HOUSE OF LORDS

Select Committee on Science and Technology

2nd Report of Session 2012–13

# Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects

Report

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# CONTENTS

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References in footnotes to the Report are as follows:
Q refers to a question in oral evidence;
Witness names without a question reference refer to written evidence.

## SUMMARY

The Government in their Plan for Growth attach great importance to education and hi-tech industry in order to create jobs and prosperity. The jobs of the future will increasingly require people with the capabilities and skills that a STEM education provides. However, there appears to be a mismatch between the STEM graduates and postgraduates that higher education institutes (HEIs) supply and the demand from employers, both in terms of the number of students and the skills and knowledge they acquire.

We start this report by analysing the current definition of STEM which uses the Joint Academic Coding System (JACS). We found this definition unsatisfactory because it is too broad and includes subjects that have not traditionally been considered STEM. An implication of such a broad definition is that there is a danger that a significant proportion of the growth in the number of students studying STEM subjects is made up of courses with little science content, thus hiding the true picture of the level of STEM skills available to meet the needs of the economy. The Government must work together with stakeholders to define STEM by using a statement of the competencies and skills that a STEM graduate and postgraduate should possess and the characteristics that a STEM course should contain.

One aspect of STEM education that was flagged up to us during this inquiry was the interface between schools and higher education (HE), and maths. We are concerned that the number of pupils studying maths post-16 is insufficient to meet the level of numeracy needed in modern society, and the level at which the subject is taught does not meet the requirements needed to study STEM subjects at undergraduate level. The study of maths should be compulsory for all students post-16 and maths to A2 level should be a requirement for students intending to study STEM subjects in HE. In addition, we urge HEIs to introduce more demanding maths requirement for admissions into STEM courses as the lack, or low level, of maths requirements at entry acts as a disincentive for pupils to study maths and high level maths at A level.

Another issue with which we had to grapple was the lack of reliable data on the supply and demand of STEM graduates and postgraduates. This lack of data makes it very difficult to assess whether there is in fact a shortage of STEM graduates and postgraduates and in which sectors. This is critical because, if it is not known whether there is a shortage, remedial actions cannot be put in place. To this end, we believe that a single body should be appointed to be a repository of information on the supply of, and demand for, STEM graduates and postgraduates with a view to providing comprehensive, real time data analysis and a commentary with market intelligence of where STEM shortages exist. These data will serve multiple purposes, such as aiding the classification of shortage areas as Strategically Important and Vulnerable Subjects (SIVS), or inform students on whether the courses they are considering studying will equip them with the skills needed by employers.

We analyse in this report how quality is assessed in HE and the mechanisms for improving quality, given that the mismatch in supply and demand for STEM graduates relates in part to a lack of high quality graduates in many sectors, not necessarily the overall number. These issues are complex and there are many nuances that have to be taken into account. However, we concluded that the remit of the QAA should be reviewed with a view to introducing a system to assure quality, standards and benchmarks in HEIs that is fit for purpose. We support accreditation of courses by professional bodies as a way of signposting high quality courses. At the same time we call on the QAA to ensure that employers are sufficiently involved in setting standards and benchmarks, and promoting quality.

It is clear that STEM postgraduates play a significant role in driving innovation, undertaking research and development, and providing leadership and entrepreneurship. However, it appears to us that, although the Government recognise the central role that STEM plays in their strategies for growth, they fail to articulate how they intend to convey to students the benefits of STEM postgraduate study, to reduce the decline in STEM qualifiers in some STEM subjects, or to improve our understanding about the demand for postgraduates and the value they offer to the economy. Additionally, they fail to make clear what support they will give to postgraduate STEM provision in order to realise their vision. To remedy this situation we call on the Government to set up an expert group, with substantial employer involvement, to consider the supply and demand of STEM postgraduate provision with the aim of formulating a strategy for STEM postgraduate education in the UK which will underpin the Government's strategies for growth.

Two recent policy reforms—on HE and immigration—are likely to have a significant impact on the HE sector. Although it is too early to assess their effect with accuracy, the evidence that we received indicates a significant concern about the outcome of the reforms. We support the role that the Government have given to HEFCE to monitor unintended consequences and to intervene, as appropriate, to protect strategic or vulnerable provision, yet we are concerned that HEFCE may not have the funds to intervene should it need to.

We believe that changes to immigration rules have resulted in a perception that the UK does not welcome students. This perception, in conjunction with the actual changes to the immigration rules, may reduce the number of overseas students coming to study to the UK and, in turn, the income that HEIs derive from these students to fund other activities. This may result in a reduction of provision of STEM courses that rely on this income to make them viable. We call on the Government to make a distinction in the immigration statistics between HE students and other immigrants, and use only the latter category to calculate net migration for policy-making purposes. This move would reconcile contradictory policies from the HO, to reduce net migration, and BIS, to expand the HE sector to promote economic growth.

There is a danger that the HE and immigration reforms could have a compound impact on stand-alone Masters degree provision producing a 'triple whammy' effect due to higher fees, lack of student finance and a decline in the number of overseas students choosing to study in the UK. By the time the effect of these reforms is quantified and analysed, it may be too late to put remedial action in place. The role of the expert group mentioned above will be crucial in this regard.

# Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects

## CHAPTER 1: INTRODUCTION

1. In the Government's *Plan for Growth*, education is described as "the foundation of economic success". The Government further stated that "our economy needs to become much more dynamic … and retooled for a high-tech future, if we are going to create the jobs and prosperity we need for the next generation".[1] The Council for Industry and Higher Education (CIHE) warned that "the workforce of the future will increasingly require higher-level skills as structural adjustments in the economy force businesses to move up the value chain. These jobs of the future will increasingly require people with the capabilities that a STEM qualification provides".[2]

2. This raises the question whether the UK produces enough STEM graduates and postgraduates to fulfil this increasing demand and realise the Government's aspiration to use science to underpin economic growth.[3] The Confederation of British Industry (CBI) reported that "STEM skills shortages are widespread" with over 40% of employers currently experiencing difficulty recruiting staff with STEM qualifications.[4] If the UK is unable to fill today's vacancies with high quality STEM graduates and postgraduates, there is little chance that the economic growth that the UK needs in the future will materialise.

3. On the other hand, STEM graduates have been increasing in recent years and we are also aware that there are reports which indicate that a substantial number of STEM graduates have taken up non-STEM jobs, suggesting that there might be an over-supply or mismatch between supply and demand.[5] This apparent contradiction, coupled with the importance that the Government attach to STEM as an engine of economic growth, sparked the Committee's inquiry.

### Scope

4. Higher education (HE) is devolved to Scotland, Wales and Northern Ireland. For this reason, this report focuses on England. However, some of the problems that we have encountered and possible solutions that we propose may apply throughout the UK.

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1 HM Treasury & BIS, *The Plan for Growth*, March 2011.

2 CIHE, *The demand for STEM graduates and postgraduates*, January 2009.

3 http://www.bis.gov.uk/news/speeches/david-willetts-policy-exchange-britain-best-place-science-2012.

4 CBI, *Building for Growth: Business Priorities for Education and Skills—Education and Skills Survey*, May 2011.

5 The Guardian, *Job figures cast doubt on Whitehall's push for science degrees,* 11 September 2011; BBC News, *Engineering graduates "taking unskilled jobs",* 8 September 2011; The Guardian, *It is nonsense to claim Britain produces too many science graduates,* 14 September 2011.

5. We have chosen to concentrate on the areas that we believe are of crucial importance to the supply and demand of a STEM-skilled workforce. We consider whether the Government are using the available levers effectively to support and influence the HE sector to meet the UK's skills needs in order to generate economic growth.

6. Although it was included in our call for evidence, we have not covered diversity because of the activities of the Royal Society and the Royal Academy of Engineering in this area. The House of Commons Health Committee is currently scrutinising medical careers. We have, therefore, excluded this area from our inquiry as well.

7. Given the significant attention that A level and GCSE study is receiving, including the Department of Education review of the National Curriculum,[6] we thought it inappropriate to include scrutiny of secondary education in this inquiry. However, the weight of evidence that we have received led us to conclude that post-16 maths and the interface between school and HE study warranted a closer look.

8. We received substantial written evidence on the recent HE reforms. Whilst it is too early to assess the repercussions of the reforms for the HE sector as a whole, we have highlighted areas of concern focusing on undergraduate and postgraduate STEM provision.

## Definitions

9. The acronym "STEM" encompasses a group of disciplines that teach the skills required for a high-tech economy. What this means in practice, and how this definition relates to specific courses in higher education institutions (HEIs), is a more complex matter and the definition varies across the HE sector and Government.

10. For the purposes of this inquiry, however, we have adopted a definition used by the Department for Business, Innovation and Skills (BIS) and the Higher Education Statistics Agency (HESA). This definition uses the Joint Academic Coding System (JACS) which classifies all subjects into 21 groups (see Appendix 7). Within these groups, STEM classifiers are: medicine and dentistry; subjects allied to medicine; biological sciences; veterinary science, agriculture and related subjects; physical sciences; mathematical sciences; computer science; engineering; technologies; and architecture, building and planning.

## Methodology

11. We published a call for evidence on 2 November 2011. We received 119 written submissions. In November 2011 we held a seminar with representatives of Government departments, academics, employers and other stakeholders. Between December 2011 and April 2012 we held 13 oral evidence sessions, including one with Vice-Chancellors from nine HEIs. In April, we also wrote to 14 HEIs with specific questions on postgraduate provision and the responses are published with the written submissions.

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[6] The Government.

## Structure of the report

12. The definition of STEM is a fundamental issue underlying this inquiry. In Chapter 2, therefore, we discuss the complexities behind this issue and the repercussions that too wide a definition have on the analysis of relevant data. Chapter 3 focuses on the interface between school and HE maths provision. In Chapter 4, we set out the policy context within which the HE sector operates. We also provide some background data on trends in STEM subjects, and discuss the supply and demand of STEM graduates and postgraduates. Chapter 5 focuses on quality, including quality assessment mechanisms and the involvement of employers and other stakeholders in the process of quality assurance. In Chapter 6, we consider recent policy reforms in HE and in immigration, and the impact that they are having, or may have, on STEM in HE.

13. The membership and interests of Committee Members are set out in Appendix 1. Those who submitted written evidence and gave oral evidence are listed in Appendix 2. The call for evidence with which we launched our inquiry is reprinted in Appendix 3. A list of attendees at the seminar is set out in Appendix 4, and a list of abbreviations and acronyms is provided in Appendix 5.

## Acknowledgements

14. We are grateful to all those who assisted in our work by providing written evidence or attending oral evidence sessions. We also thank our Specialist Adviser, Professor Sir William Wakeham, for his expertise and guidance throughout this inquiry. We stress, however, that the conclusions we draw and recommendations we make are ours alone.

## CHAPTER 2: DEFINITION OF STEM

15. One of the first issues which we had to address when we began this inquiry was how to define a STEM subject. We found that the definition varied between different bodies within and outside Government and also from country to country (making comparisons about the number of STEM graduates difficult).[7] Although (in paragraph 23) we propose a different approach to defining STEM subjects, the definition which we have adopted, at this stage, makes use of JACS. We do not, however, find JACS entirely satisfactory for the reasons set out (in paragraph 17) below.

16. JACS "is owned and maintained" by the Universities and Colleges Admissions Service (UCAS) and HESA and "is used for subject coding of provision across higher education in the UK".[8] Box 1 sets out the subject groups at the highest level of JACS 3, with Groups A-K constituting a collective set of disciplines we refer to here as STEM. Each Group is subdivided into subjects. For example, "physical sciences" is subdivided into nine subject areas and then into 114 further subjects. Appendix 7 to this report lists the subject areas included in each highest-level Group for STEM. The full listing by subject can be found on the HESA website.[9]

**BOX 1**

**JACS 3 listing of the highest-level Groups[10]**

Groups with STEM are in bold (Groups A-K):

**A – Medicine and Dentistry**

**B – Subjects allied to Medicine**

**C – Biological Sciences**

**D – Veterinary Sciences, Agriculture and related subjects**

**F – Physical Sciences**

**G – Mathematical Sciences**

**H – Engineering**

**I – Computer Sciences**

**J – Technologies**

**K – Architecture, Building and Planning**

L – Social Studies

M – Law

N – Business and Administrative Studies

P – Mass Communication and Documentation

Q – Linguistics, Classics and Related Subjects

R – European Languages, Literature and related subjects

7 The Government, the Science Council.

8 http://www.hesa.ac.uk/content/view/1776/649/.

9 http://www.hesa.ac.uk.

10 http://www.hesa.ac.uk/content/view/1805/296/.

T – Eastern, Asiatic, African, American and Australasian Languages, Literature and related subjects

V – Historical and Philosophical Studies

W – Creative Arts and Design

X – Education

17. Although JACS is a useful tool for defining STEM and for carrying out analysis of trends in the study of STEM subjects, different organisations have raised objections to some of the subject areas included, or excluded, from the definition of STEM within JACS or in other definitions.[11] For example, some Sector Skills Councils use narrow definitions, depending on their interests, and do not usually include medicine and subjects allied to medicine. The Higher Education Funding Council for England (HEFCE) excludes some subjects such as architecture from their analysis of STEM subjects;[12] and other bodies prefer the broader definition used in this report, which includes computing, psychology and medicine.[13] The Careers Research and Advisory Centre (CRAC) commented that "subjects such as nursing, but also psychology, sports science and archaeological science ... fall within JACS Subject Groups most commonly considered to be within STEM, but many would consider these might not be STEM subjects".[14]

18. The problem in defining STEM using JACS is that it leads to the inclusion of some degree subjects that traditionally have not been considered STEM (and where the direct STEM content may be small) such as some complementary medical courses or some sports science courses. In terms of the overall numbers of students studying, and graduating from, STEM, such courses are then given the same value and weight as subjects such as engineering or chemistry, even though they may not be considered by many to be STEM and graduates from these courses may not have sufficient STEM skills to satisfy the demands of the employment market for STEM graduates.

19. The Government suggest in their evidence that other classifications are possible, for example, "core" and "non-core" subjects or "hard" and "soft" subjects, with the newer courses, such as sports science and forensic sciences, being categorised as "soft" subjects.[15] However, because of the continually evolving disciplines within science and the difficulties surrounding the classification of subjects within JACS, it can be difficult to disaggregate and classify courses under such headings.

