6 DECEMBER 2012

REFORMING KEY STAGE 4 QUALIFICATIONS

RESPONSE TO THE
DEPARTMENT FOR EDUCATION CONSULTATION

GATSBY

SUMMARY

i The National Curriculum requires that all young people study physics, chemistry and biology through to the end of Key Stage 4. It must continue to do so if our young people are to be adequately prepared for working and living with scientific ideas and technologies.

ii The introduction of a requirement for all schools to offer GCSEs in physics, chemistry and biology has been a success in terms of improving progression to A levels, particularly in physics. It has also been a vital driver in increasing the number of specialist teachers in these subjects. Any reforms to Key Stage 4 science must seek to build on this success, and must not allow physics, chemistry or biology to become optional at age 14. The Government must make an unambiguous public commitment to breadth of study across the sciences for all 14-16 year olds.

iii We agree it would be desirable to develop just a single suite of EBCs in physics, chemistry and biology which the vast majority of Key Stage 4 students could successfully follow, including those planning to progress into apprenticeships and technical training routes. This would represent a significant transformation in Key Stage 4 science which has the potential to drive major improvements in the provision of specialist teaching in physics, chemistry and biology. However such developments would require proper review and piloting and would therefore only be possible within a timescale that saw first teaching begin in September 2018 at the earliest.

iv If a delay to the introduction of EBCs in the sciences is not politically acceptable then an alternative pathway of combined science at Key Stage 4 will need to be retained, to prevent young people disengaging from one or more of the sciences at age 14.

v Practical skills are a crucial part of science qualifications. Over the last 20 years, there has been a steady erosion of laboratory skills taught in school science and this is of significant concern to industry and universities. The reform of Key Stage 4 qualifications offers an opportunity to reverse this trend, improve assessment methodologies and re-invigorate practical work in schools and colleges.

vi Science practical skills must be assessed in a valid and reliable way. It is unacceptable that the assessment of laboratory skills has been reduced to the point where a GCSE student who is unable, for example, to use a microscope or to heat measured volumes of liquid without breaking test tubes is still able to achieve maximum marks for their practical work as long as they can write about how they should have done it.

vii Any reformed system must not attempt to assess practical skills solely by written examination. At the end of a science course, students must be able to demonstrate they can do science and do it well, not merely write about it.

INTRODUCTION

1 Gatsby is a Trust set up in 1967 by David Sainsbury (now Lord Sainsbury of Turville) to realise his charitable objectives. We focus our support on the following areas:

- Plant science research
- Neuroscience research
- Science and engineering education
- Economic development in Africa
- Public policy research and advice
- The Arts

2 Gatsby is pleased to respond to the Government's consultation on 'Reforming Key Stage 4 qualifications'. Our response focuses on three areas of particular importance to science education:

- the importance of acknowledging the needs of the modern workforce when redeveloping KS4 science curricula and qualifications;
- the need to give all young people breadth of science study across physics, chemistry and biology at KS4;
- the opportunity to improve the assessment of practical skills in science.

THE IMPORTANCE OF SCIENCE FOR ALL AT KEY STAGE 4

3 Science has, quite rightly, always been a core subject within the National Curriculum. This has meant that all students in state maintained schools have been required to study physics, chemistry and biology until the age of 16. In 2012, just over a third (34%) of Year 9 pupils are meeting that requirement by opting to take three individual GCSEs in physics, chemistry and biology (the remainder by studying one or two combined science GCSEs)[1]. This represents a significant increase in proportions of young people studying the separate sciences over the last few years and is one of the reasons that progression to post-16 sciences has begun to improve, after years of mounting concern about the future of the physical sciences in universities.

4 Proponents of science's core subject status have tended to claim two purposes for science education: that all educated citizens should be familiar with the big ideas in and about science; and that for some, science education is the springboard to a career expanding the frontiers of science. Although still valid, these purposes hark back to the mid-20th century. Today they are an incomplete and misleading shorthand.

