House of Lords Science and Technology Committee: Higher Education in STEM Subjects

Response by the Wellcome Trust

March 2012

Key Points

1. In addition to providing a pipeline of graduates for careers in research and technology-driven industries, STEM study provides graduates with important transferrable skills. The fact that many STEM graduates find employment outside traditional STEM fields should be seen as positive.

2. It is difficult to predict what impact the Government's higher education reforms will have on students' ability and willingness to study STEM, and enter STEM careers. The fact that some institutions intend to charge higher fees for STEM degrees is of serious concern, as is the potential impact on the quantity and quality of people transitioning to postgraduate study. It is essential that there is national oversight of the offer of STEM courses.

3. Improvements in the quality and availability of careers advice, and better communication from employers around the value of STEM qualifications and the wide variety of opportunities they present, will also improve the supply of high quality individuals into the STEM workforce. Actions are required at all the stages of the education pipeline covered by this inquiry.

4. The UK STEM workforce is highly dependent on international, as well as home grown, talent. Government restrictions on skilled immigration from outside the EEA present a significant threat to the sustainability of the UK's STEM workforce.

INTRODUCTION

5. We welcome the opportunity to respond to this inquiry. A healthy pipeline of individuals with skills and qualifications in STEM is important both to maintain the competitiveness of the UK research base and of the critical economic sectors that depend on STEM skills, including the life sciences. While considerable progress has been made in a number of the areas highlighted by this inquiry, the rapidly changing landscape means it is important to continue to monitor emerging trends. It is important that actions to improve the STEM pipeline are consistent and well integrated across schools, higher education and industry, to avoid any risk of silos developing.

6. The Terms of Reference for this inquiry acknowledges that STEM graduates have important transferrable skills – for example numeracy, quantitative and analytical skills – which are valued by industries outside the traditional definition of 'STEM' sectors. However, this important point is contradicted by a following statement that the significant proportion of STEM graduates working in "jobs that do not require a STEM degree" is grounds for concern. The Committee should certainly be concerned if there is evidence of talent shortages in particular industries or areas of research, or if STEM graduates are

finding it difficult to secure skilled employment. However, the fact that STEM graduates are finding employment in a wide range of areas should generally be seen as positive, both for the individuals involved and for the diverse sectors that will benefit from their skills.

7. The Committee asks about the definition of a 'STEM subject' and a 'STEM job'. It would be difficult to develop an exhaustive list of every subject or job that falls under the STEM umbrella, and there will inevitably be grey areas. For example, medicine is not usually considered a STEM subject, even though the field is founded on the biosciences, and many medically-qualified individuals end up working in research. A recent study by the Science Council has highlighted the wide variety of science roles across the economy, providing a useful insight into the importance that these roles play in society[1].

8. The breadth of STEM means that significant variation is likely to exist between industries and fields of study in relation to the questions and concerns identified in the inquiry. The difficulties that the civil engineering sector experiences in attracting skilled staff may be quite different to the challenges experienced by the pharmaceutical industry. We know that gender diversity is less of an issue in the biological compared to the physical sciences. While it is valuable to identify areas of commonality, there is a risk of over-generalising problems. In making its recommendations, the Committee should consider whether STEM-wide solutions are needed, or more targeted actions in specific STEM industries, research fields or areas of study.

9. While the inquiry focuses on the supply of STEM graduates from the higher education system, it is important to acknowledge issues related to retention of talent, particularly for certain groups of individuals and especially at higher levels. For example, the number of male and female applicants for Wellcome Trust PhD programmes is roughly equal, but the proportion of female applicants is dramatically lower for Investigator Awards and senior fellowships[2].

10. The UK STEM workforce is highly dependent on international, as well as home grown, talent. Government restrictions on immigration from outside the European Economic Area (EEA) are detrimental to the UK's ability to attract top international researchers and academics, and therefore present a significant threat to the quality and sustainability of the STEM workforce. This will be exacerbated if the Government's higher education reforms decrease the number of UK residents choosing to enrol in a STEM qualification, undertake postgraduate study, or pursue a research career. Immigration issues are discussed further in paragraph 20.

11. There is a paucity of quality data when it comes to understanding the supply and demand for STEM graduates. It will be important to improve this evidence base, particularly given the Government's expectation that employers will increasingly hire local workers rather than relying on immigrants from outside the EEA. Data sets are not well integrated across government – for example it would be valuable to compare data held by the UK Border Agency, such as the information used to compile the Shortage

[1] The Science Council (2011) *The current and future UK science workforce* http://www.sciencecouncil.org/sites/default/files/UK_Science_Workforce_FinalReport_TBR_2011.pdf
[2] PhD studentships: 49% (male): 51% (female); Early Career Fellowships: 52% (male): 48% (female). Investigator Awards in 2010/11: 140 male (81%) and 33 female (19%) researchers applied. However, the award rates after interview for these applications were 49% (male): 51% (female).