20. A significant number of the submissions we received took another approach and defined STEM by describing the skills that a STEM graduate ought to have, thereby moving away from the argument about which subjects should

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11 ABPI, BMA, CRAC, Council for the Mathematical Sciences, Medical Schools Council, Open University, The Physiological Society, Royal Geographical Society, Society of Biology, University of Oxford and the Wellcome Trust.

12 HEFCE.

13 ABPI, BMA, Council for the Mathematical Sciences, Institute of Education, Medical Schools Council, Open University, University of Oxford.

14 CRAC.

15 The Government.

be included in the definition of STEM.[16] The Science Council, for example, argued that science should be defined "as a methodology, rather than as a subject or group of subjects".[17] The University of Oxford suggested that:

> "... the defining characteristic of an undergraduate education in the STEM subjects is the ability to think analytically, including about abstract problems, and to use evidence to support propositions. The associated skills a STEM graduate has—including numeracy, literacy, ability to use information technology, programming skills, group working, presentational skills, time organisation, and research skills—are all valuable to any employer."[18]

21. The characteristics of a STEM graduate usually include: numeracy and the ability to generate, understand and analyse empirical data including critical analysis; an understanding of scientific and mathematical principles; the ability to apply a systematic and critical assessment of complex problems with an emphasis on solving them and applying the theoretical knowledge of the subject to practical problems; the ability to communicate scientific issues to stakeholders and others; ingenuity, logical reasoning and practical intelligence. In our view, defining STEM in this way is the more rational approach. UCAS and HESA are currently considering a fundamental revision of course subject classifications.[19] It would, we suggest, be sensible for these bodies to take this approach into account when reviewing the current classification system. It is these sorts of skills—the essential STEM skills—that are needed to generate economic growth; and when, in our recommendations, we refer to STEM subjects, it is this stricter definition which we have in mind.

22. The definition of STEM has to be born in mind when analysing data, particularly data relating to trends for undergraduate and postgraduate provision. As we have seen, the definition of STEM using JACS classification is broad. An implication of such a wide-ranging definition is that there is a danger that a significant proportion of the growth in STEM uptake may be made up of courses with little science content, thus hiding the true picture of the level of STEM skills available to meet the needs of the economy.

23. **We recommend that, given the importance that the Government attach to STEM skills in stimulating economic growth and the wider importance of a STEM-literate society, the Government should work together with HESA, the Research Councils, HEIs and professional bodies to formulate and apply a standard definition of STEM. The definition should derive from a statement of the competencies and skills that a STEM graduate should possess and the characteristics that a STEM course should contain, including direct STEM content.**

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16 Higher Education Academy, Research Councils UK, the Royal Society of Chemistry, British Academy, Science Council, University of Oxford, Institute of Physics.

17 The Science Council.

18 University of Oxford.

19 UCAS.

# CHAPTER 3: THE SCHOOL AND HIGHER EDUCATION INTERFACE, AND MATHS PROVISION

24. In February 2010, Sir Mark Walport, Director of the Wellcome Trust, stated in a letter to the Rt Hon David Willetts MP, Minister for Science and Innovation at BIS, that "the future of the United Kingdom depends critically on the education of future generations. Science, technology, engineering and mathematics (STEM) must be at the forefront of education in order for the United Kingdom to address some of the most important challenges facing society ... we owe it to our children to prepare them for an exciting and uncertain future—and education is the most powerful tool to achieve this".[20] We could not agree more.

## The mathematical skills gap

25. A number of attempts have been made to improve maths provision over the years. They include a major change to the curriculum and examination process in 2000 (which resulted in a dramatic reduction in the number of students studying maths).[21] In 2006, the Royal Society argued that the gap between the mathematical skills of students when they entered HE and the mathematical skills needed for STEM first degrees was a problem which had become acute. Two reasons were suggested to explain the gap: first, lack of fluency in basic mathematical skills; and, secondly, the fact that some A level syllabuses allowed topics to be excluded which were relevant to some first degree courses.[22] The evidence we received suggested that the problem remains.

26. In addition to the skills gap at the school-HEI interface, we also received evidence that graduates were often found to lack the numeracy skills needed to succeed in the workplace,[23] an issue confirmed by employer surveys conducted by the CBI which identified a shortage of students with adequate maths skills.[24]

27. A number of factors are said to have contributed to this decline in maths skills. They include:

- too few students choosing to study maths post-16 (although numbers have started to rise in recent years);
- changes to the curriculum, course structure, examinations and the modular nature of A level provision;
- a dearth of qualified teachers;
- poor careers advice in schools; and
- the fact that some HEIs do not require a post-16 maths qualification at entry to study STEM subjects.
- Maths study post-16

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20 The Science and Learning Expert Group, *Science and mathematics Secondary Education for the 21st Century*, February 2010.

21 Royal Society, ACME, Cambridge Assessment, Score.

22 Royal Society, *A degree ofcConcern? UK first degrees in Science, Technology and Mathematics,* 2006.

23 ABPI, CBI, Engineering Professors' Council, Medical Schools Council, The Physiological Society.

24 CBI.

28. In 2009, the UK was 28th in the international education league table in maths (based on the skills of 15 year olds), placing it behind many East Asian and European countries.[25] 85% of all students in England give up maths at the age of 16.[26] According to a study in 2010, competitor countries achieve much better results not only in terms of the number of students that study maths post-16 but the level of maths that they study.[27] Table 1 illustrates the results of this research. In a report commissioned by the Conservative Party and published in August 2011, Carol Volderman's Task Force described this situation as "a national disgrace" and said that "unless we improve [post-16 provision] very significantly we will cease to be among the leading economic and academic countries in the world".[28] The Advisory Committee on Mathematics Education (ACME) had come to a similar conclusion in June 2011. As a result, ACME is consulting on the development of pathways of courses for continuing maths study.[29]

25 OECD, *PISA 2009 Results: What Students Know and Can Do—Student performance in reading, mathematics and science*, 2012.

26 Carol Volderman's Task Force, *A world-class mathematics education for all our young people*, August 2011.

27 The Nuffield Foundation, Hodgen et al., *Is the UK an outlier? An international comparison of upper secondary mathematics education*, December 2010.

28 *Op. cit., A world-class mathematics education for all our young people.*

29 ACME, *Mathematical need—mathematics in the workplace and in higher education*, June 2011.

## TABLE 1

### Students taking mathematics post-16 in 24 countries and states[30]

**Students taking mathematics post-16**

| | Any mathematics | Advanced mathematics |
|---|---|---|
| Japan | All | High |
| Korea | All | High |
| Taiwan | All | High |
| Estonia | All | Medium |
| Finland | All | Medium |
| Sweden | All | Medium |
| Russia | All | Low |
| Czech Republic | All | – |
| France | Most | Medium |
| USA (Mass) | Most | Medium |
| Germany | Most | Low |
| Ireland | Most | Low |
| Canada (BC) | Most | – |
| Hungary | Most | – |
| New Zealand | Many | High |
| Singapore | Many | High |
| Australia (NSW) | Many | Medium |
| Netherlands | Many | Low |
| Hong Kong | Some | Medium |
| Scotland | Some | Medium |
| Spain | Some | Low |
| **England** | **Few** | **Low** |
| Northern Ireland | Few | Low |
| Wales | Few | Low |

**Key**

| | | | | | |
|---|---|---|---|---|---|
| **Any mathematics** | 5–19% | 20–50% | 51–79% | 80–95% | 95–100% |
| **Advanced mathematics** | 0–15% | | 15–30% | | 30–100% |

*Data on participation in advanced mathematics were insufficient in Canada (BC), Czech Republic and Hungary.*

29. According to a recent Office for Standards in Education, Children's Services and Skills (Ofsted) report, published in May 2012, compared with the 2008 figures, A level entries in 2011 were up by 31% in maths and by 35% in further maths. The corresponding figures for AS were 58% and 120% respectively.[31] This is encouraging. However, given the low baseline from which these figures are derived, we remain concerned about the high number of students who do not continue maths education post-16. Observing that "maths dropped at age 16 is easily forgotten, and skills are not consolidated",[32] ACME was in favour of maths being studied in some form

30 *Ibid.*

31 Ofsted, *Mathematics: made to measure,* May 2012.

32 *Op. cit., Mathematical need—mathematics in the workplace and in higher education.*

by all students up to the age of 18. The Royal Society made a similar recommendation in their State of the Nation report in 2011.[33]

30. The number of students taking maths post-16 is insufficient to meet the level of numeracy needed in our society, and the level at which it is taught often fails to meet the requirements for studying STEM subjects at undergraduate level. We share the view that all students should study some form of maths post-16, the particular area of maths depending on the needs of the student. For example, prospective engineering students would require mechanics as part of their post-16 maths, whereas prospective biology students would benefit from studying statistics.

31. We are aware that on 2 July 2012, the Government proposed a policy whereby those who do not achieve a good pass in English and maths at GCSE will be required to continue those subjects until the age of 18. We welcome the Government's commitment to addressing the problem of too many 16 year olds giving up maths after GCSEs. We do not, however, agree with the Government's proposed solution. In our view, all students to the age of 18, and society more generally, would benefit from them continuing their maths education. It is simply not enough to make post-16 maths compulsory for those who find it particularly challenging.

32. **We recommend that, as part of their National Curriculum review, the Government make studying maths in some form compulsory for all students post-16. We recommend also that maths to A2 level should be a requirement for students intending to study STEM subjects in HE.**

## A level course content and structure

33. Until March 2012, the Qualifications and Curriculum Development Agency (QCDA) was responsible for curriculum development and setting criteria for qualifications. Since then, the National Curriculum assessments function has been performed by the Standards and Testing Agency (STA). The Office of Qualifications and Examinations Regulation (Ofqual) is an independent body responsible for standards, regulation and approving the examination boards' specifications.

34. A number of Vice-Chancellors told us that not only had their HEIs had to offer remedial maths to those who had not taken A level maths,[34] but such courses were also needed for students who had performed well at A level maths.[35] Professor Brian Cantor, Vice-Chancellor of the University of York, told us, for example: "we have to give maths remedial classes, often even to triple-A students".[36] Professor Sir Christopher Snowden, Vice-Chancellor of the University of Surrey, said: "I think that in pretty much every university the issues over maths skills apply. Indeed, this has been an issue now for many years within universities, partly due to the increase in the breadth of maths that is studied at schools but with a lack of depth. In some cases, for

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33 Royal Society, *Preparing for the transfer to STEM Higher Education,* February 2011.

34 QQ 40, 42.

35 Engineering Professors' Council, Professor John MacInnes.

36 Q 42.

example, there is a complete absence of calculus, which is an issue in many subjects".[37]

35. Imperial College London, with others, was critical of the modular approach to maths because it did "not encourage students to retain knowledge or to think critically about how the various parts of their subject interrelates ... [because] important parts of the curriculum are sometimes not a compulsory part of the course".[38] Ofsted concluded, in its recent report, that "too much teaching concentrated on the acquisition of disparate skills that enabled pupils to pass tests and examinations but did not equip them for the next stage of education, work and life".[39] On the basis of the evidence we received, it appears that a modular approach may not be the most appropriate way to teach maths on the grounds that it discourages teachers from adopting a holistic approach to the subject.

36. In a speech in March 2012, the Secretary of State for Education, the Rt Hon Michael Gove MP, stated: "we need to move away from an expensive and time-consuming culture of proliferating external examinations—modules, re-sits and retakes—towards fewer high quality qualifications overseen and conferred not by commercial organisations but by institutions of academic excellence such as our best universities".[40] We agree, in principle, that it is sensible for HEIs and employers to have a say about the content of school qualifications in general and maths and A levels in particular. However, we question how the Minister's proposed approach will work in practice. Ofqual has already warned that academics "would not have the time to set aside for such activities on top of their academic roles" and suggested that "learned bodies were best placed to provide the higher education sector view because they knew more about A levels than individual academics".[41]

37. HEIs should interact more with schools in setting up the curriculum, as should employers and other stakeholders, with a view to raising standards. Given that the Roberts Review (see paragraph 57) recommended in 2002 that HEIs and schools should work together to smooth the transition from A level to HE, we find it difficult to understand why HEIs have not made more effort to ensure that the A level curriculum adequately prepares students for HE. Although Professor Sir Leszek Borysiewicz, Vice-Chancellor of the University of Cambridge, told us that many HEIs were engaged in setting the curriculum, Professor Malcolm Grant, Vice-Chancellor of University College London, told us: "I do not think that universities have done anywhere near enough to work with the curricula".[42]

38. Concerns have also been raised that competing examination boards are driving standards down as schools seek easier examinations in order to achieve higher places in national league tables.[43] The Wellcome Trust, for example, suggested that competing examination boards were having that

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37 *Ibid*.

38 Imperial College London, National Higher Education STEM Programme, Q 42, Q 47, Q 51, Q 226.

39 *Op. cit., Maths: made to measure.*

40 http://www.bbc.co.uk/news/education-17585199.

41 Ofqual, *Fit for Purpose? The view of the higher education sector, teachers and employers on the suitability of A levels*, April 2012.

42 Q 47.

43 QQ 45–47, the UK Deans of Science, the Wellcome Trust.

effect "rather than developing the necessary level of challenge".[44] A recent report from the House of Commons Education Committee drew a similar conclusion and recommended a single national syllabus for each subject, accredited by Ofqual, with national subject committees, set up by Ofqual and including representatives from universities, employers and learned bodies, to monitor standards.[45]

39. **We support the Government's efforts to involve HEIs in setting the curriculum and we urge HEIs to engage fully and make every effort to smooth the transition from school to HE, particularly in maths. In order to inform this process, we urge that HEIs work together to establish where the skills gaps are and which areas of the maths syllabus are essential for STEM undergraduate study. We would expect this work to be completed by July 2014.**

40. **We support the recommendation by the House of Commons Education Committee that there should be a single comprehensive national syllabus, accredited by Ofqual, to offset the risk that competing examination boards will tend to drive down standards. We would expect the national syllabus for maths to meet the needs of all students post-16 (in accordance with our conclusion and recommendation in paragraphs 30 to 32 above). The proposed national subject committees will be critical to the success of the new scheme. Should the scheme go ahead therefore, we would seek assurance that the HEIs would have a significant role within the committees and that the committees would be given the capacity to be fully effective in ensuring that standards, particularly at A2, are maintained.**

41. **The Education Committee recommended that the Government should pilot a national syllabus in one large entry subject as part of the forthcoming A level reforms. We would recommend that maths should be the subject of such a pilot.**

## Qualified teachers

42. The shortage of specialist maths teachers has been the subject of many previous studies. Several witnesses told us that the problem remained,[46] and that it was important because, as Professor Cantor said, "you do not teach good maths ... unless you get inspirational teachers".[47] It was also important because of the vicious cycle whereby a lack of students taking up maths A levels would mean fewer studying maths in HE which, in turn, would mean fewer specialist teachers and, as a result, fewer students studying maths. The Department of Education, recognising the role of teaching in increasing the progression of students to A level STEM subjects,[48] has introduced a number of initiatives to increase the number of specialist teachers (such as, golden

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44 The Wellcome Trust.

