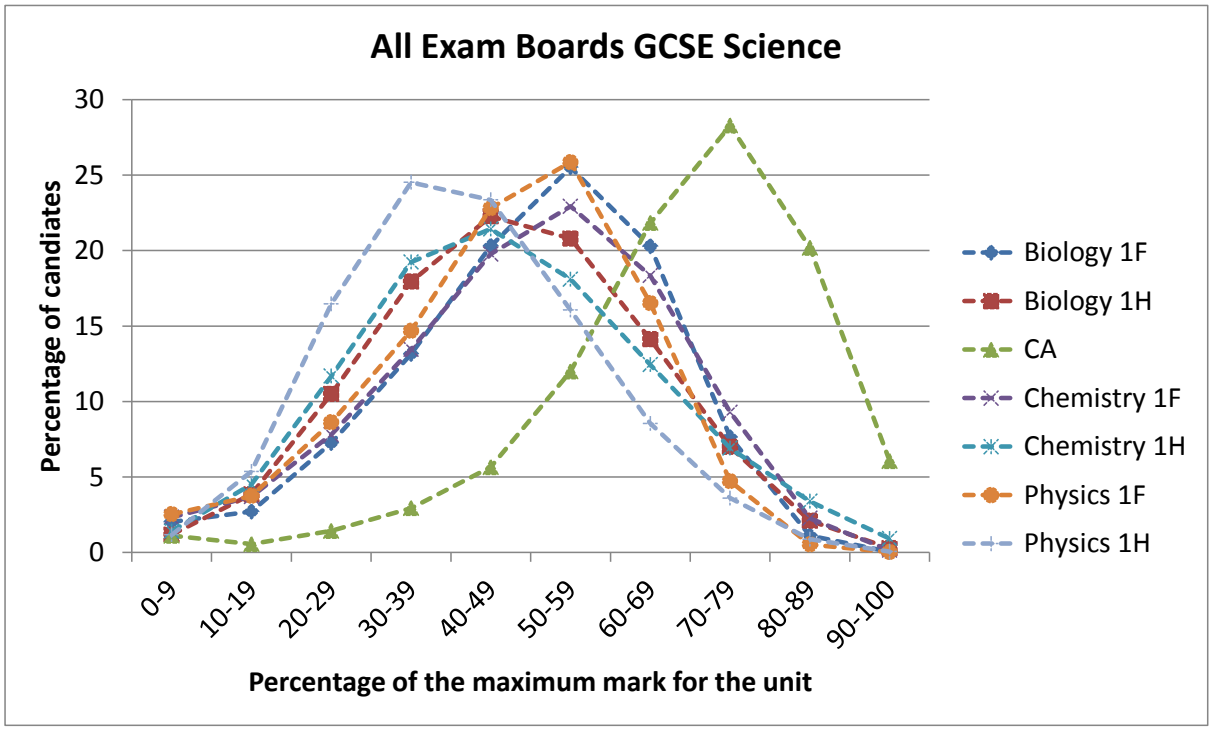
[14] The '59 club' consists of the heads of science of 33 independent schools across England.

science subjects. Ofsted, in their 2013 report, *Maintaining curiosity*,[15] highlighted "time for learners to develop science practical skills" as one of six factors which promoted high achievement. Improved achievement may in turn lead to a greater take-up of science subjects at a higher level, which could have benefits for the UK economy.

Having said this, there is a risk that the new assessment arrangements could lead to fewer experiments being carried out by students. It is argued that schools will focus less time and money on experiments, with laboratories receiving a smaller budget. If this is the case there would clearly be a negative impact on science practical skills, and in the longer term potentially on the economy.

Increased differential in marks

The controlled assessment marks for the current qualifications are often skewed towards the maximum mark, with a higher proportion of students receiving the same mark than is the case with written papers. It is likely that this is owing to a combination of the type of skill these assessments are measuring and also the pressure on teachers (who are required to plan, oversee and mark these assessments) to get the best results.



[15] www.gov.uk/government/publications/maintaining-curiosity-a-survey-into-science-education-in-schools

A significant effect of a compressed mark range is that it makes it more difficult to see genuine differences in students' attainment as the amount of information the assessments provide about this is diminished.

When students' marks are tightly clustered together it also means that grade boundaries have to be closer together. This decreases the reliability of a given student's final grade. This is because a very small difference in their mark – which could be caused by, say, them slightly underperforming on the day of the assessment – would be more likely to affect their overall grade than in cases where the grade boundaries are more spread out.

These deficiencies with the current controlled assessments mean that removing them from the qualification as proposed would improve, overall, the reliability of the students' grades. This would have benefits for students in terms of the fairness of their grades and for schools if these qualifications continue to contribute to accountability measures. It may also have benefits more broadly in terms of wider public confidence in the system.

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