Occupation List, with data held by the Higher Education Statistics Agency on trends in STEM study.

16-18 supply

12. In 2010 and 2011, entries to all three core science A levels at last achieved an annual percentage increase greater than the overall increase in A level entries. Rising entries in physical sciences (especially physics) and mathematics (especially further mathematics) followed a dramatic decline in the 1990s and the start of the following decade. This trend of increasing entries will need to be sustained over the next 5-10 years to have the desired impact on the number of STEM qualified individuals[3].

13. This improvement in the *quantity* of 16-18 STEM students followed many years of wide-ranging and often long-term Government and stakeholder initiatives. Attention now also needs to be paid to improving the *quality* of STEM trained individuals. There are two areas that need significant attention: enhancing practical skills and mathematical knowledge. Indeed, mathematical skills should be better developed for all 16-18 students, not just those studying STEM. These gains could be achieved by requiring the examination boards to properly assess practical knowledge and demand the relevant mathematical skills for science qualifications. The current structure of the examination system has raised concerns that competing examination boards are driving standards down rather than developing the necessary level of challenge[4].

14. While the Committee has chosen to focus on secondary education, there is considerable evidence that the seeds of future career choices are sown earlier than this. Young people's interest in science is often sparked in primary schools, but few schools have even one teacher with a STEM background and many primary school teachers lack confidence in teaching science. Furthermore, a recent survey by the Wellcome Trust[5] found that many primary school teachers reported a decline in the status of science over the past two years, coinciding with the removal of external science tests at age 11. The Royal Society has called for a skilled science specialist in every primary school, Based on the success of the Department for Education's programme for mathematics specialists, the Trust intends to pilot a scheme to up-skill primary science leaders, to complement the Government's plans to recruit and train primary science specialist teachers.

15. The Trust is supportive of current Government initiatives to support STEM in schools, specifically:

    - **Science Learning Centres / Project ENTHUSE** – the Department for Education, industry and the Wellcome Trust have joined forces in Project ENTHUSE, making

[3] Royal Society (2011). *Preparing for the transfer from school and college science and mathematics education to UK STEM higher education* http://royalsociety.org/uploadedFiles/Royal_Society_Content/education/policy/state-of-nation/2011_02_15-SR4-Fullreport.pdf

[4] Wellcome Trust response to the House of Commons Education Select Committee inquiry: *How should examinations for 15-19 year olds in England be run?* (2011). http://www.wellcome.ac.uk/stellent/groups/corporatesite/%40policy_communications/documents/web_document/wtvm053825.pdf

[5] Primary science survey carried out in collaboration with the National Science Learning Centre in July 2011, with 467 respondents. Detailed results are available on the Wellcome Trust website.

it possible for teachers from all over the country to upgrade their subject knowledge and teaching skills at the National Science Learning Centre (NSLC). The National Audit Office (2010) describes evidence of improved teaching and higher take-up of science and mathematics as a result of the NSLC's training courses[6]. In the 2011 Autumn Statement we were delighted to see the Government announce a further £10 million investment in Project ENTHUSE from 2013-14, which will be matched by the Wellcome Trust. We look forward to working with Government on the review of the network of Science Learning Centres, funding for which is coming to an end in 2013.

- **STEM Ambassadors[7] –** This programme brings volunteers from STEM backgrounds into schools to inspire young people about STEM subjects. STEM Ambassadors contribute through formal lessons or extra-curricular activities, with the aim to increase the motivation and enthusiasm for STEM. Importantly they also help young people to better understand the variety of career opportunities that STEM can offer, and increase schools' and teachers' links with local companies.

16. The Government must ensure a science education, at the appropriate level, is available to all. This will have benefits in terms of improving scientific literacy across the population, as well as boosting the STEM pipeline. At secondary level, ensuring that all students have access to triple science should be a priority. It is possible that the English Baccalaureate (EBacc) will increase the number of students studying two science GCSEs, as it requires to A*-C passes in science. It seems unlikely that the EBacc will drive uptake of triple science, and it is possible that the new timetabling pressures that it introduces will move students away from triple science.