45 Education Committee, 9th Report (2012–13): *The administration of examinations for 15–19 year olds in England* (HC 141-I).

46 CBI, Council for the Mathematical Sciences, Professor Sir John Holman, Imperial College London, Pearson Centre for Policy and Learning, Royal Society of Chemistry, Royal Society, Universities UK, and the Wellcome Trust.

47 Q 50.

48 Ofsted.

handshakes and bursaries), but, by their own admission, "the targets set by the previous Government for numbers of specialists teaching physics and maths will not be met".[49] The Science and Learning Expert Group advised in their study entitled *Science and mathematics secondary education for the 21st Century:* "in order to increase the quantity and quality of specialist teachers we will need to continue to recruit more STEM graduates into teaching, provide excellent training for them and retain excellent teachers within the profession by ensuring that their careers are rewarding in every respect".[50]

43. **We recommend that the Government increase their efforts to boost specialist STEM teacher recruitment. The Government should assess which existing initiatives have yielded positive results and which have not worked, so that resources can be concentrated on those schemes that produce the best outcomes.**

## Careers advice and education

44. From September 2012, schools will be responsible for ensuring their pupils have access to independent and impartial careers guidance.[51] In April 2012, the Government launched a national and career-wide careers service through a new web portal, the National Careers Service. (Although it is too early to assess its effectiveness, we note that the Campaign for Science and Engineering (CaSE) have already raised concerns: "It is our understanding that there is no framework for this [careers advice] provision and it won't be comprehensively audited. As a result, schools which provide a below-par careers service cannot be quickly or easily identified, to the detriment of their students".)[52]

45. High quality careers advice to young people is essential to demonstrate to students the benefits of studying STEM. This is all the more important because, according to the Gatsby Foundation, "STEM A levels have the reputation of being harder than most other A levels and this acts as a disincentive for students to opt for them, and for schools and colleges to guide students to take them".[53] The Wellcome Trust, with others, also told us that the quality of careers advice was vital because "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".[54] The Association of the British Pharmaceutical Industry (ABPI) gave an example when they told us how a lack of understanding and knowledge in maths could be a barrier to recruitment to the pharmaceutical industry.[55] Despite its importance, businesses appear unimpressed by the quality of careers advice. According to the CBI, "only 6% of businesses are confident that careers advice is good enough".[56]

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49 Royal Society, *Increasing the size of the pool*, February 2011.

50 *Op. cit., Science and mathematics secondary education for the 21st Century.*

51 Although the statutory duty on schools to provide careers education and guidance has been removed: MyScience.

52 CaSE.

53 Gatsby Foundation, *STEM Careers Review*, November 2010.

54 The Wellcome Trust, ABPI, University of Manchester, Professor Sir John Holman, MyScience, Universities UK, Ofsted, and the Society of Biology.

55 ABPI.

56 CBI.

46. **We recommend that the Government should direct the new National Careers Service to ensure that appropriate advice is given to young people about the following: STEM subject choice at school and its possible consequences for future study and careers; the choices available within STEM subjects at HE level and beyond and the advantages of pursuing a STEM degree; and, relevant careers advice that highlights the jobs available to STEM graduates both within STEM and in other industries. In order to make STEM careers and subject choices more accessible to students, parents and teachers, we would encourage the Government to use new technologies by, for example, commissioning a STEM careers App.**[57]

47. As well as careers advice, knowledge of careers education for those working with students is also important. According to the CBI, "for many young people, teachers are the first port of call for advice about subject choices and future study or work. But with most teachers having limited experience of work outside the education system, their insights can be restricted".[58] Ofsted told us that "teachers and careers advisers do not consistently have the expertise to advise on the plethora of other career routes in STEM".[59] We have some concerns that the shift to a national careers service will not provide sufficient incentive for teachers to seek to improve their expertise. **Schools should ensure that support for careers education through continuing professional development (CPD) is provided to those offering careers advice to students.**

### Higher education maths requirements at university entry

48. The number of students studying maths A level dropped by 20% after the introduction of curriculum reforms in 2000. As a result, many HEIs reduced their entry requirements.[60] Although student numbers have recovered, this has not been reflected in a resumption of higher HEI entry requirements. The qualifications and level of attainment needed for entry at HEIs vary significantly, even for the same courses. Figure 1 provides an overview of the number of HE entrants who have maths at A level by degree subject. The data suggest that maths requirements for HEIs at entry are not demanding enough. The ABPI told us that "recent research has found that the vast majority (92%) of bioscience undergraduate programmes did not require the students to have studied maths beyond GCSE, with some institutions accepting less than a grade C at GCSE maths".[61] This could have the potential of severely limiting career choices in the future.

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57 A software application typically used in a smartphone or mobile device.

58 CBI.

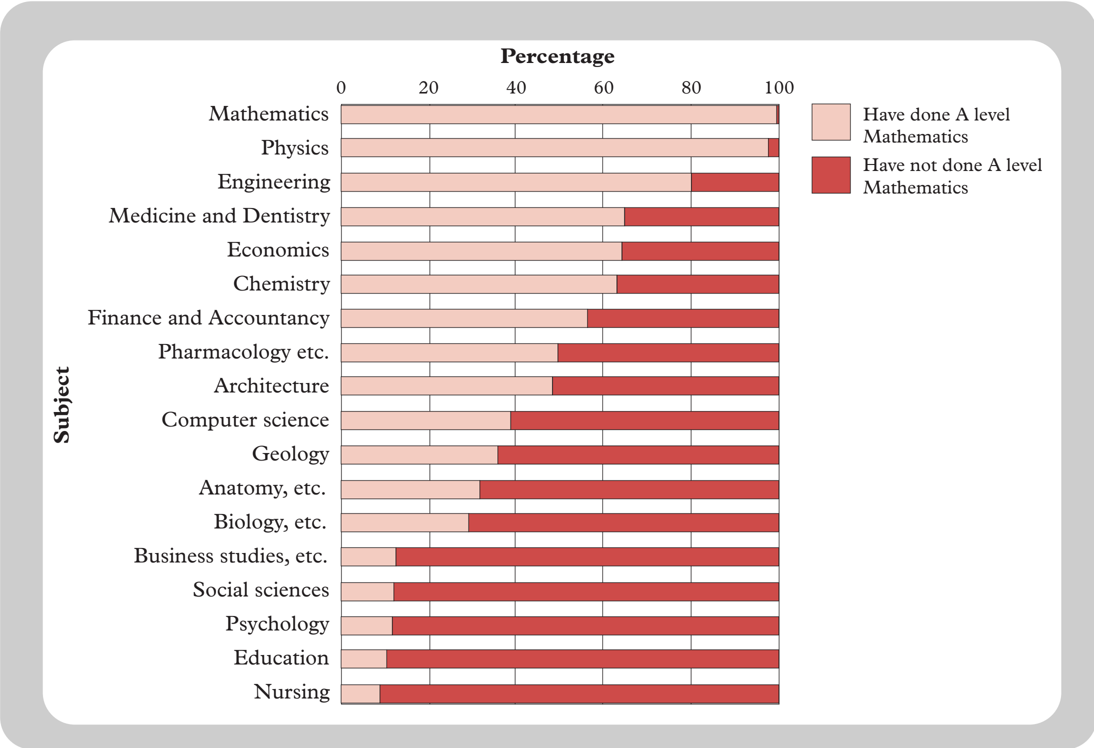
59 Ofsted.

60 *Op. cit., A world-class mathematics education for all our young people.*

61 ABPI.

## FIGURE 1

**Proportion of HE entrants by subject with or without A level maths, UK 2009[62]**




49. **The lack, or low level, of maths requirements for admission to HEIs, particularly for programmes in STEM subjects, acts as a disincentive for students to take maths and high level maths at A level. We urge HEIs to introduce more demanding maths requirements at entry for STEM courses. The proposed change should be introduced within a time frame that would allow current school pupils to adapt their subject choices at school to the new requirements.** The benefits of this policy would be two-fold: it would send the right signal to young people about the importance of maths for their future career choices, therefore increasing the number of pupils studying maths at A level; and maths knowledge and skills at university entry are likely to improve. **We further recommend that HEIs should work together to ensure that entry requirements for the same course are consistent across different HEIs.**

62 *Op. cit.*, *A world-class mathematics education for all our young people.* Figure 1 covers only those who have come through the A level route so those with other qualifications, such as qualifications awarded by the Business and Technology Education Council (BTECs), Scottish Highers and overseas qualifications, are not included.

# CHAPTER 4: SUPPLY AND DEMAND IN STEM HIGHER EDUCATION

50. In 1969, the then Prime Minister, the Rt Hon Harold Wilson MP (later Lord Wilson of Rievaulx), said:

> "First we must produce more scientists, secondly having produced them we must be a great deal more successful in keeping them in this country. Thirdly, having trained them and kept them here, we must make more intelligent use of them when they are trained, than we do with those we have got, and fourthly we must organise British industry so that it applies the results of scientific research more purposefully to our national production effort".[63]

51. There are two main aspects to consider when analysing supply and demand in STEM HE. First, whether the UK is producing enough STEM graduates and postgraduates to satisfy demand; and, secondly, whether those graduates are of sufficient quality, and have the right skills, to meet the needs of employers. In this chapter, we consider the first issue. The second is discussed in Chapter 5.

## Higher education and STEM

52. According to the Government, a fundamental principle of the HE system is that HEIs are:

> "autonomous, self-governing institutions. It is for them to make their own decisions about the courses they provide; their admissions policy; to implement their own funding strategies and to make the necessary decisions to ensure they are responsive to student choice and that their institutions can continue to flourish. These decisions will affect STEM at both undergraduate and postgraduate level."[64]

53. This principle implies that the Government cannot dictate directly to HEIs the courses they should offer. However, because HEIs are the recipients of substantial amounts of public money in the form of grants, subsidies and student loans, the Government have a number of levers with which they are able to exert influence over the HE sector (see paragraphs 94–104 and Chapter 5). Crucially, in an autonomous system, employers also have an important role to play in attracting STEM graduates[65] and defining the needs of their organisations.

### *Previous reports*

54. Several attempts have been made over the decades to tackle some of the issues raised in this report, many with similar conclusions and

63 On a BBC Horizon Programme.

64 The Government.

65 Expert Group for Women in STEM, University of Cambridge, University of Oxford, UK Deans of Sciences.

recommendations, notably the Robbins Report in 1963,[66] the Dearing Report in 1997[67] and the Roberts Review in 2002.[68]

55. In 1963, the Robbins Committee identified four objectives of HE: instruction in skills for employment; promoting the general powers of the mind; advancing learning; transmitting a common culture and common standards of citizenship.[69] To a large extent, these objectives continue to apply. The Robbins Committee chose to make "instruction in skills for employment" the first objective, not because it was the most important, but because they believed it was often ignored or undervalued. The report stated: "we deceive ourselves if we claim that more than a small fraction of students in institutions of higher education would be where they are if there were no significance for their future careers in what they hear and read; and it is a mistake to suppose that there is anything discreditable in this".[70] Nearly 50 years later, there is still a tension between those who advocate that HE should "train" students for their first job and those who take the view that HE should primarily "educate" students.

56. The Dearing Report adapted the Robbins Report objectives, stating that:

> "The aim of higher education should be to sustain a learning society. The four main purposes which make up this aim are:
>
> - to inspire and enable individuals to develop their capabilities to the highest potential levels throughout life, so that they grow intellectually, are well equipped for work, can contribute effectively to society and achieve personal fulfilment;
> - to increase knowledge and understanding for their own sake and to foster their application to the benefit of the economy and society;
> - to serve the needs of an adaptable, sustainable, knowledge-based economy at local, regional and national levels;
> - to play a major role in shaping a democratic, civilised, inclusive society."[71]

The conclusions of the Dearing Report suggest that training for employment and education are both key outcomes of HE. We share that view.

57. The Roberts Review, *SET for success*, looked at the supply of science and engineering skills throughout the education system. Most notably, the Review made a series of recommendations that lead to the introduction of a new funding stream to improve the employability skills of postgraduates.

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66 Committee on Higher Education chaired by Lord Robbins, *Higher Education: Report of the Committee appointed by the Prime Minister*, September 1963, Cmnd 2154 ("the Robbins Report").

67 National Committee of Inquiry into Higher Education chaired by Sir Ronald Dearing (now Lord Dearing), *Report of the National Committee*, July 1997 ("the Dearing Report").

68 Sir Gareth Roberts' Review, SET for success: the supply of people with science, technology, engineering and mathematics skills, April 2002 ("the Roberts Review).

