EXCELLENCE IN SCIENCE

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Lord Willis of Knaresbrough
c/o Elisa Rubio
Clerk to the Science and Technology Sub-Committee 1
House of Lords
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From the Physical Secretary and Vice-President Professor John Pethica FRS
16 December 2011
Our ref: SciB/1112/JP/LD

Dear Lord Willis,

The Royal Society has noted with interest the Science and Technology Sub-Committee inquiry into higher education in STEM subjects. This is an area where the Fellows of the Royal Society, who are researchers and teachers in the higher education system in the UK, have a great deal of expertise.

In 2006, the Society issued a report, *A degree of concern*[1], considering the future supply and demand for science, technology and mathematics graduates, concentrating on undergraduate supply. We followed this in 2008 with *A higher degree of concern*[2], which looked at postgraduate education. These two reports, which I attach for your information, do not contain the most up to date data, but the general messages remain valid.

1. UK HE courses in STEM continue to provide a sound foundation for students, and develop skills and knowledge which are essential in the workforce for both STEM careers, and broader areas of employment.
2. STEM graduates provide essential skill sets; positive action is required to ensure that the provision and take up of science courses is not significantly diminished and that the skills base graduates take into the broader economy is maintained.
3. In order to ensure that STEM courses are responding to the requirements of employers, more emphasis must be given to a collaborative approach to learning between universities and industry, including some employer engagement with curriculum development.
4. Students are increasingly mobile; the UK is competing in a global market for international students, but also, for UK domiciled candidates. The UK currently performs well in terms of attracting overseas students. However, it must not be complacent or place more barriers in the way of students coming to the UK, because new providers are beginning to challenge well established locations of study.

Any study in this area today will have to consider the potential implications of the Higher Education White Paper. Some concerns have been raised about the potential for new regulations on student numbers to make STEM subjects less attractive, particularly as numbers seem to currently be rising for applications in some

[1] http://royalsociety.org/policy/publications/2006/degree-of-concern/

[2] http://royalsociety.org/policy/publications/2008/higher-degree-of-concern/

science and engineering subjects. We welcome the recent announcements, following their consultation for 2012/13, by HEFCE that SIVS recruitment below AAB will be excluded from the cut to non-AAB places on condition that institutions maintain at least their entrant levels to those courses.[3]

The Royal Society has conducted significant work in recent years in analysing the 'state of the nation' in relation to STEM education between the ages of 5-19. The most recent, and final, report in our series, published in February 2011, specifically looks at school and college science in the context of the transfer to higher education.[4] Again, I include a copy for your reference, but in specific response to your consultation queries, we can draw out the following:

1. The Royal Society's final 'state of the nation' report on UK science and mathematics education found that across the UK in 2009 just 17% of 16–18 year olds completed one or more core sciences A-levels or equivalent qualifications.[5] Such a small proportion means that progression to university STEM degrees is limited and this is confirmed by data from previous years. Over time this appears to have led to a deficit of high quality graduates available to enter employment in commerce, industry and as specialist science and mathematics teachers in schools and colleges. Scottish students who study Highers, however, currently have greater flexibility, are encouraged to take a broad range of subjects, and are therefore more likely to have a more appropriate preparation for (STEM) higher education. There are concerns however that this may change with the development of new Scottish qualifications (Curriculum for Excellence).

2. Science and mathematics are compulsory in the UK up to age 16 (science only until age 14 in Northern Ireland), yet only a small proportion of students chooses to study these subjects post-16. There is little clarity yet about the impact on this of the introduction of the English Baccalaureate in early 2011 and the raising of participation in education in England to age 17/18 over the next few years[6]. There may be unintended consequences, such as on the uptake and availability of triple science GCSE which, although not suitable for all, does provide an excellent base for progressing to science, engineering and mathematics study post-16. Prior attainment is the single biggest factor in predicting whether pupils study these subjects post-16,[7] and influences on educational performance can be traced throughout children's educational careers from the very earliest stages.[8] There are a number of other factors, many of which interrelate in complicated ways, which affect students' attainment and progression to post-16 science and mathematics. These include: students' socioeconomic status (SES), ethnicity and gender; their attitudes towards science and mathematics; science and mathematics curricula, qualifications, assessment and resources; and policy making and educational reform which has a direct bearing on science and mathematics.

3. A teacher's knowledge of their subject has been shown to affect pupils' attitude to and attainment and progression in science and mathematics education.[9] Specialist teachers are likely to be more confident and enthusiastic in teaching their subject, including (especially in respect of science) running practical sessions. At post-16 level, 18%, 12% and 43% of institutions in England, Wales,

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[3] http://www.hefce.ac.uk/learning/funding/201213/faq.htm#q6

[4] http://royalsociety.org/State-Nation-Increasing-Size-Pool/

[5] http://royalsociety.org/State-Nation-Increasing-Size-Pool/

[6] Participation in education or training in England will be extended to age 17 from 2013 and age 18 from 2016 (Education Act 2011)

[7] http://royalsociety.org/State-of-the-Nation-Science-and-Mathematics-Education-14-19/

[8] http://royalsociety.org/State-of-the-Nation-Science-and-Mathematics-Education-5-14/

[9] http://royalsociety.org/State-of-the-Nation-The-UKs-Science-and-Mathematics-Teaching-Workforce/

and Northern Ireland failed to present any physics A-level candidates in 2010 and this clearly links with the poor availability of specialists in this particularly badly hit subject. The Coalition Government's recent Initial Teacher Training strategy is aiming to address both this shortage and other issues related to the supply of sufficient specialist teachers in science and mathematics at both primary and secondary levels in England.[10] Other key action areas required from the relevant UK education authorities are:

i. Ensuring access to subject-specific continuing professional development (CPD) for science and mathematics teachers throughout their careers.
ii. Maintaining satisfactory levels/quality of qualified technicians, laboratories, equipment and computing hardware in secondary schools and colleges, and ensuring that practical/field work is appropriately provided for and supported.
iii. Ensuring subjects which are significant for industrial growth, especially computing, are appropriately taught in schools. The Royal Society will be publishing a report on the teaching of computer science on 13 January 2012.
iv. Facilitating the provision of a solid and inspirational grounding in science and mathematics for all students through the right curriculum content and associated pedagogy.
v. Allowing assessment methods to genuinely support students' progress and not be focused on narrowly constructed measures of school performance (accompanied by 'teaching to the test' lessons), as well as ensuring the provision of appropriate and meaningful qualifications to support this.
vi. Providing the necessary information, advice and guidance for pupils on careers that relate to science and mathematics.
vii. Supporting research on how children learn science and mathematics and applying this to inform teaching practices.

The Royal Society will continue to monitor the provision of STEM education in the UK, at all stages from primary through to postdoctoral training. If you have any queries about any of the reports mentioned above, please contact Laura Dawson (laura.dawson@royalsociety.org) who will be able to assist you. I note that you are also interested in benchmarking the UK's performance against other countries; there are a number of OECD publications in this area, but if you are keen on learning more about specific countries, Laura may be able to put your team in touch with contacts within their national academies.

I look forward to reading the report of your Committee.

Yours sincerely

John Pethica

[10] *Training our next generation of outstanding teachers: Implementation plan* Released 8 November 2011 http://www.education.gov.uk/schools/careers/traininganddevelopment/a0078019/training-outstanding-teachers