17. Improving the quality of careers advice is vital, as subject choices at 14 and 16 can send young people down the wrong path, for example if they miss the qualifications they need for STEM careers. For example, young people often do not appreciate the importance of further studies in mathematics. The National Audit Office[8] listed careers information and guidance as one of five critical success factors in improving take-up and achievement in science. The Government already produces labour market information in the Annual Survey of Hours and Earnings (ASHE). If this could be augmented and made directly available to people planning their careers, especially young people and their parents, it would give them direct access to authentic information to inform decisions about future courses of study.

18. To continue to attract sufficient quality and quantity of students into STEM study, stronger incentives will be needed, especially as some students tend to see STEM subjects as a difficult option[9]. Higher education institutions need to get better at

[6] National Audit Office (November 2010). Educating the Next Generation of Scientists http://www.nao.org.uk//idoc.ashx?docId=95a6046d-8162-438c-b074-c9975db8a90e&version=-1
[7] http://www.stemnet.org.uk/content/stem-ambassadors
[8] *Educating the Next Generation of Scientists* National Audit Office (November 2010)
[9] Durham University (2008) Relative difficulty of examinations in different subjects http://www.cemcentre.org/attachments/SCORE2008report.pdf

communicating the value of STEM qualifications. A recent report by the Russell Group provides a useful model[10].

19. Employers must also communicate the value of STEM qualifications better, with emphasis on the wide range of career options available, and opportunities for salary progression (rather than just starting salaries)[11]. We welcome the 'kite-marking' initiative in the Government's Autumn Statement. Employers can also play a more proactive role in attracting students into STEM subjects by providing bursaries and work and internship opportunities.

Graduate supply

20. As part of our charitable mission, the Wellcome Trust supports "the brightest minds in biomedical research and the medical humanities" – in other words, we fund only the best. From our perspective as a funder of PhD programmes and other postgraduate training schemes, we do not have any specific concerns about the quality of students coming through from undergraduate level.

21. The introduction of accreditation should help improve the quality of STEM graduates, promote best practice in STEM teaching and harmonise course content across institutions. The Society of Biology has introduced an accreditation process for undergraduate bioscience degrees, and we welcome the announcement in the Government's recent Strategy for Life Sciences that this will be expanded.

22. The Committee's questions refer to the supply of graduates "from the UK, EU and internationally". It is worth noting that a significant proportion of the UK's current research and academic workforce originate from outside the EEA. Even if there were ample STEM graduates to supply the UK workforce, international scientists should still be welcomed for the diversity of skills, knowledge and connections that they bring, enhancing research and innovation. Science is a global affair and flourishes through international collaborations. Non-EEA nationals make up 10.6 per cent of all UK academic staff; although in some science and engineering disciplines the proportion is as high as 26 per cent[12]. The Wellcome Trust is concerned that the Government's immigration reforms are likely to have a negative impact on the UK's ability to continue attracting high quality international staff. In particular:

    - The Government's decision to close the Tier 1 Post-Study Work route could make it much more difficult for talented international graduates of UK universities to enter the UK workforce following their graduation. While the Government is allowing international graduates to transfer into the main Tier 2 work category, in practice not all graduates will meet the requirements – specifically the need for a job offer paying more than £20,000.

[10] The Russell Group (2011). *Informed choices* http://www.russellgroup.ac.uk/media/informed-choices/InformedChoices-latest.pdf

[11] The Royal Academy of Engineering (2011).*The labour market value of STEM qualifications and occupations.* http://www.raeng.org.uk/news/releases/pdf/The_Labour_Market_Value_of_STEM_Qualifications_and_Occupations.pdf

[12] Higher Education Statistics Agency, 2009/10

- The closure of the Tier 1 (General) category and the additional restrictions on Tier 2 have made it much more difficult for graduate-level talent to enter the UK. Tier 1 (General) specifically prioritised those who were young and qualified to degree-level or higher. Under Tier 2 no points are awarded for youth or qualifications[13], and employers can only hire a foreigner if they can demonstrate that there is no UK or EEA worker who could do the job;

- The proposal to restrict Tier 5 to 12 months rather than 24 months will threaten the viability of a number of important STEM training schemes, including the Newton Fellowships operated by the Royal Society, and the sponsored researchers programme led by Research Councils UK.

23. At this stage it is difficult to say with any certainty what impact the higher education reforms will have on STEM provision at the undergraduate level. This will need to be carefully monitored. However, it is of serious concern that some institutions have set higher fees for STEM courses than courses in other areas, even though STEM courses will continue to receive public tuition subsidies. This could reduce numbers of STEM undergraduates and systematically deter certain groups of students from studying STEM, notably the debt averse. As part of its funding arrangements for teaching in STEM subjects, the Government should seek a commitment from institutions that students choosing to study STEM subjects will not face higher fees than other students at the same institution.