5 In today's world science education is vital to enable young people to take advantage of a vast and expanding range of jobs that rely on science; from the electrician who rewires your house to the optical technician who makes your glasses, and from the nursing assistant interpreting the charts at the end of your hospital bed to the technician who keeps the computers running. The point is that it is no longer just scientists who work with science. Anyone working in health, engineering, agriculture, construction, telecommunications, the environment, and a panoply of other areas of the economy will need at least a basic understanding of the science that underpins their sector. For their own sakes therefore, young people must not be allowed to diminish their education and career prospects by opting out of science before the age of 16. Equally, the science education on offer must meet the

[1] Department of Education Research Brief DFE-RB249 *The Effects of the English Baccalaureate*, September 2012.

needs of all students, including those who will progress into more technical courses and jobs after Key Stage 4.

BREADTH OF STUDY ACROSS PHYSICS, CHEMISTRY AND BIOLOGY AT KEY STAGE 4

6 All students at Key Stage 4 should have to study physics, chemistry and biology. Even though increasing numbers of schools are able to disapply the National Curriculum (for example because of their status as Academies), the current National Curriculum requirement at Key Stage 4 for students to study all three science disciplines remains vital in sending a clear and powerful message about the Government's expectations regarding breadth of study in science.

7 While breadth of study in science has been a National Curriculum requirement for nearly 25 years, only relatively recently has there been an additional requirement that all schools should offer separate GCSEs in physics, chemistry and biology.

8 The aspirations of the previous government to increase uptake of A levels in physics, chemistry and biology, driven by a stronger focus on the teaching of the separate sciences at Key Stage 4 was warmly welcomed by the science community and employers alike. This stronger focus, supported by an investment in specialist teachers in these subjects, has seen an upswing in post-16 science participation. Now is not the time to step back from success. We therefore applaud the Government's commitment to physics, chemistry and biology being taught as separate subjects at Key Stage 4 and hence for students to gain the opportunities for future progression to the myriad of jobs and further qualifications that they afford.

9 If the current arrangement, whereby students can obtain the English Baccalaureate (EBacc) by securing passes in just two science GCSEs, is continued with EBCs, there is a significant risk that in order to increase overall participation in the separate sciences at Key Stage 4 schools will allow their students to drop one of the sciences at age 14. Recent research[2] and historical data[3] suggests that, should the study of physics become optional at Key Stage 4, we would in all likelihood return to the situation pre-National Curriculum when the majority of girls dropped physics at age 14 and barred themselves from entry to A level. The government must act swiftly to prevent perverse incentives being introduced into the new system which could act against its aim of increasing progression in science post-16.

10 As stated earlier, we believe <u>all</u> students at Key Stage 4 should be expected to study physics, chemistry and biology and should be taught by specialist teachers in these subjects. Therefore, we agree it would be desirable to develop a single suite of 3 science EBCs which the vast majority of students (80%-plus) could successfully follow and which would still be able to discriminate appropriately across the full ability range. This would represent a significant transformation in Key Stage 4 science which we feel has the potential to drive major improvements in the provision of specialist teaching in physics, chemistry and biology.

11 However, if such a transformation is to be successfully achieved, a substantial amount of work is needed to: establish the optimum size of science EBCs; develop the most relevant content; and pilot the most appropriate assessment and examination structure. It is clear to us that the proposed timescale for the introduction of the new EBCs prohibits work to the required depth being undertaken. At the very least such a programme of work should include a pilot phase among one cohort of Key Stage 4 students, meaning that first teaching of the final qualifications could be from September 2018 at the earliest. Allowing proper time for qualification development would also give schools more time to prepare for implementation, particularly as it concerns recruitment and deployment of sufficient specialist teachers, and timetabling of option blocks.

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[2] Murphy, P. and Whitelegg, E. (2006) *Girls in the Physics Classroom*, Institute of Physics.

[3] Department for Education and Skills, (2007) *Gender and education: the evidence on pupils in England*.

12 We firmly believe it will be not be possible to develop, in time for first teaching in 2015, one suite of EBCs in physics, chemistry and biology which meets the needs of all students. For this reason we feel that there is a case for, at least in the interim, an alternative Key Stage 4 science pathway, probably a combined science option.

13 The decision whether to continue with combined science qualifications under a new system will be critical to future post-16 progression rates in science and engineering, especially for those students who progress to apprenticeships and other technical training routes.

THE OPPORTUNITY TO IMPROVE THE ASSESSMENT OF SCIENCE PRACTICAL SKILLS

14 Although we have significant concerns regarding the proposed timescales for the reform of science qualifications, we recognise the reforms present an opportunity to improve education in the sciences, and in particular the assessment of practical work. We therefore urge the Government to examine the issue with extreme care.