69 *Op. cit., Higher Education: Report of the Committee appointed by the Prime Minister.*

70 *Ibid.*

71 *Op. cit., Report of the National Committee.*

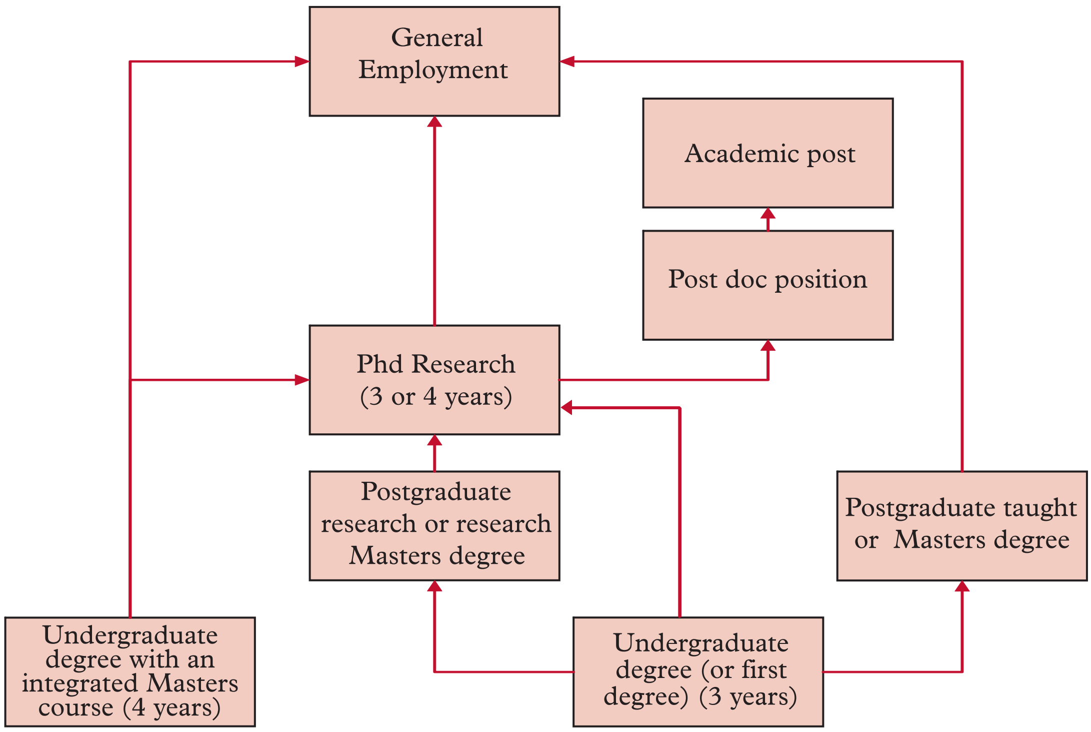
*Qualifications in higher education*

58. There are a number of qualifications which students can gain in HE. In general, they are classified as either undergraduate (first) and postgraduate (higher) degrees (see Figure 2). First degrees have, in the past, usually lasted three years and resulted in a Bachelors degree. There has, however, been a move towards four year courses in STEM subjects, particularly engineering, leading to an integrated Masters degree and increasingly Masters are seen as a prerequisite for postgraduate study internationally.[72] Such a degree, or its equivalent at Masters level, is essential to achieving Chartered status in engineering and some other areas.

59. After completing a first degree, graduates have the option of continuing their education either through a taught Masters degree or through research. A research Masters degree usually takes a year, after which a student may progress to a doctorate (PhD); alternatively, a student may go directly to studying for a PhD. A PhD may take three to four years. In HESA data, these two routes are classified as "postgraduate research courses". Taught Masters are classified by HESA as "postgraduate taught courses". The purpose of a taught Masters degree is said to be threefold: to specialise in a specific subject or area, to convert from an expertise in one discipline to a degree in a second discipline, or to enhance a Bachelors degree to qualify for a "license to practice" in an area such as engineering. Doctoral graduates may chose to enter general employment or take a post-doctoral position with a view to pursuing a career in academia.

**FIGURE 2**

**Qualifications in higher education**



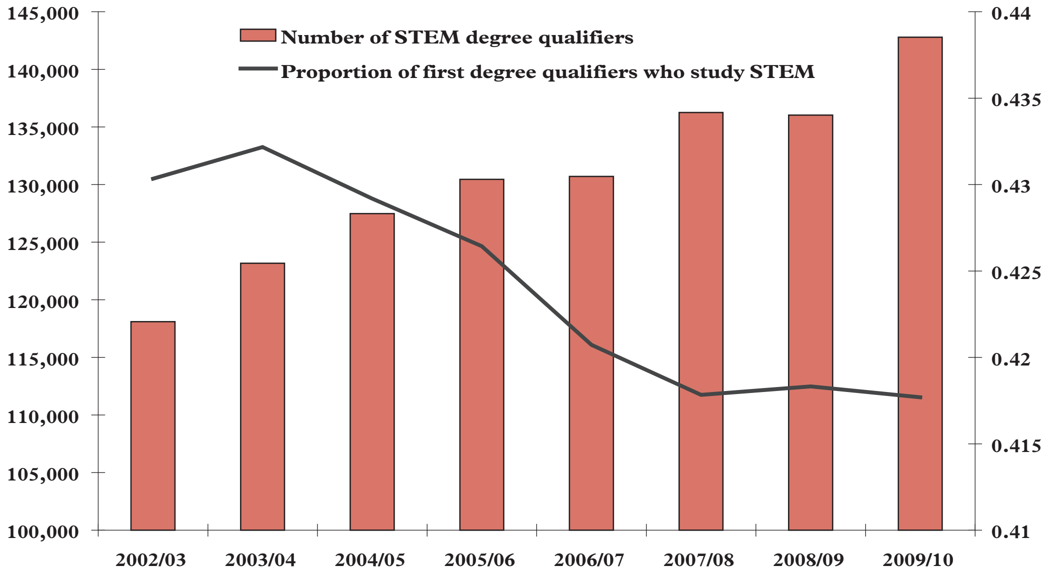

72 Council for the Mathematical Sciences, Royal Society of Chemistry, Society of Biology, the Science Council, UK Deans of Science.

*Trends*

60. The overall number of "qualifiers" (that is, students who have qualified for their award (graduates)) in STEM subjects at undergraduate level in HE has increased from approximately 118,000 in 2002–03 to over 140,000 in 2009–10; although, as a percentage of the overall number of HE students, the number decreased slightly from just over 43% in 2002–03 to just under 42% in 2009–10 (see Figure 3). These figures are based on a broad definition of STEM subjects (see Chapter 3). To achieve a better understanding of the growth in the uptake of STEM subjects, it is necessary to disaggregate them (see, as an example of disaggregation, Figure 4).

**FIGURE 3**

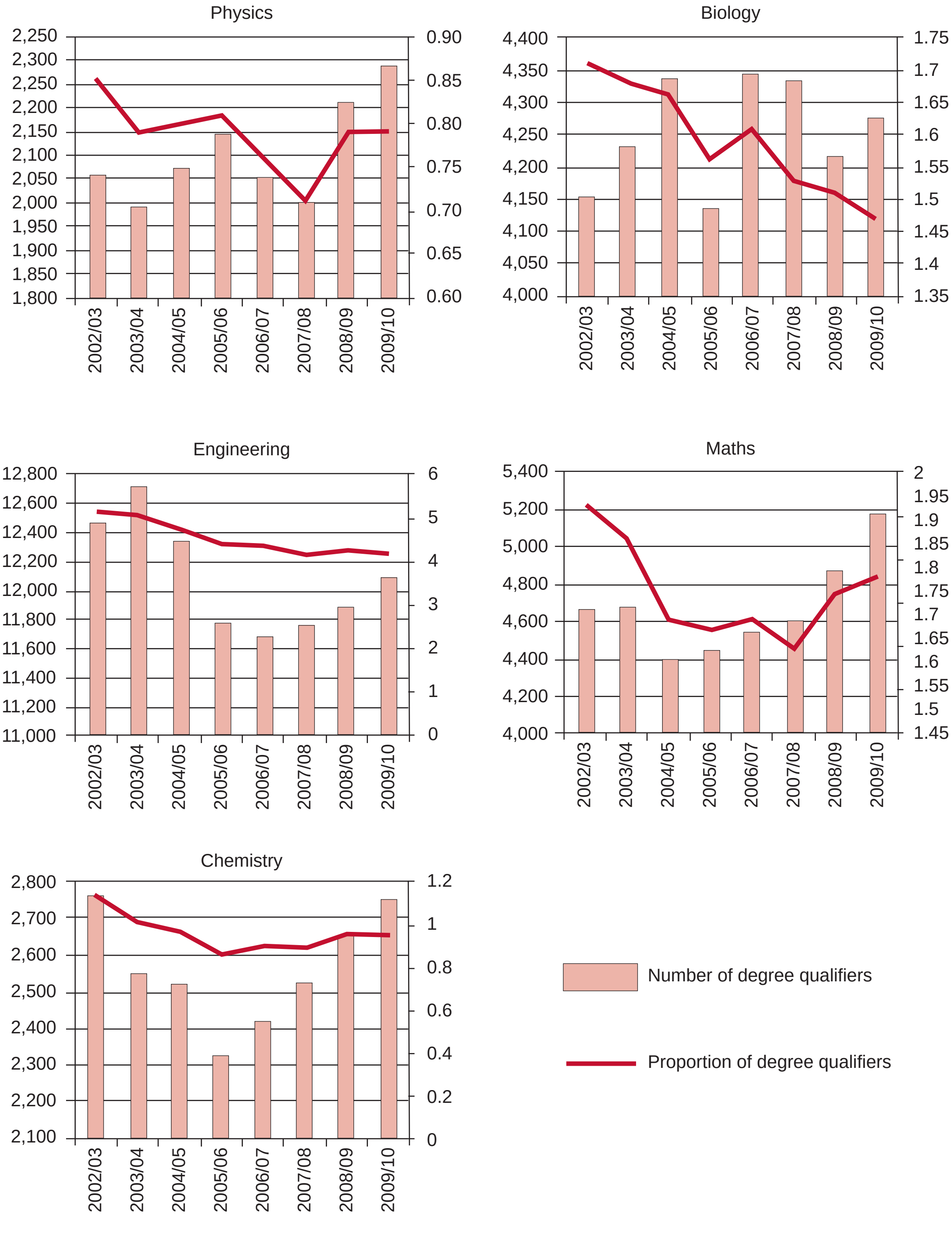
**STEM qualifiers (UK and overseas) from HEIs[73]**




[73] The Government.

## FIGURE 4

**Number and proportion of UK domiciled qualifiers of some STEM subjects**




61. Data in Table 2 set out in Appendix 6 to this report reveal a decrease or no growth in the number of UK domiciled first degree qualifiers in engineering (-3%) and chemistry (0%) over an eight-year period, from 2002–03 to 2009–10. This is in contrast to an increase in qualifiers for all subjects of 20%. In particular, the number of students studying computer science has dropped by 27%. On a more positive note, there has been an increase in the number of mathematical sciences qualifiers of 11% over the period and a similar 11% increase in physics. This is a turnaround from the previous decade when

there was a significant drop in the number of students studying these "core" STEM subjects from 1995 to 2000.[74] However, this increase is from a low starting point and each subject still represents a very low proportion of the overall STEM figure (with only 2,290 students acquiring a first degree in physics and 5,175 in maths out of the total of 122,940 studying STEM subjects in 2009–10). We note that there have been very large increases in student qualifiers in sport science, which make up a significant proportion of the number studying biological sciences (up 122%, from 3,650 to 8,120) and forensic and archaeological science (up 349%, from 360 to 1,615) over the same period.

62. The number of UK domiciled STEM Masters degree qualifiers has risen by 30% over the same eight-year period (see Table 4). This is in contrast to a 34% increase in the number for non-STEM subjects. There has also been a significant decline in the number of qualifiers in computer science (-45%) and chemistry (-12%) with little growth in the mathematical sciences (2%). Engineering increased by 37% and physics by 43%. Again, there have been very large increases in the number of qualifiers in sports science (172%) and forensic and archaeological science (94%). This data relates to UK domiciled qualifiers only. The trends look very different when taking into account EU and overseas students (see Chapter 6).

63. Table 6 shows increases in the number of UK domiciled PhD qualifiers across the board, with a 15% increase in STEM subjects and 15% increase in non-STEM subjects between 2002–03 to 2009–10. There are some areas of concern. PhD degree qualifiers in chemistry, for example, decreased by 11% while biology qualifiers decreased by 16%. There was also little growth within engineering (3%).

64. Historical data on the trends in student numbers in STEM reveal that overall there has been an increase in the number of STEM students, although a significant proportion of that growth has taken place in what the Government describe as the "softer sciences", such as sports science and forensic science. There has been relatively little growth in traditional or "core" sciences, such as engineering and a decline in computer science.

## Data

### *Lack of data on the supply and demand for STEM graduates and postgraduates*

65. Several witnesses commented on the limited data available on the supply and demand for STEM graduates.[75] The Wellcome Trust, for example, said: "there is a paucity of quality data when it comes to understanding the supply and demand for STEM graduates ... Data sets are not well integrated across Government".[76] On the supply of graduates, the UK Deans of Science stated that "although some data is collected on student numbers (for example, by the HESA on undergraduate and postgraduate students and by HEFCE on doctoral completion rates) we are not aware of any detailed data being

74 *Op. cit., SET for success: the supply of people with science, technology, engineering and mathematics skills.*

75 AMS, Cambridge Assessment, CRAC, Lord Sainsbury of Turville, UK Deans of Science, University of Central Lancashire, the Wellcome Ttust.

76 The Wellcome Trust.

collected and properly analysed on an annual basis".[77] LGC, a STEM employer, made a similar complaint about linking supply with demand data:

> "We are not aware of any government-facilitated mechanism to feed our demands for graduate skills into the education system, and influence the supply of training. Whilst manpower planning does not seem a realistic proposition, provision of reliable data addressing sector-specific trends in supply of, and demand for, STEM graduates and post-graduates would be of use to all the different communities with vested interests in understanding and addressing labour market gaps and dynamics."[78]

66. HESA maintains a database of all students enrolled on undergraduate courses at HEIs derived from annual returns made by the institutions. Various statistics based on these data are publicly available from the HESA website. Other bespoke statistical data can be produced on request at a cost. HESA is a "private limited company which has formal agreements with Government departments to provide the data which they require, and it is funded by subscription from all of the universities and higher education colleges throughout the United Kingdom".[79] While their mission is to ensure that stakeholders "have easy access … to a comprehensive body of reliable statistical information and analysis about UK higher education",[80] some witnesses such as Professor Andrew George of Imperial College London, were critical of the data collected, how they are collected, what information is made freely available and its format, and the time lag in its publication.[81]

67. The Headmasters' and Headmistresses' Conference (HMC) told us that "it is notable that in HESA data generally there are large numbers of unknowns for some of the categories where reasonable completeness might have been expected".[82] The British Computer Society (BCS) described HESA employment statistics for computer science as "misleading" and said that they over-estimated the true unemployment situation for computer science graduates "because degrees with very little computer science content are bundled with true computer science degrees when calculating the statistics".[83] We were also frustrated by the inability to disaggregate data beyond the high level subject categories to determine where graduates progress following their studies.

68. The data available about the supply and demand for STEM postgraduates are also weak. Witnesses told us that data collected about higher degree graduates in general are either insufficient or have little meaning. The Academy of Medical Sciences (AMS), for example, told us that "to understand the benefits of postgraduate education and training, UK HEIs should develop and implement a simple system of tracking postgraduates. More data on workforce numbers would allow more strategic appraisal of capacity and re-profiling needs".[84]

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77 UK Deans of Science.

