

20 DECEMBER 2013

NEW A LEVEL
SUBJECT CONTENT
FOR SCIENCE

RESPONSE TO THE
DEPARTMENT FOR EDUCATION CONSULTATION



GATSBY

KEY MESSAGES

- 1 The most important aspect of science A levels which needs to be addressed is their present failure to ensure that those entering university science degrees have adequate practical skills.
- 2 We welcome the introduction of a set of core skills for 'Working Scientifically' that coincide with our own research into what universities require from A levels. However, we note that the status of these skills is ambiguous, no attempt has been made to differentiate across the sciences and, without direct reference to assessment objectives, their level of demand is open to interpretation. We recommend this section is revised in line with the approach taken to mathematical skills in Appendix 6.
- 3 It is impossible to consider improvements in practical skills by divorcing subject content from assessment in science A levels. We will be responding to the Ofqual consultation on 'new A level regulatory requirements' in January and will not be supporting the exclusion of practical skills assessment from A level grades in the sciences. We feel this misrepresents the importance of practical skills for students and their progression to university.

INTRODUCTION

- 4 Gatsby is a foundation 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
- 5 Practical work is an essential part of school science education. Good quality practical science develops important skills, deepens knowledge, enhances engagement among students, and challenges them to apply both knowledge and skills in purposeful contexts. Yet, 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.
- 6 Evidence shows that practical science needs support in UK schools and colleges and Gatsby is currently engaged in a programme focused on better assessment, improved access to teaching resources, and strengthened roles for technicians and senior leaders¹.

A LEVELS ARE NOT ADEQUATELY PREPARING YOUNG PEOPLE FOR THE PRACTICAL DEMANDS OF UNDERGRADUATE SCIENCE COURSES AT UNIVERSITY.

- 7 In recent research by Gatsby, 97% of lab managers in Russell Group universities surveyed reported that incoming undergraduates are poorly equipped for first year practicals². In the majority of cases this situation has reportedly worsened over the past 5 years (57%), more so than declines in knowledge (29%) and understanding (37%). This was despite all respondents increasing entry requirements to their courses. Some universities now assume even the brightest A level students will start their courses with no practical skills at all.

THE SUBJECT CONTENT NEEDS TO MAKE IT CLEAR THAT ‘WORKING SCIENTIFICALLY’ IS INTEGRAL TO SCIENCE AND AS SUCH WILL BE ASSESSED AS PART OF SCIENCE A LEVELS.

- 8 We welcome the list of ‘skills and behaviours’ given in “Appendix 5: Working Scientifically”. These largely coincide with Gatsby’s own findings from a series of workshops run on our behalf with representatives from a range of UK universities³, the results of which we shared with all the Awarding Organisations in October 2012.

¹ Further information about this programme of work and the evidence collected is on the Gatsby website (<http://www.gatsby.org.uk/Education/Projects/Review-of-Practical-Science-in-Schools.aspx>).

² Labskills of new undergraduates (Russell group survey), Laura Grant Associates for the Gatsby Charitable Foundation (May 2011).

³ Practical skills of new undergraduates (Workshops), Laura Grant Associates for the Gatsby Charitable Foundation (Oct 2011). Forty-five HE staff from bioscience, chemistry and physics departments in twenty-five UK universities participated.

- 9 A survey we ran with STEM employers – 70% of whom employ staff with A levels (or below) as their highest qualification – showed that employers are broadly in agreement with universities about the quality of practical skills among new entrants⁴. A particularly high value is placed on problem-solving in practical and real-life contexts, and the mastery of basic skills and procedures which comes from frequent exposure to relevant equipment and techniques.
- 10 It is therefore disappointing that the proposed content gives no firm indication that the skills listed in this section will be assessed. Instead, it is merely stated that the ‘specifications must encourage these through opportunities for regular hands on practical work’. We find this statement weak and ambiguous in showing the extent to which specifications will need to demonstrate their fulfilment of the criteria, and no attempt has been made to differentiate across the sciences. We do not believe such lack of clarity would be acceptable in the specification of theoretical knowledge and understanding, and nor should it be in the specification of practical skills.
- 11 We suggest that the introduction to ‘working scientifically’ is more explicit about the integration of the skills and propose the following change to the text:
- As part of the study of A-level sciences all students must develop the following key skills and behaviours. Specifications must encourage this by providing regular opportunities for hands on practical work and setting out how learners’ attainment in this area will be assessed.*
- 12 We recommend that the same approach is used for the practical skill requirements in ‘Working Scientifically’ as is taken in Appendix 6 with the mathematical skills. For mathematics, the content makes clear that students must achieve competence in these skills and that these will all be assessed over the lifetime of the specification. Each skill has also been exemplified as an assessment objective and we recommend a similar exercise is done for each of physics, chemistry and biology.

SCIENCE A LEVELS MUST INCLUDE A SET OF PRACTICAL SKILLS AND EXPERIMENTS THAT WILL MATCH THE REQUIREMENTS OF UNDERGRADUATE SCIENCE COURSES.

- 13 The subject content needs to be expanded to include a more specific set of practical skills for each of the sciences, and make clear an expectation that A level science specifications should list the range of experiments and investigations that candidates will need to undertake.
- 14 Our workshops with representatives from UK universities identified a number of techniques and ranges of equipment important for students to be competent with at the outset of their first year. These are listed below.
- 15 *Chemistry lab techniques* including: dexterity and manipulation; using glassware, burettes and titrations; accurate weighing and preparing solutions. The chemists also identified some specific experiments that would be beneficial for students to have conducted, including synthesis of aspirin, melting point, recrystallization, and chromatography.
- 16 *Physics instruments and equipment.* In physics, the specific skills related to familiarity with instruments and equipment that would be used in the first year physics lab: oscilloscope, stopwatch, Vernier scale, DC I/V source, AC signal generator, frequency counter, multimeters (I, V, R, AC/DC), and simple circuits.

⁴ STEM Employer’s views on science skills for the workplace, Gatsby Foundation (November 2011).

- 17 *Biosciences lab techniques* included: calibration curves, assays, spectrophotometry, pH buffers, weighing, microscopy, density and pipettes. Field skills were also discussed.
- 18 We recommend that the above lists of skills together with a recommended range of practical experiments and investigations for each science subject should be refined in consultation with the Institute of Physics, Royal Society of Chemistry and Society of Biology, who we understand are establishing Curriculum Committees who will be able to advise on such detail.

IT IS IMPOSSIBLE TO PREDICT WHETHER THE REVISED CONTENT WILL RESULT IN IMPROVEMENTS IN SCIENCE A LEVELS WITHOUT CONSIDERING THEIR ASSESSMENT.

- 19 While assessment was technically outside of the remit of Professor Mark Smith's independent review of A levels, his July report notes that assessment was discussed at meetings of the group, and concludes that there is a need to 'resolve issues about the assessment of practical skills'. We agree, but are surprised that Ofqual has recently proposed removing the assessment of these skills from the A level grade. We will be responding to the Ofqual consultation in January 2014.
- 20 We urge the DfE to ensure that the next steps in reforming science A levels deal directly and openly with issues of assessment, and ensure that discussions on what is taught, and how it should be assessed, are joined up from now on.
- 21 The Gatsby Foundation will be supporting the development of better assessment of science qualifications over the next 3 years and we would be pleased to discuss our plans with the DfE. We believe that better assessment is critical to improving qualifications and achieving higher standards of teaching and learning in the sciences at all levels.
- 22 We would welcome the opportunity to discuss with the Department the points raised in this submission. Any questions regarding its content should be directed to:

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