INCREASING THE SIZE OF THE POOL:

Preparing for the transfer from school and college science and mathematics education to UK STEM higher education

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In February 2011, the Royal Society recommended reform of the UK's A-level system in order to allow more students to progress to higher education within the core sciences[1] and mathematics, to help produce more STEM (science, technology, engineering and mathematics) specialists, including school and college teachers, and ensure that the UK remains a world leader in science.[2]

The Royal Society's fourth 'state of the nation' report, *Preparing for the transfer from school and college science and mathematics education to UK STEM higher education*, assessed participation in science and mathematics in post-16 school leaving examinations. Detailed analysis of the pupil-level data revealed, for the first time, the combinations of science and mathematics subjects taken by students.

The report's main finding is the worryingly low level of participation in science and mathematics by 16-19 year olds in all parts of the UK except Scotland. This means that the 'pool' of students able to proceed to study STEM subjects at first degree level is too small to fulfil the needs of UK employers, as identified in the CBI/EDI education and skills survey in 2010. In England, Wales and Northern Ireland in 2009, only 28/27/37% of all A-level students respectively achieved at least one mainstream science qualification (with or without mathematics), compared with 50% of students in Scotland. Furthermore, a significant number of institutions in England, Wales and Northern Ireland do not enter any candidates for A-level physics or mathematics. In 2009, 18%, 12% and 43%, respectively, of all relevant institutions in these nations failed to present a single physics A-level candidate.

The higher proportions of students taking core sciences and mathematics in Scotland are likely to be due to the fact that most of these students take at least five Highers. Elsewhere in the UK students typically complete three A-levels. Increasing the number of subjects studied post-16 widens the options at degree level, including access to STEM undergraduate courses.

Higher education institutions tend to want STEM undergraduates to have taken more than one science subject, and many degrees require two core sciences plus mathematics. However, the entry requirements needed are often unclear to potential applicants, and there is a need for improved information, advice and guidance (IAG) for young people.

A key recommendation from the report is that there should be a review of the A-level system. A Baccalaureate-type approach to post-16 education is currently being taken forward in Wales and Scotland. The Society suggests that an A-level-based Baccalaureate or similar system is also needed in England. The precise nature of what this Baccalaureate should look like requires careful investigation and input from a variety of interested parties, most notably Government, employers, professional bodies, the teaching profession and students.

Changing the structure of the qualifications system alone will not be effective, however, unless it is supported by improvements in other areas. There is powerful evidence in the Society's 'state of the nation' reports to show that there is a need to improve significantly the recruitment and retention of physics and chemistry teachers. Inspiring and effective teachers, with subject-specific knowledge, are widely acknowledged to be a major influence on students' choice of subjects, and their performance. However, with only some 12,000 UK-domiciled graduates in core science subjects[3] the Government will struggle to recruit its target of around 5,000 new teachers in these subjects for 2011/12 in England.

A national rise in the numbers of young people opting to specialise in science and mathematics post-16 will only occur if the following are taken into consideration:

1. The numbers of specialist science and mathematics teachers in both the primary and secondary workforce must increase.

2. Information, advice and guidance for young people must improve in quality.

3. Teachers should undertake subject-specific continuing professional development (CPD) as part of their overall CPD entitlement.

4. The number of qualified laboratory technicians in secondary schools must increase.

5. Physical resources (laboratories, lab equipment and computing hardware) need to be available and of sufficient quality to fully support science and mathematics teaching.

6. The revised 5–16 National Curriculum must provide a solid, inspirational and progressive grounding in science and mathematics for students.

7. The assessment regime must not focus on narrowly constructed measures of school performance.

8. Qualifications must be appropriate, available to all students and support progression in post-16 science and mathematics.

9. Understanding of how children learn should inform teaching practices.

'The UK has great scientific strengths, which underpin our society, culture and economy: we must build on these and continue to aspire to be the best country in the world in which to do science.'[4] Our future success in science depends on the current generation of students.

The Royal Society's four 'state of the nation' reports have produced extensive data on science and mathematics education from 5-19 and the teaching profession, across all four nations of the UK; the full reports are available on our website. If you have any views on the Royal Society's educational work, or would like further information, please contact the education team at education@royalsociety.org.

(1) Core sciences includes biological sciences, chemistry and physics.

(2) *Preparing for the transfer from school and college science and mathematics education to UK STEM higher education. A 'state of the nation' report.* Royal Society, February 2011. http://royalsociety.org/education/policy/state-of-nation/higher-education/

(3) Based on the total numbers of first degree graduates in biology (biology, botany, zoology, genetics and microbiology), chemistry and physics and astronomy in 2009/10.

(4) *The Scientific Century: securing our future prosperity.* Royal Society, March 2010. http://royalsociety.org/education/policy/reports/

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HOW HEFCE AND THE RESEARCH COUNCILS ARE UNDERMINING SCIENCE AND THE NATIONAL INTEREST

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Until recently the system of dual support for scientific research was predicated on the principle that researchers should be free to follow the scholarly agenda set by themselves and their international peers. Dual support is based on the division of labour; the research councils provide grants for specific projects and programmes, while *HEFCE* and the other funding councils provide block grant funding to support the research infrastructure, and to provide the capacity to undertake research commissioned by the private sector, government departments, charities, the European Union and other international bodies. Individual academics could rely on the fact that they could carry out a certain amount of their own research without having to apply for funding from a research council. This makes sense because some work is so exploratory in nature that no detailed research proposal is available. On the other hand, universities expected researchers to teach and carry out administrative duties, and so extended amounts of research leave still required funding. Dual support has a clear rationale that is rarely mentioned these days, namely that research council funding is based on a prospective assessment of a plan for future work, while the funding councils award resources based on a retrospective assessment of the work done in the years prior to