78 LGC.

79 http://www.hesa.ac.uk/content/view/4/54/.

80 *Ibid.*

81 Q 454.

82 The Headmasters' and Headmistresses' Conference.

83 The British Computer Society.

84 AMS.

69. Professor George, speaking about the data collected by HESA, said: "the data is very poor at the moment ... we collect data, but it is not very good data because the HESA rules for collecting data on postgraduate students make no sense at all".[85] He called for data to be collected in such a way as to enable differentiation between stand-alone Masters courses, research Masters and PhDs. The UK Deans of Science, and other HE representatives from University College London (UCL) and Cranfield University, made a similar point.[86] With regard to destination surveys of postgraduates, it has been suggested that information about the destination of postgraduates six months after graduation gives "a completely wrong picture" because they are usually writing their theses.[87] The University of Greenwich told us: "there is no consistent means of collecting employer demand or graduate destinations for PhD students".[88]

70. Ministers were also critical of HESA. Damian Green MP, Home Office Minister for Immigration, was surprised at the time lag between collection of data and their availability: "every university must know on 1 October who has arrived, what subjects they are doing, where they are from and so on. Nevertheless, the body that is responsible for collecting the data cannot produce them until 18 months afterwards. ... I find that surprising".[89] The Rt Hon David Willetts MP told us with regard to the time lag: "we are investigating whether there are changes we can make to improve that situation. It is an understandable frustration".[90] On the usefulness of HESA data he said:

> "I accept that this is a problem; at the moment everybody is unhappy. Universities complain about the burden of data collection. Some data that they collect and send up to the centre are never referred to again, so they complain to me that they are collecting data to no purpose. On the other hand, you are absolutely right that elementary data about outcomes and employment prospects from doing particular courses at particular universities that prospective students should have is very hard to obtain. We are working on this."[91]

71. Lord Sainsbury of Turville, former Science Minister and businessman, told us:

> "[there is a] pressing need for the key stakeholders (including young people, university vice-chancellors, and policy-makers) to be regularly presented with reliable, useable data and market intelligence about the supply of, and demand for, STEM graduates ... a single agency—probably HEFCE [the Higher Education Funding Council for England] or UKCES [the UK Commission for Employment and Skills]—must be tasked by Government to collate all of the relevant information and data from the numerous different agencies which currently collect it. This same agency should further be required to publish, annually, a small set of highly readable digests of the information. It is not possible to do

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85 Q 454 (Professor George).

86 UK Deans of Science

87 Q 454 (Professor Bogle).

88 University of Greenwich.

89 Q 377.

90 Q 422.

91 Q 418.

long-term manpower planning, but it is important if the labour market is to work well that everyone has information on the current position … There is a need for regular, reliable and comparable data and market intelligence on the supply and demand of STEM graduates."[92]

72. The lack of reliable data on the supply and demand for STEM graduates and postgraduates makes it very difficult to assess whether there is a shortage of STEM graduates and postgraduates, and in which sectors. More needs to be done to identify areas of shortage so that remedial action can be taken and to enable students to make informed choices about whether the courses they are considering will equip them with the skills needed by employers.

73. **We recommend that the Government appoint a single body (or amalgamates the efforts of existing bodies such as HESA, UCAS, UKCES, CIHE, the Higher Education Careers Services Unit (HECSU) or the new National Centre for Universities and Business) to be a repository of relevant information currently collected by different agencies on the supply and demand for STEM graduates with a view to providing comprehensive, real time data analysis and a commentary with market intelligence of where STEM shortages exist, broken down by sector. This body should provide yearly updates to HEFCE, Government and other stakeholders on skills shortages so that remedial action can be taken to protect, or grow, those STEM areas which are needed to support economic growth and where market failure means that supply does not meet demand. All these data should be accessible to all stakeholders in order, amongst other things, to inform student choice.**

74. **We recommend that this body should also be responsible for holding, monitoring and analysing data for postgraduate education, including the employment of qualifiers from postgraduate courses on an ongoing basis—disaggregated into PhD, research Masters and taught Masters, and by subject areas.**

75. **We urge HEIs to contribute to the provision of data to this body by putting in place a robust, long-term tracking system for postgraduate provision and destination data.**

## Supply and demand in undergraduate provision

76. There has been much debate about whether the growing supply of graduates meets the demand for STEM skills within the economy and about how demand might change in the future. STEM graduates and postgraduates are reported to be in high demand by both STEM and non-STEM employers for their analytical thinking, problem solving skills and numeracy as well as for their technical skills or subject specific skills.[93] The CBI found that 41% of recruiters prefer to recruit STEM graduates and are willing to pay a premium for people with qualifications they value.[94]

77. STEM skills also feature heavily in the Government's future plans for growth and various broad projections for future demand for STEM skills to meet

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92 Lord Sainsbury of Turville.

93 1994 Group, CRAC, HEFCE, RCUK.

94 *Op. cit., Building for Growth: Business Priorities for Education and Skills—Education and Skills Survey.*

these needs have been made.[95] The 2010 UKCES National Strategic Skills Audit highlighted a number of areas of growth in the economy within both STEM and non-STEM sectors that will require STEM skills, including advanced manufacturing, life sciences and pharmaceuticals, low carbon economy, professional and financial services, digital economy and engineering and construction.[96] A CBI report, *Mapping the route to growth*, estimated that 80% of new jobs are in high-skill areas and require high-tech graduates, and that over half of the jobs to be filled in the UK to 2017 will require people to hold graduate level qualifications.[97] Forecasts for industries in science, technology and engineering alone show a demand for 600,000 professionally trained skilled staff by 2017. According to the CBI, the number of those studying degrees in these areas "must increase by over 40% on current levels if this demand is to be met".[98]

78. Although, as we have said, a lack of data makes assessment of the supply and demand for STEM graduates and postgraduates difficult, the evidence we received suggests that, despite the increased number of STEM graduates over the last 10 years, employers are still having trouble recruiting STEM graduates. The CBI, for example, reported that 43% of employers said they were having difficulties.[99] We, therefore, asked where the STEM graduates were working.

79. In 2009, BIS published a study, *The Demand for Science, Technology, Engineering and Mathematics (STEM) Skills*,[100] which addressed this issue. The study concluded that the shortage of STEM graduates was specific to certain areas such as engineering and IT, and varied according to region. It is not possible, therefore, to draw many conclusions about supply and demand from national level surveys. We also received evidence of reported shortages in the number of graduates with skills to meet the needs of STEM specific sectors such as the computer gaming and visual effects industry, power electronics sector and nuclear engineering, as well as *in-vivo* techniques, of interest to the pharmaceutical industry.[101] A number of STEM skill areas also appear on the skills shortage occupations list produced by the Migration Advisory Committee, including engineering and geosciences.[102] The 2009 National Employer Skills Survey for England showed that 31% of high-tech manufacturing firms were recruiting people from outside the UK because of a lack of suitably qualified people within the UK.[103]

### *STEM graduates in non-STEM employment*

80. Classifying employers into STEM and non-STEM is not straightforward. However, it is clear that a substantial number of STEM graduates—almost

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95 SEMTA, Institute of Engineering and Technology, CBI, HEFCE.

96 TBR Economic Reseach Consultancy for the Science Council, *The current and future UK science workforce*, September 2011.

97 University Alliance; CBI, *Mapping the route to growth: Rebalancing employment,* June 2011.

98 CBI, *Set for growth: Business priorities for science engineering and technology,* August 2010.

99 CBI.

100 BIS, *The demand for Science, Technology, Engineering and Mathematics (STEM) Skills,* January 2009.

101 Academy of Medical Sciences, ABPI, British Computer Society, Government, HEFCE, Institute of Engineering and Technology, the Physiological Society.

102 Royal Academy of Engineering, Geological Society, National Higher Education STEM Programme.

103 Engineering UK.

half—choose to take up employment in what have traditionally been considered non-STEM areas, such as the financial sector. We acknowledge that there are benefits to STEM graduates working in non-STEM jobs in that they increase the overall scientific literacy of the workforce. It is, however, a cause for concern if the diversion of a significant number of STEM graduates away from STEM jobs means that the UK is not equipped with the skills it needs to meet future plans for growth within high-tech sectors. We, therefore, considered why STEM graduates are attracted to non-STEM jobs.

81. The issue was the subject of a research paper published by BIS in March 2011, *STEM graduates in non-STEM jobs*, which concluded that there was no "clear or simple main reason why some STEM graduates are not in STEM jobs" and that the decision-making process that graduates went through was complex; many factors were at play but "the most likely one" was that students and graduates found non-STEM work "potentially to be more interesting".[104] The research paper also said that the two main reasons seen by employers for STEM graduates to decide against specialised STEM jobs and careers were "the perceived greater attractiveness of careers outside STEM (not least the perception of higher salaries) and the graduates' lack of real knowledge about working in STEM core functions".[105] This is worrying for STEM sectors trying to attract the highest quality STEM graduates into their areas. More promisingly, however, the report concluded that salary was not the leading factor in a student's decision-making process. There is, therefore, scope for employers to play a greater role in raising awareness of STEM careers amongst graduates and offering both financial and non-financial incentives to attract them to STEM sectors. We discuss the role of employers in raising awareness of STEM careers in paragraphs 160–174.

### *Are the best graduates attracted to STEM jobs?*

82. Current HESA data do not show where the best and brightest STEM students (according to degree level) end up. The evidence is only anecdotal. However, we imagine that STEM employers and the Government would be concerned if the top STEM graduates go into non-STEM jobs for the reasons described above. At present, 4% of physical sciences graduates, 2% of engineering graduates, and 20% of mathematical sciences graduates go to the financial sector;[106] it is not known if this includes the top performers in each discipline. Although the BIS paper concluded that salary was not the leading factor in a student's decision-making process, it will be for some students and it has been suggested that STEM employers in certain areas are not paying enough to attract the best STEM graduates.[107] The Institute of Physics, for example, told us that, to compete with non-STEM, STEM employers "have to offer better pay, which certainly has been the case with the financial sector, which has openly recruited the best physics PhD graduates".[108]

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104 BIS, *STEM graduates in non-STEM jobs,* March 2011.

105 *Ibid.*

106 The Science Council; *Op. cit., The Demand for Science, Technology, Engineering and Mathematics (STEM) Skills.*

107 HEA, Institute of Physics, Royal Academy of Engineering.

108 Institute of Physics.

83. **We recommend that the Government commission a study to find out the first destination of STEM graduates with a first degree (by degree class) as well as postgraduates. The study should also attempt to find out the reasons that lie behind students' career choices. This information would help to explain what makes STEM graduates and postgraduates choose non-STEM jobs and allow STEM employers to take action to attract the best and brightest into STEM careers, particularly research.**

### *The supply of the "soft" sciences*

84. A significant proportion of the growth of STEM graduates in recent years has occurred in newer courses, rather than the more traditional STEM subjects, which have reportedly been popularised by, for example, television programmes on forensic science or by changes in popular culture leading to an increase in sports science courses.[109] The Government call them "soft STEM" courses.[110] Some witnesses argue that graduates from these courses are of significant benefit to the economy because their general STEM skills are just as much in demand as those of other STEM graduates.[111] It is also argued that such courses have attracted a greater number of students to study STEM subjects. Dame Julia Goodfellow, Vice-Chancellor of the University of Kent, for example, explained how these courses attracted students who would not have otherwise considered a STEM degree.[112]

85. Others were more critical of the scientific content of these courses. LGC, an employer of forensic scientists, told us that: "the majority of these courses do not equip students with the right fundamental technical skill-set for employment in our laboratories".[113] LGC also said: "A set of courses have sprung up to appeal to what people are envisaging is a good career in forensic science. You can have a very good career in forensic science ... but the way it is portrayed on television is not reality".[114]

86. We have already drawn attention to the lack of data about the career choices of graduates. Furthermore, the difficulty in disaggregating "softer" science students from those on other courses within the broader STEM categories of the JACS system makes it hard to tell whether these "softer" STEM courses are equipping students with the necessary STEM skills to meet the needs of the economy. We have yet to be convinced about the value added to graduates of "soft" science courses, such as some forensic science and sports science courses, and the value added to the economy, and it is not possible to deduce from the available data whether employers in general, and STEM employers in particular, value such graduates.

87. **Given the significant number of students choosing to study "softer" science courses, we recommend that HEFCE and HEIs collaborate in conducting a study into the career progression of students of new STEM courses (such as some sports science and forensic science courses) to enable those undertaking these courses to decide whether**

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109 The Telegraph, *CSI leads to increase in forensic science courses,* 22 October 2008.

110 The Government.

111 Q 367 (Professor Sir Adrian Smith), Million+, Q 56 (Professor Les Ebdon).

112 Q 56.

113 LGC.

114 Q 154.

**they are being equipped with the skills graduates need to succeed in the STEM job market.**

*The role of Government and HEFCE in ensuring supply of STEM graduates and postgraduates meets demand in terms of quantity*

88. In an open market for graduates and postgraduates, the onus is on employers to ensure that they pay the market rate, or provide other means of attracting STEM graduates to stay in STEM sectors. The Rt Hon David Willetts MP told us: "employers should send out a clear signal about how much they value people with these skills. They cannot completely escape that part of the bargain".[115] However, where market failure occurs, the Government have a role to play in ensuring that supply meets demand for STEM graduates, particularly when their strategy for economic growth is based on the existence of a healthy science base.

89. To this end, in 2005, the Government introduced a policy on what were described as Strategically Important and Vulnerable Subjects (SIVS)—subjects about where there was "compelling evidence of a requirement for action to enable them to continue to be available at a level and in a manner that meets the national interest".[116] Not all STEM subjects are SIVS. At present, they include: chemistry, engineering, maths and physics within the STEM subjects, and modern foreign languages, although in recent times biological sciences and computer science have also received some support from this policy.[117] HEFCE spent £50 million a year (£350 million in total) over seven years (2005–12) supporting SIVS while their teaching budget for 2012–13 is £3.6 billion.[118]

90. Examples of interventions since the policy was introduced include: promoting demand and attainment among potential students (for example through the National HE STEM programme); securing and increasing the supply of provision (for example, through additional teaching funding for very high cost and vulnerable science subjects); and, monitoring and forecasting the provision of SIVS. The third HEFCE Chief Executive's advisory group on SIVS concluded in 2011 that, although "individual projects have provided value for money and those on the supply-side appear to have been particularly effective", it was "difficult to disaggregate the impact of investments on the demand-side and to establish whether there has been a sustainable resolution of the root causes of vulnerability, for example levels of student demand".[119] A further analysis in 2011 found that "SIVS have seen a continued expansion, and at a rate higher than other subjects during recent years. However, some concerns remain, for example among the engineering and modern language disciplines".[120]

91. The 1994 Group, a group of 19 research-intensive universities, stated that SIVS "have seen positive effects on raising the aspirations of young people to study these subjects".[121] Others agreed.[122] It appears that the SIVS policy has

[115] Q 404.