24. The higher education reforms may also have an impact on the diversity and geographical spread of STEM graduates. It is predicted that more students will decide to stay at home when studying in order to save money – if their local HEIs do not offer the full range of STEM subjects, their options will be limited.

Post-graduate supply

25. The Wellcome Trust was an early pioneer of the four year approach to PhD programmes, which has since been adopted by other research funders, for example through the EPSRC/ESRC Doctoral Training Centres. We currently support 30 Programmes based in centres of excellence throughout the UK, and an additional seven clinical PhD programmes.

26. In developing our four-year PhD programme the Trust elected to prioritise quality over quantity – ensuring that the individuals we fund have access to the very best training environments, even if that means funding fewer people and a limited number of institutions. This targeted approach is consistent with our mission as a charitable funder, but at the national level there may be value in greater diversity.

27. While there is a perception that PhD training has not historically been sensitive to the range of careers that PhD graduates will ultimately undertake, we consider that this situation is improving. Like most other developed nations, the UK has seen a significant increase in the number of PhD graduates over recent decades – as the number of permanent academic positions has not increased at the same rate, there is increasing recognition and acceptance that not all PhD graduates will end up in research and

[13] While priority is given in Tier 2 to 'PhD level' occupations, the extra points are granted irrespective of whether the individual in question actually has a PhD.

academic roles. PhD programmes, including those funded by the Wellcome Trust, are increasingly incorporating training in transferable skills such as communication and leadership, in addition to technical training.

28. We would argue that the expansion in PhD-qualified individuals is positive for the UK even if many of these individuals do not end up working directly in research. It is important for postgraduate students to have access to high quality careers advice to counter any perception that a non-academic career path is less worthy. For those who wish to remain in academia, appropriate support and advice at each career stage is also important. This is especially pertinent for women in science given the decline in numbers of women as the seniority of positions increases.

29. In 2009, the Trust launched 'Career Tracker', a longitudinal prospective study to track Trust award holders' careers over time, with a focus on recipients of PhD and early career fellowships. The early results show that the majority of the participants in the study have remained in academic research, although the proportion of women remaining in academia was lower (66 per cent compared to 80 per cent of males). Although most PhD holders who had left academic research were still working in science-related areas – such as the pharmaceutical/biotech industry medicine, science administration or science communications – others had started careers in new fields, such as TV production, social work and investment. The reasons given for leaving academia included: a "willingness to contribute to improve global health but not at the bench"; "uninspiring career prospects"; and a "dislike of politics that seem to be associated with an academic career". When asked to suggest some barriers to the pursuit of a career in science, the Career Tracker participants mentioned difficulty in obtaining funding and a lack of job security. We would be happy to share more detailed results with the Committee if this would of interest.

30. As a research funder we are concerned about the potential impact of the higher education reforms on students' decisions about whether to pursue postgraduate study, and ultimately a research career. In the current economic climate the extent of this impact may not become fully apparent, as the difficult graduate job market is likely to strengthen incentives to pursue further study. However, as the economy recovers and graduate opportunities increase, students who are concerned about their level of debt may think twice about enrolling in a higher qualification, particularly if this is likely to mean additional debt. It was announced in the higher education white paper that the government intended to monitor this area closely, but we welcome HEFCE's willingness to adopt a more proactive approach, including exploring options for providing financial support to postgraduates.

31. Masters degrees are increasingly seen as entry-level qualifications for STEM graduates wishing to work within the sector or progress to PhDs. Indeed, the majority of chemistry and engineering courses are now four-year integrated Masters programmes. To avoid a break in the STEM pipeline, state funding should support Masters level courses where these are an entry-level qualification or are essential for progression to a PhD. Financial incentives are needed given that increasing levels of debt may deter students from further study – this will not only reduce numbers but may risk course closures.

Industry

32. There are numerous ways industry can encourage students to pursue STEM disciplines. For example:

- Providing financial support to individual students through bursaries and scholarships;
- Working with HEIs to ensure that industry priorities and activities are represented within STEM courses, for example by supplying guest lecturers.
- Participating in STEM Ambassadors and other schemes that increase awareness of the value and diversity of STEM careers
- Offering work experience and enrichment to students throughout education

33. Better information about wage progression may encourage more potential students to consider a STEM career, as graduate salaries are not always representative of long-term earning potential. With regard to encouraging young people to consider research careers, it is also important to highlight the non-monetary advantages, such as independence, ability to work flexibly, prestige, opportunities to travel or work abroad, intellectual stimulation, and the potential to help solve important problems.