15 The main purposes of practical work in the curriculum are to:

- enhance the learning of science concepts and explanations;
- develop understanding of the processes of science; and
- develop technical and investigative skills.

16 Over the last 20 years there has been an erosion in the teaching of laboratory skills in school science. This erosion is a cause of significant concern to industry and higher education institutions; evidence[4,5] shows that it is in practical skills that universities and employers have least confidence when it comes to the recruitment of school leavers with science qualifications. The reform of Key Stage 4 qualifications is an opportunity to reverse this trend, to re-invigorate practical work in school science and at the same time increase the engagement of young people in science and their participation in the sciences post-16.

17 Practical work is an essential part of science qualifications and practical skills must be assessed in a valid and reliable way in order to enable employers, colleges and universities to regain lost confidence in school science education. It is unacceptable that the assessment of laboratory skills has been reduced to the point where a GCSE student who is unable, for example, to use a microscope or to heat measured volumes of liquid without breaking test tubes is still able to achieve maximum marks for their practical work as long as they can write about how they should have done it.

18 The Government's intention is to improve rigour and confidence in Key Stage 4 qualifications. Neither will be achieved if, under a reformed system, practical science skills are assessed solely by a written examination. At the end of a science course, students must be able to do science and do it well, not merely write about it - just as in foreign language EBCs a student will surely be required to demonstrate competence at speaking the language as well as writing it.

19 We support the government's intentions to 'end the perverse incentives created by the interaction of our qualifications and accountability system'. In the sciences, practical work has been a notable victim of these perverse incentives. Evidence suggests that in many schools controlled assessment has resulted in fewer, and lower quality, practical activities undertaken in science at Key Stage 4.[6]

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[4] *University teachers' views on the practical skills of science undergraduates,* Gatsby Practical Work Programme Research Summary No.1 (2012)
[5] *STEM Employers' views on science skills for the workplace*, Gatsby Practical Work Programme Research Summary No.3 (2012)
[6] *School teachers' views and experiences of practical work in science*, Gatsby Practical Work Programme Research Summary No.2 (2012)

However if practical work is not assessed, school leaders tell us they will feel under pressure to allocate scarce resources to other subjects where the impact on student attainment and league table position will be more obvious. This would have serious negative impacts on the achievement, participation and engagement of young people in science.

20 Research into science assessment methodologies used in high-performing international jurisdictions suggests that, in order for England to perform better internationally, science EBCs would need to explicitly include and assess practical skills[7]. We assert that Awarding Organisations need to prove that the methods of assessment and grading structures they propose for new Key Stage 4 science qualifications match if not exceed the demands of Singapore, Finland and China in relation to practical work.

21 We are currently working with SCORE[8] to compile a list of the most important practical skills across the sciences that should be included at Key Stage 4. Awarding Organisations have confirmed to us that they would be able to improve the assessment of practical work in science if they were given the time to develop assessment instruments to match the skills rated most important by the science community. So, once again, we urge the government to reconsider and delay its planned timetable for introducing the new system of qualifications.

CONCLUSION

22 The Government has made clear its intention to move rapidly and decisively with reforms to Key Stage 4 qualifications. If it continues along this path, it must acknowledge the significant risks not only to improvements in science education, but to hard won recent successes, particularly in the uptake of the sciences post-16 and increased equality in the study of the separate sciences among 14-16 year olds. The risks are compounded by the complex interplay between qualifications and school accountability measures.

23 The science community would feel more confident that these risks were being taken for the greater good if the Government were clearer about its priorities and vision for science education, particularly regarding the content of the secondary science National Curriculum and the role of Ofqual in ensuring science qualifications are of high quality.

24 In particular, the Government must make a public commitment to breadth of study across physics, chemistry and biology for all at Key Stage 4, and demonstrate its understanding that science is a practical subject and therefore that practical skills need to be assessed.

25 We would welcome the opportunity to discuss with the Department the points raised in this response. In the meantime, any questions regarding its content should be directed to:

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[7] Reiss, M., Abrahams, I. and Sharpe, R. (2012) *Improving the assessment of practical work in school science.*
[8] 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 and is comprised of the Association for Science Education, Institute of Physics, Royal Society, Royal Society of Chemistry and Society of Biology.