[116] HEFCE.

[117] *Ibid.*

[118] http://www.hesa.ac.uk.

[119] The HEFCE Advisory Group, *Strategically Important and Vulnerable subjects,* September 2011.

[120] HEFCE.

[121] 1994 Group.

been, at least partly, responsible for raising the numbers studying SIVS. Universities UK told us: "the strong policy focus given to STEM, through initiatives such as HEFCE SIVS programme, is likely to have contributed to ... increasing student demand for and enrolment in STEM subjects in higher education".[123]

92. Some concerns about SIVS have been expressed. Most are about the subjects included in the SIVS list—for example, that biological science, computer science, geophysics and physiology are not considered to be SIVS.[124] We are concerned that, given the importance that the Government attach to STEM in their strategies for economic growth, they have little obvious input to the decision as to which subjects are to be afforded SIVS support. The Rt Hon David Willetts MP told us: "in the time that I have been in Government alongside the Secretary of State, I do not think that I have ever tried to specify what should or should not be a strategically important and vulnerable subject".[125] This approach differs markedly from the previous administration, which set out strategic areas of provision in a letter to HEFCE, which was then charged with determining which of these it considered to be vulnerable and therefore in need of protection.[126]

93. Following the HE reforms, HEFCE has adopted a new approach to SIVS. In addition to supporting existing SIVS, HEFCE will monitor the health of all subjects and make "selective, collaborative interventions where there is strong quantitative and qualitative evidence of a particular risk to the continued availability of a subject".[127] It is unclear at this stage whether more funding will be allocated to SIVS policies or whether the small pot of SIVS funding is going to be spread more thinly. (HEFCE has also introduced measures to support high-cost subjects, including STEM subjects.

94. CaSE called for additional funding for SIVS:

> "we remain concerned that there are not enough incentives for HEIs to increase STEM provision. Current policy is predicated on student choice driving STEM provision, and while we hope that this will indeed occur, we also argue that the importance of STEM graduates to the UK's future is so great that additional safeguards should be put in place. The simplest and most effective change would be to increase the relative subsidy for SIVS from HEFCE."[128]

95. The Engineering Professors' Council also warned that "it will be important to ensure that funds provided for SIVS and STEM initiatives are not used for other purposes. STEM subjects generally need more funding than many others—despite typical student fees being the same for all subjects".[129]

96. Sir Alan Langlands, Chief Executive of HEFCE, offered some assurance:

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122 RCUK, UK Deans of Science, Universities UK.

123 Universities UK.

124 1994 Group, ABPI, Society of Biology, The Physiological Society, Royal Astronomical Society.

125 Q 411.

126 The Government.

127 HEFCE.

128 CaSE.

129 Engineering Professors' Council.

> "the HEFCE support for SIVS, but within that the STEM subjects, I think is pretty secure for the next two or three years. The Government have been clear that they want that to continue to be a priority, to the point at which, even with strains of competition and market running through some of their veins, they have asked us to intervene to ensure that STEM subjects are not damaged by the unintended consequences of the reform process."[130]

97. It appears that SIVS policy has had a positive impact on STEM and the Government should therefore continue to support the initiative. There are concerns that the HE reforms (see Chapter 6) may erode STEM provision in favour of cheaper subjects. The SIVS policy is an important tool to help counteract that. The new approach to SIVS proposed by HEFCE is to be welcomed in that it will allow other subjects, such as computer science, to be offered support if they are deemed vulnerable.

98. **We recommend that the proposed body in charge of collecting and analysing data (see the recommendation in paragraph 73 above) should, by providing evidence and analysis to HEFCE and the Government, contribute to the process of establishing which subjects should be given SIVS status.**

99. **While HEFCE has a legitimate role in determining which subjects are vulnerable and should be supported as part of the SIVS programme, we recommend that the Government should decide which subjects are strategic and should, therefore, be given SIVS status. The Government's decision could be included in the Secretary of State's annual letter to HEFCE.**

## Demand and supply in postgraduate provision

100. From 2002–03 to 2009–10, there was a 72% increase in the number of STEM Masters qualifiers, both research and taught, against a 70% increase in all subjects. However, more than half of the STEM Masters students who graduated in 2010 were from overseas. UK domiciled students accounted for only 30% of this growth (see Tables 3 and 4 in Appendix 6). Over the same period, the number of STEM PhD graduates increased by 28% against a 26% increase in all subjects, and 42% of PhD students who finished their doctoral degrees in 2010 were from overseas (see Tables 5 and 6 in Appendix 6). UK domiciled students accounted for 15% of this growth. As we have already said (in paragraph 22), these figures mask the drop or lack of growth in some of the more traditional STEM subjects at postgraduate level in UK domiciled students, including chemistry and maths in Masters qualifiers and engineering and chemistry in PhD qualifiers.

101. We should be concerned that we are not attracting more home students to study STEM postgraduate courses in certain STEM subjects. In particular, this relative lack of UK domiciled students could have a substantial impact on sectors that, for security reasons, only employ UK nationals such as defence and the security services.[131]

102. A number of reports have concluded that the knowledge and capabilities of postgraduates are highly prized by business and their skills are critical for

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130 Q 101.

131 Q 77, University of Surrey, UK Deans of Science.

tackling major business challenges and driving innovation and growth.[132] Taught Masters courses provide students with the skills they need to specialise and work in a range of careers.[133] Masters postgraduate provision was described by Professor Sir Adrian Smith as playing "an important role in upskilling and re-training the UK workforce".[134]

103. The first ever analysis of employment destinations and the impact of doctoral graduates three years after graduation using data from HESA showed that, of the 2004–05 cohort, 19% were working in HE research roles three and half years after graduation and 22% were employed in HE teaching and lecturing roles. The other 50% were employed in other research positions, doctoral occupations and other roles. As RCUK noted, this means that "only between one quarter and one third of UK doctoral graduates progress to research or teaching and lecturing roles in universities".[135] With regard to earnings, "90% of postgraduates working full time earned between £23,000 and £71,000 with a median salary of £34,000, around £10,000 higher than first degree graduates at the same point in their careers". The study concluded that "doctoral graduates are highly employable and most are employed in 'doctoral occupations' that are different from the majority of first degree and Masters degree occupations".[136]

104. Recent reports and submissions to this inquiry have also highlighted that we know very little about what roles postgraduate provision is playing outside of research, concluding that it has been neglected as an issue by Government throughout the Independent Review of Higher Education Funding and Student Finance (Browne Review) and HE reforms.[137] Professor Sir Adrian Smith noted, for example, that "the value that postgraduate education brings to the UK is under-researched and under-appreciated".[138] As a result, he recommended that Government and others should do more to identify and promote the potential benefits of postgraduate study.

105. A CIHE report entitled *Talent fishing: what business what from postgraduates* found that "there is a high demand for, and strong satisfaction with higher degrees [postgraduates], but that there are still areas where HEIs and businesses must work together to ensure postgraduates have the skills and knowledge that employers need".[139] The study showed that around 70% of employers sought out Masters graduates because they valued the analytical thinking and problem-solving skills that a Masters degree provides. Of those that recruited PhD students, they valued the "subject-specific skills and research and technical skills" as well as the new ideas and innovation that they brought to their business.[140] The CBI found, however, that "some STEM employers have ... reported difficulty recruiting postgraduate STEM

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132 CIHE; RCUK, *The value of graduates and postgraduates*, 2009; Professor Sir Adrian Smith, *One step beyond: making the most of postgraduate education*, March 2010; the 1994 Group, *The Postgraduate Crisis*, February 2012; CIHE, *Talent fishing: what business want from postgraduates*, March 2010.

133 The Science Council, Society of Biology, Council for the Mathematical Sciences.

134 *Op. cit., One step beyond: making the most of postgraduate education;* the 1994 Group, *The Postgraduate Crisis*, February 2012.

135 RCUK.

136 Vitae, *What do researchers do? Doctoral graduate destinations and impact three years on*, 2010 .

137 *Op. cit., The Postgraduate Crisis*; UK Deans of Science, University Alliance.

138 *Op. cit., One step beyond: making the most of postgraduate education.*

139 *Op. cit., Talent fishing: what business want from postgraduates.*

140 *Ibid.*

skills—almost a third (28%) of science, hi-tech and IT employers report current difficulties recruiting STEM postgraduates".[141]

106. It is clear that STEM postgraduates are valued and in demand amongst employers, and that they play a significant role in driving innovation, undertaking research and development, and providing leadership and entrepreneurship. The University of Central Lancashire and others told us that the Government should be making the case for postgraduate study and that they would welcome a more strategic focus on the contributions that postgraduate students make to the economy.[142] It appears to us that, although the Government recognise the central role that STEM plays in their strategy for growth, they fail to articulate how they intend to highlight to students the benefits of postgraduate study, to reduce the decline in STEM qualifiers in some STEM subjects, or to improve our understanding about the demand for postgraduates and the value they offer to the economy. They also fail to make clear what support they will give to postgraduate STEM provision in order to realise their vision. This is, in our view, a mistake.

107. **We recommend that the Government set up an expert group to consider the supply and demand of STEM postgraduate provision in the UK and to identify weaknesses and areas of skills shortage. The Government, as the strategic leader, should agree the terms of reference of this group with a view to formulating a strategy for STEM postgraduate education in the UK which will underpin their strategies for growth. As part of the expert group, we urge employers to spell out their needs to Government and to identify skills shortages at STEM postgraduate level.**

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141 CBI.

142 University of Central Lancashire, Million+, University Alliance, the Wellcome Trust.

## CHAPTER 5: QUALITY, STANDARDS AND BENCHMARKS

108. In 2009, the Quality Assurance Agency (QAA) told the House of Commons BIS Committee: “the quality of the education offered by UK institutions is its strength and the basis of its strong reputation”.[143] Many others have made the same point to us.[144] However, in 2002 the Roberts Review looked at the question of supply and demand and concluded that shortages in some areas related to quality, not quantity, of graduates, stressing that there was a lack of graduates with appropriate general and transferrable skills (otherwise known as “employability skills”—see paragraphs 114–116), or the required breadth of knowledge in their technical or scientific field.[145] These conclusions are mirrored in more recent reports from BIS and others, and also in the evidence we received.[146] Given that the mismatch in supply and demand for STEM graduates relates in part to a lack of high quality graduates in many sectors, not necessarily in the overall number, we decided to look at how quality is assessed and at the mechanisms for improving quality. These issues are particularly important given proposals to open up degree-awarding powers and allowing the title of “university” to be used by more providers.

109. At present, quality assurance of degrees is the responsibility of a number of bodies including HEIs, HEFCE, QAA, and Government. However, individual institutions are autonomous organisations and, as such, have primary responsibility for academic standards and quality.[147] QAA provides a means of external assurance to this process.

110. Under the HE reforms, it is envisaged that students—making decisions based on the course information provided by HEIs—will play a greater role in driving up quality. According to the Government, “the future of higher education is moving to a model where supply and demand will operate in a more transparent market. Students will demand better information about the quality of their degrees, and how these will lead to their chosen careers. Universities will need to respond, particularly in STEM where there is greater correlation between specific industry needs and the content and skills taught”.[148] Employers and Government also have a role to play.

111. Although we consider both undergraduate and postgraduate provision in this chapter, we also look specifically at the role that the Research Councils and HEFCE play in providing quality assurance at the postgraduate level. We also look at the move to doctoral provision through Doctoral Training Centres (DTCs) and away from the supply of doctoral studentships related to single research grants.

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143 BIS Committee, 12th Report (2010–12): *Government reform of Higher Education* (HC 885).

144 University of Manchester, University of Oxford, Council for the Mathematical Sciences, the Wellcome Trust.

145 *Op. cit., the Roberts Review.*

146 *Op. cit., STEM graduates in non-STEM jobs*; *Op. cit., The demand for STEM skills;* CBI, CRAC, National Higher Education STEM programme, Syngenta, ABPI.

147 QAA.

148 The Government.

## Definitions of quality and how it is measured

### *Definitions*

112. Quality can often mean different things to different people.[149] Defining "quality" and its measurement is, therefore, an important starting point to the debate. The QAA makes a distinction between "standards" and "quality":

- Standard—the level of achievement that a student has to reach to gain an academic award (for example, a degree).
- Quality—a way of describing how well the learning opportunities available to students are managed to help them to achieve their award. It is about making sure that appropriate and effective teaching, support, assessment and learning opportunities are provided for students.

113. In 1993, John Biggs defined the three dimensions of quality in the '3P' model as "presage", "process" and "product" (see Box 2). "Presage" defines the context that is set before students start learning, such as the quality of the student or teacher; "process" defines variables that affect the student's learning experience; and "products" relate to the outcomes of that learning.[150] In our view, the quality of a degree is dependent on all three factors to ensure that high quality graduates leave HE with the right skills and knowledge to prepare them for work..

**BOX 2**

**Measurements of quality**

In 2010, the HEA published a report entitled Dimensions of Quality which critiqued different quality measures used within HE. They grouped them, in accordance with John Biggs' '3P' model, into "presage", "process" and "products", although they are related to each other.

- "Presage" variables are described as those that exist within a university context before a student starts learning including resources or the quality of student or teacher.
- "Process" variables are described as those that characterise what is going on in teaching and learning and include class size, the amount of class contact and the extent of feedback to students.
- "Product" variables concern the outcomes of the educational process, such as student performance, retention and employability.

The report concluded that measures of educational process are good predictors of educational gain. Such measures are also considered to be more comparable than product or presage variables across HEIs which have very different mission statements.

Good process measures of quality include class size, level of student engagement, who undertakes teaching and the quantity and quality of student feedback. The best variables concern pedagogical practices that engender student engagement.

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149 Royal Academy of Engineering, the Science Council.

150 HEA, Graham Gibbs, *Dimensions of Quality*, September 2010.

> The report also concluded that teachers who have teaching qualifications have been found to be rated more highly by their students than teachers who have no such qualifications.
>
> In terms of outcomes it was noted that there was considerable scope to assess work submitted by students as more direct indicators of educational quality than proxy measures such as thos derived from National Student Survey scores.

*Employability skills*

114. The terms "quality" and "employability skills" are often confused. "Employability skills" are defined by the Higher Education Academy (HEA) as "a set of achievements, (skills, understandings and personal attributes) that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy".[151] Although an HE system should not concentrate solely on training students for the employment market—it is just one of the objectives of the sector—as we said in Chapter 4, a high quality education and training for employment are not incompatible and graduates should be leaving HE with the right skills for employment. Imperial College London told us, for example, that:

> "A high quality research-led and laboratory-based or maths education, equips students to think critically and independently, and to foster the analytical skills necessary to provide solutions to economic, social and industrial problems. Such skills are not only necessary for careers in traditional STEM industries, but are requirements for a variety of business sectors."[152]

115. Employability skills should also include other attributes, or "softer skills", within the outcome measures for a course, such as awareness of the business environment and communication skills.[153]

116. One question we encountered was: how accurately can supply be matched to demand in a diverse economy? The Institution of Engineering and Technology (IET), for example, told us that "while large companies have the capacity to recruit 'raw' graduates and provide training this is generally not the case for SMEs [Small and Medium-sized Enterprises] who need skilled graduates who are equipped to 'hit the ground running' and contribute immediately in the workplace".[154] However, as Vectura observed, there is a danger of going too far in trying to meet all the employability needs identified by employers—"since each company will have different requirements it is not particularly practical to try and match supply and demand in this way".[155] Employers have a role in continuing to develop the skills of graduates in employment, and HEIs have a role to help them do this. But it is not the role of HEIs to tailor degree courses specifically to individual companies. Rather, it is to ensure that graduates emerge with the right skill set to adapt and grow. The role of employers is

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151 HEA, *Employability in higher education: what it is—what it is not*, April 2006.

152 Imperial College London.

153 1994 Group, ABPI, LGC.

154 Institute of Engineering and Technology.

155 Vectura.

also to define the basic skill set of an employable graduate or postgraduate. We consider how employers should be involved in setting the skills outcomes for courses in paragraphs 160–174.

*The measurement of quality*

117. The quality of a degree course can be measured through a number of variables including direct learning outcomes or looking at the processes which have been linked with high quality provision. Measures can also be direct or proxies of quality.

*Quality assurance*

118. The Government's Higher Education White Paper, *Students at the Heart of the System*, published in 2011, proposed that HEFCE should become a lead regulator to promote and protect the interests of students and the wider public, taking over from the Government the function of granting degree-awarding powers. In evidence, Government said: "the UK approach to quality assurance is highly regarded and the revised arrangements for Institutional Review introduced in September 2011 by the QAA have a stronger focus on quality enhancement and on involving students".[156] The HE reforms will not involve a change to the review process but propose a move to a more risk-based approach to quality assurance, building on the current system but focusing QAA effort on areas of most impact.

119. BIS has consulted on these proposed changes, which include proposals to introduce a sanction to suspend, or remove, degree-awarding powers where quality or academic standards fall below acceptable thresholds. Additionally, HEFCE are currently consulting on the triggers which would prompt QAA to carry out an out-of-cycle investigation, as well as the frequency of review, for implementation in 2013–14. The proposals include greater powers for students to instigate out-of-cycle reviews if they have concerns about quality. Under the HE reforms, QAA will also look at the provision of information about the quality and standards of academic programmes. A QAA consultation will follow the HEFCE consultation later in the year.

120. The Government's response to the Higher Education White Paper consultation stated that they will "not at this stage be seeking to introduce changes to primary legislation" but they would move their reform agenda forward "primarily through non-legislative means".[157] It is not clear to us, therefore, if Parliament will be given the opportunity to scrutinise the proposed changes to quality assurance and HEFCE's power. **We recommend that the Government explain in their response to this report what opportunity Parliament will be given to scrutinise further the proposed changes to quality assurance, as set out in the Higher Education White Paper. The Government should also set out a timetable for when the changes will take place and outline the form they will take.**

156 The Government.

157 BIS, *Government response: Consultations on: 1-students at the heart of the system, 2-A new fit for purpose regulatory framework for the higher education sector*, June 2012.

## The role of the QAA and of HEIs in driving up quality

121. HEFCE has a statutory responsibility for quality assurance under the Further and Higher Education Act 1992. They do this, by contract, through the QAA, which reviews HEIs in England, Wales and Northern Ireland.[158] The QAA is independent of both Government and HEIs. It is funded by subscriptions from universities and colleges and through contracts with the HE funding bodies. They report on quality assurance by visiting universities and colleges to review how well they are fulfilling their responsibilities. They also offer guidance on maintaining and improving quality assurance processes and developing course delivery through the Academic Infrastructure.[159]

122. QAA HEI reviews focus on the standards of HE awards (set out in the Quality Code which covers undergraduate and postgraduate courses), the quality of the learning experience (for example, the provision of learning opportunities), the provision of information about the quality and standards of academic programmes, and the commitment to quality enhancement. For example, QAA assesses whether universities set and maintain UK-agreed benchmark statements or threshold standards for HE awards as set out in the Framework for Higher Education Qualifications in England, Wales and Northern Ireland (FHEQ).[160] These are reviewed, as required, in collaboration with institutions, and professional, statutory and regulatory bodies. The FHEQ also contains a doctoral qualification descriptor which summarises "the research-specific and personal attributes agreed by the higher education sector as a minimum level of achievement for any doctoral graduate" to "achieve equivalence of academic standards across doctoral awards by summarising the key attributes expected of a doctoral graduate." There is a similar descriptor for Masters degrees.[161]

123. In 2009, in evidence to the House of Commons Innovation, Universities, Science and Skills (IUSS) Committee, the QAA emphasised their process-based approach to quality assurance: "we visit institutions to conduct our audits, make judgements and publish reports, but we are not an inspectorate or a regulator and do not have statutory powers. We aim to ensure that institutions have effective processes in place to secure their academic standards, but we do not judge the standards themselves".[162] When questioned on why they looked at processes not outcomes, the QAA said that quality outcomes were included in the Quality Code, which was a "framework of benchmarks, which sets standards and provide programme specifications for individual courses … together with codes of practice about key areas of university activity". They were "responsible for maintaining that", which they did "in partnership not only with institutions but also with

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158 After consultation, in 2010 a set of principles for the quality assurance system were agreed and the development of the new institutional review in England, Wales and Northern Ireland, were introduced at the start of 2011–12. They were designed to be more public-facing, clarify the judgements on quality, increase flexibility and introduced themed reports to address specific areas of concern to help enhance quality.

159 The Academic Infrastructure is a set of nationally agreed reference points which give all institutions a shared starting point for setting, describing and assuring the quality and standards of their HE courses. More information is available on the QAA website at www.qaa.ac.uk/academicinfrastructure/.

160 QAA, *The framework for higher education qualifications in England, Wales and Northern Ireland*, August 2008.

161 QAA, *Doctoral degree characteristics*, September 2011.

162 IUSS Committee, 11th Report (2008–09): *Students and Universities* (HC 170–I).

relevant professional bodies, with expertise sometimes from employers and, increasingly, with input from students as well”.[163]

124. The QAA is responsible for measuring the processes by which quality is assured and for facilitating the development of outcome measures through the development of the standards and benchmarks. In our view, however, this is not enough to drive up quality when the standards and benchmarks are based on attaining a threshold level and allow no assessment of quality provision above the threshold. When asked if degrees from two universities were comparable in terms of the standards required, Anthony McClaran, Chief Executive of the QAA, said: “we are talking about the setting of threshold standards. We are not talking about the distance beyond the threshold that any particular qualification may go”.[164] HEA, in their report *Dimensions of Quality*, describe the absence of comparability of degree standards as a major “obstacle to the interpretation of student performance data”.[165]

125. The HEA also noted in their report that “national agencies have a valuable role to be fulfilled in supporting the use of valid measures of quality”, in effect seeking to make sure that HEIs are using the best measures of quality. In our view, they are not fulfilling this need. The QAA gives little incentive for HEIs to go beyond that threshold of assessment to drive up quality. The Quality Code sets minimum standards and benchmark statements, and the QAA then judge HEIs on the processes they have in place to enable them to meet them, rather than influencing HEIs to raise standards, improve benchmark statements and the quality of provision.

126. When challenged on this issue, the QAA said: “we have another role … which is also about supporting institutions in the continuous improvement of their quality and standards”.[166] This is achieved through offering suggestions of best practice, and through themed reports on specific issues. However, we found little evidence of how such efforts have resulted in an increase in quality of provision and, in any event, would question whether it would be possible to do so given that they are only assuring a minimum threshold standard for courses across the UK with little incentive to revise benchmark statements.

### *Ensuring that standards and benchmarks address skills gaps in the economy*

127. Many undergraduates and postgraduates reportedly lack the skills and competencies required for employment. The ABPI told us, for example, that “although the numbers of STEM students and graduates have been increasing in recent years … many choose to study subjects which do not provide the appropriate skills for roles in academic or industrial research and development or for other jobs in industry …. Many will not have studied the topics which provide essential skills for bioscience research”.[167] We also learned, to our astonishment, that graduates from biochemistry can leave HEIs with limited experience of practical laboratory work.[168]

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163 Q 171.

164 Q 180.

165 *Op. cit.*, *Dimensions of Quality*.

166 Q 169.

167 ABPI.

168 Q 328.

128. All this suggests that there may be scope for improvement of the quality of graduates through more employer-HE engagement on course content and other activities (see paragraphs 160–174). We note that a CBI survey in 2011 reported that only 17% of responding employers were engaged with universities to develop business-relevant STEM courses (albeit higher for some sectors such as energy and water (53%), construction (30%), science/engineering/IT (38%)).[169] There is clearly room for improvement.

129. When we asked whether standards and benchmark statements took sufficient account of employability skills, Mr McClaran of the QAA assured us that "in terms of the skills that are built into both the framework of higher education qualifications, …but also, in terms of the subject benchmarks, there certainly is a description of skills, including the skills that might be applied by the graduate once they have gone into employment".[170] This led to us to ask why graduates are failing to acquire basic employability skills.

130. With regard to employers involvement in setting standards and benchmarks, we were concerned to see that, according to the QAA benchmark statements, few industry representatives are currently involved in setting some benchmarks (for example, those for engineering). Cogent were also critical of the QAA benchmarks. Dr Caroline Sudworth, Higher Education Manager from Cogent, described her experience: "from the work that I have done with the National HE STEM Programme, we have looked at the CBI benchmark and employability, mapped it to the QAA benchmark statement, and there is a lot missing from those particular STEM degrees. We have tried to discuss this with the QAA but to no avail at this moment in time, so we would like the QAA to look at how employers interact with that quality assurance in STEM degrees".[171] Mr McClaran conceded that he "would be the first to acknowledge that involvement of employers should expand". He went on: "That is one of the issues, as we move into the new review method that we have just begun in England, where we want to expand the involvement, both of students on the one hand and employers on the other". He also said that QAA was having discussions with CHIE about "ways in which we can get expert input from employers to particular areas".[172]

131. **Given the skills gaps that exist in key areas across the graduate pool, the QAA has a long way to go in ensuring that employers are sufficiently involved in setting standards and benchmarks. We recommend that the QAA should do more to recruit employers, SMEs in particular, to engage with HEIs and take part in setting QAA standards and benchmark statements. The QAA should be in a position to report back on how it plans take this recommendation forward by July 2013.**

132. **We further recommend that the remit of the QAA should be reviewed with a view to introducing a system to assure quality, standards and benchmarks in HEIs that is fit for purpose. This should include the development (and achievement) of objectives for the inclusion of employers in the setting of standards and benchmarks, and a yearly**

169 The Government.

170 Q 199.

171 Q 237.

172 Q 188.

**list of thematic problem areas, accompanied by an action plan, where consistent skills gaps occur.**

### Funding to develop the employability skills of postgraduates

133. We recognise that efforts have been made by HEIs and others to improve the employability skills of undergraduates and postgraduates. In 2002, the Roberts Review highlighted the need for the development of research careers and to improve the transferable skills (employability skills) of postgraduate students. As a result, the Research Councils created a specific funding stream (Roberts' Money) of over £120 million between 2003–11[173] to address these issues in all research disciplines. The Roberts' Money was used to fund new training schemes or activities aimed at improving the employability skills of postgraduate students. A number of submissions were supportive of the scheme and the impact it has had on improving the employability skills of postgraduates.[174]

134. In 2010, the Research Councils commissioned a review of the Roberts scheme. The review found that there have been major improvements facilitated by the Roberts' Money such as "improved understanding of the importance of more formalised training and career development for all researchers; and improvement in the way career development and transferable skills training is provided for researchers." But, the review concluded that "there was little interaction of employers and other stakeholders in setting up skills development programmes which could potentially diminish the effectiveness of the programmes". Our recommendation for improved engagement between HEIs and employers, therefore, applies equally to the postgraduate level. As a result, we were pleased to hear that the Researcher Development Framework (RDF), developed by Vitae in consultation with employers, has gone some way to improve the employability skills of postgraduates and guide the knowledge, behaviour and attributes of a successful researcher.[175]

135. Given its findings, the Research Council review recommended that "funding should ... continue to be made available specifically for the development of transferrable skills of researchers and their careers".[176] However, in 2011, the Roberts' Money funding stream was closed. Research Councils UK (RCUK) told us that this was because funding was now being embedded in the standard funding mechanisms. However, we share the concerns of the University of Manchester and the University of Oxford that embedding this type of funding may dilute the message that transferrable skills in postgraduates should form a fundamental part of their training.[177]

136. **We recommend that the Research Councils monitor the impact of embedding Roberts' Money into the standard funding mechanisms.**

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173 Vitae.

174 The 1994 Group, the British Computer Society, Engineering Professors' Council, Heads of Departments of Mathematical Sciences, Institute of Physics, University of Manchester, University of Oxford, Vitae.

175 Q 461, Q 197, Q 201, ABPI, Aston University, Cardiff University, University of Greenwich, University of Oxford, University of Salford, University of Surrey, University of Warwick, Imperial College London, Open University, Oxford Brookes University, Vitae.

176 RCUK, *Review of progress in implementing the recommendations of Sir Gareth Roberts, regarding employability and career development of PhD students and research staff*, October 2010.

177 University of Manchester, University of Oxford.

## Quality of teaching

137. Several witnesses expressed concern about a lack of incentives for HEIs to improve the quality of teaching within their institutions. The QAA measures a number of process factors that are proxy measures for the quality of teaching. But, as with the standards, they are testing to a threshold level. They are not assessing whether teachers are of a high quality.

138. The HEA, which has 165 HEI subscribers,[178] has an important role to play in promoting good practice in teaching in HEIs. The HEA is owned by Universities UK and GuildHE "which supports the higher education sector in providing the best possible learning experience for all students".[179] It promotes professional development and accreditation of teaching through its re-launched UK Professional Standards Framework (see Box 3).[180]

**BOX 3**

**The priorities of the Higher Education Academy**

- Helping to improve the quality of learning and teaching practice by providing a structured framework and resources to underpin professional development and by supporting a vibrant and professional learning culture across the sector;
- Supporting leaders and managers to develop an organisational culture and infrastructure within which student and staff learning can thrive, and in which change is managed confidently and creatively;
- Responding quickly and intelligently to the most urgent and significant strategic issues and contemporary challenges that the sector is facing, supporting the sector to react wisely and decisively during times of unprecedented change and acting as a national voice to positively influence change;
- Underpinning all of the above with high quality and rigorous research and evidence and applying this insight to enhance policy and practice.[181]

139. The recent HEA report, *Dimensions of Quality*, concluded that teachers who have teaching qualifications are rated more highly by their students than teachers that do not. Professor Craig Mahoney, Chief Executive of the HEA, told us: "out of the 180,000 academics working in UK higher education, there are currently 30,000 academics registered on our books as being qualified to teach, having completed a postgraduate certificate in higher education, or having completed a recognised programme through our organisations, which aligns at the same standard against a professional standards framework".[182] He argued that the actual number of qualified teachers was probably higher than this because HEIs were not required to report to the HEA if they had provided training through other means.

140. This evidence suggests, however, that there is a significant shortage of academics "trained" to teach to a high standard. ABPI said that one reason

178 Q 193.

179 *Ibid.*

180 HEA.

181 *Ibid.*

182 Q 195.

for this shortfall was that the Research Excellence Framework (REF) did not offer sufficient incentive for HEIs to provide top quality teaching.[183] According to Professor Mahoney, longitudinal studies have indicated that "promotions criteria, more commonly … recognise research characteristics and research achievements than teaching achievements".[184]

141. The HEA suggested that, if teaching is to be valued in the same way as research, the career structures within universities needed to change so that more promotion opportunities were made available to good teachers.[185] The AMS made a similar point.[186] The AMS also suggested that guidelines on best practice for improving teaching were integral to improving the value and recognition of teaching. They argued that Government and professional bodies should be proactive in orchestrating the spread of good practice in the management of the teaching load. The Society of Biology suggested putting in place measures to highlight the importance of teaching at HEIs such as HE teaching awards, CPD in teaching and clear routes to promotion that recognised the importance of teaching.[187]

142. There is considerable debate about the relationship between teaching and research.[188] We recognise that research is an important factor in determining the quality of provision within STEM when students wish to go on to conduct their own research, but we agree with HEA that it should not be the only factor. HEA said that "we are seeing a rebalancing" of promotions criteria away from research and towards recognition of good teaching. However, we received little evidence of this rebalancing. From 2014, it is proposed that data on the professional accreditation of teaching staff, which is collected by HESA, could be used to trigger an out-of-cycle review by the QAA if the numbers were considered to be lower than the average.[189] Whilst welcoming this development, it is not, in our view, enough.

143. The Higher Education White Paper, under the HE reforms, stated that "well-informed students will drive teaching excellence". Our panel of students valued an emphasis on teaching but thought teaching was not a high priority within all HEIs. Fabio Fiorelli, a fourth-year MEng chemical engineering student at University College London, for example, told us: "I believe that what could be improved is the interaction with the students. It would be nice to be able to reward those teachers who make the best of their time with the students".[190]

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183 ABPI.

184 Q 199.

185 HEA.

186 AMS, *Redressing the balance: the status and valuation of teaching in academic careers in the biomedical sciences*, March 2010.

187 Society of Biology, Q 222.

188 ABPI, AMS, the British Computer Society, BMA, Council for the Mathematical Sciences, Heads of Departments of Mathematical Sciences, Engineering Professors' Council, Institute of Physics, the Medical Schools Council, the Physiological Society, Royal Academy of Engineering, Royal Society of Chemistry, Russell Group, Society of Biology, SEPNet, University of Oxford, UK Deans of Sciences, QAA, the Government; *Op. cit., Dimensions of Quality*.

189 HEFCE, *A risk-based approach to quality assurance—consultation*, May 2012.

190 Q 326.

144. In 2010, the Browne Review recommended that all HE staff should receive teacher training.[191] We agree that this should be the aspiration of all HEIs, and that students, if they are to drive quality in the system, should be able to find out how many of their teachers have had accredited teacher training. The Government response to the 2012 Review of Business-University Collaboration (the Wilson Review) stated that they were exploring whether they could usefully provide additional information for students including "encouraging HEIs to publish anonymised information about the qualifications and expertise of their teaching staff and to publish summary reports of their student evaluation surveys of teaching on their websites". They said that HEFCE was developing options for such provision.[192]

145. We considered whether the Government or HEFCE should play a greater role in improving the quality of teaching in HEIs. We concluded that they should not on the grounds that HEIs were primarily responsible for the quality of teaching. However, we look to HEFCE to take steps to ensure that the REF does not act as a disincentive to HEIs to promote quality in teaching.

146. **We recommend that the number of lecturers that have received teacher training during the course of their careers should be set out in the Key Information Set (KIS) (see paragraphs 151 to 159), along with information about the training received, and we urge HEIs to offer an accredited course on teaching which all academic staff would be required to complete.**

147. **Student assessment of staff performance and teaching quality should be applied across all HEIs. We recommend that HEIs should have a robust system in place for assessing the quality of teaching including an anonymised and standardised assessment by students. The anonymised results of such assessments should be published in the KIS at a departmental level. QAA should be charged with reviewing whether HEIs have appropriate systems in place to achieve this and that the assessment of teaching quality is fit for purpose.**

### The role of students in driving up quality of provision

148. The HE reforms seek to give students the power "to prompt quality investigations where there are grounds for concern". The proposed changes to quality assurance would continue to allow students the ability to trigger out-of-cycle investigations under the QAA "concerns" scheme so as to provide an early warning sign that quality and standards might be at risk. The changes seek to raise awareness of this scheme. Students are also able to raise concerns through the Office of the Independent Adjudicator (OIA).

149. HEFCE's consultation also proposes the establishment of an annual process for scrutinising key data and information which could prompt an investigation. Such data could include feedback from students through the National Student Survey (NSS) data.[193] In addition, the proposals seek to ensure that there is continued student engagement in quality assurance and

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[191] Lord Browne of Madingley, *Securing a sustainable future for higher education: an independent review of higher education funding and student finance*, October 2010.

[192] BIS, *Following up the Wilson Review of business-university collaboration: next steps for universities, business and government*, June 2012.

[193] *Op. cit., A risk-based approach to quality assurance—consultation.*

enhancement processes more generally. The recently introduced Institutional Review was designed to "embed the principle of full student engagement in quality assurance", outlining ways in which students could engage in the process.[194]

150. We asked our panel of students about how they judged quality within their institutions and if they were aware of how they could influence quality of provision. Their views on quality varied. Preferred measures for quality included access to facilities,[195] and how well their studies prepared them for work[196] . Anecdotal evidence from the student panel suggested that many do not know how quality is measured in their HEIs. Will Evans, for example, a third-year biochemistry student from Imperial College London, told us: "I did not know what the QAA was until I was invited to this meeting".[197]

*The Key Information Set (KIS)*

151. Part of the move to a stronger focus on involving students and aiding student choice to drive up quality is through the provision of more information about courses. This has been done through the development of the KIS, which HEIs must provide for prospective students.

152. The KIS will outline information that students have identified as useful to them in choosing a course. These areas are:

- student satisfaction
- course information
- employment and salary data
- accommodation costs
- financial information, such as fees
- students' union information.[198]

153. We note that the QAA's proposals for the use of data to trigger out-of-cycle reviews do not include referring to wider data held in the KIS, other than the NSS. This is because, they say, they "do not consider ... [the KIS] to offer comparable, well-understood, established, valid or reliable proxies for the quality of teaching and learning".[199] The HEA also concluded in their *Dimensions of Quality* report that it seemed unlikely that comparative indicators of quality currently available could provide prospective students with a valid basis to distinguish between individual courses with regards to quality.[200]

154. Concerns have also been expressed that focusing on the NSS and, therefore, on student evaluation of their "experience" might be at the expense of taking into account learning outcomes, and that students may not always be the

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194 *Ibid.*

195 Q 325.

196 QQ 324–325.

197 Q 327.

198 http://www.hefce.ac.uk/learning/infohe/kis.htm.

199 *Op. cit., A risk-based approach to quality assurance—consultation.*

200 *Op. cit., Dimensions of Quality.*

best judge of their own educational or employment interests.[201] Furthermore, the student experience is "difficult to quantify". As Will Evans told us: "I have not been to any other universities so I have nothing to compare it with".[202]

155. The Imperial College Student Union told us that:

> "the KIS is a welcome innovation which, if it contains the right information, will drive up quality and improve the decision-making process of prospective students. However, most current students are not aware of the proposals. It will be a major challenge to encourage prospective students to use the objective information offered in the KIS over the subjective information they are bombarded with from friends, family, peers and prospectuses."[203]

156. They proposed that "more fields be introduced to the KIS to allow prospective students to compare teaching quality, such as: a percentage breakdown of teaching mode (one-to-one, tutorials, lectures, self-directed study, fieldwork)", amongst other measures. [204]

157. The KIS will require HEIs to focus effort in key areas and inform student choice. However, according to the National HE STEM programme:

> "initial 'mock-ups' show only an initial analysis of perceived quality and short-term measures; the longer-term benefits to the learner of higher education study are not included. For example, only six-month post-graduation employment data is currently shown, but the full benefits of STEM study may not be evident until several years after graduation. The provision of such longer-term careers information for graduates would allow prospective students to assess and compare the value of studying STEM programmes."[205]

158. Amran Hussain, a biomedical sciences graduate, told us that other outcome factors should also be included in the KIS, such as which skills would be gained from which courses, potential career paths, as well as more information on the destination of graduates.[206] The Higher Education White Paper recognised that, because of the lack of data currently available, this is an area of weakness. We are not convinced that HEIs are yet in a position to provide students with the information they need. We agree also that the KIS should be extended to the postgraduate level.

159. The KIS is a good starting point to help to ensure that students have the information they need to make an informed decision about their courses. However, the value of some of the information offered is not clear or sufficient to enable a student to make an informed choice about the quality of provision delivered by their course. **The Government should ensure that the information provided in the KIS gives students the information they need to make an informed choice about the quality of their course. We recommend that the KIS should contain more**

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201 Professor MacInnes, University of Oxford, Medical Schools Council, Russell Group, Heads of Departments of Mathematical Sciences.

202 Q 324.

203 Imperial College Union

204 Imperial College Union.

205 National Higher Education STEM Programme.

206 Q 334, Q 360.

**detailed information on destination data beyond six months, as well as career paths; other measures of quality (including teaching); and more information on outcomes (that is, the skills that students will acquire during their studies). A similar KIS should also be available to postgraduate students with equivalent information on postgraduate provision.**

### Increasing employer involvement to ensure that graduates leave HEIs with the right employability skills

160. We have already said (in paragraph 128) that employers need to be more involved in setting of standards to ensure that graduates leave HEIs with the right employability skills. This is just one aspect, however, of the wider need for engagement. The recent Employability Skills Review, published by the National HE STEM Programme, recommended that the following steps should be taken:

> "Encourage HEIs to explore ways of engaging with employers to develop employability support plans that will help ensure their graduates have the relevant practical skills that are required for the workplace; deliver an enhanced capacity for employer engagement supported by training and a commitment by employers to financially support programmes which provide clear benefit; encourage HEIs to utilise 'in-house' careers advice and guidance support resources; and increase HEI awareness of the developing methods of providing both direct and indirect experience of employers, and support their wider adoption across STEM."[207]

161. We received evidence of several examples of successful employer engagement with HEIs, such as industry representatives sitting on advisory boards within HEIs, and the Wilson Review also identified a number of examples of good practice. However, two areas in particular were drawn to our attention as being especially important for effective engagement. The first concerns the involvement of employers in accreditation by professional bodies; and, the second concerns the number and quality of work placements and sandwich courses. We discuss each of these below.

#### *Accreditation*

162. The Government said in their *Plan for Growth*, published in March 2011, that accreditation schemes will give employers the confidence that graduates have the necessary skills.[208] A key benefit of accreditation is that it is informed by the needs of employers but is independent of any individual employer. Accreditation for a professional qualification (such as a Chartered Chemist, Physicist, Chartered Scientist or Registered Scientist) indicates the acceptability of a degree as part of the qualification route to professional status, which has built-in transferability.

163. Accreditation is seen to be a useful medium through which to engage industry in setting employability outcomes. For example, the Society of Biology said:

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[207] National Higher Education STEM Programme, *Higher Education STEM employability skills review*, April 2011.

[208] *Op. cit., Plan for Growth.*

> "when fully rolled-out across all the biosciences, accreditation will recognise outstanding biosciences courses across the UK that focus not only on core knowledge but also on experimental and analytical skills. It is our hope that Degree Accreditation will provide employers with assurance over the levels of laboratory and fieldwork experience provided by a degree, and the coverage of key areas of expertise required for further employment in specialist scientific careers. Accreditation will also make it easier for students to choose degrees which will equip them for future scientific careers."[209]

164. Mark Down, Chief Executive of the Society of Biology, told us: "professional bodies are well placed to facilitate ... dialogue [between universities and employers] because we have people who sit in both camps".[210] Dr Rob Best of the Institution of Chemical Engineers and the Engineering Council supported this view: "the Register Standards Committee of the Engineering Council is made up of about 50% of people from industry and 50% academics".[211]

165. The Engineering Council commented: "there is a very good match between the Engineering Council's published general learning outcomes for accredited engineering degrees and the employability skills cited by the CBI".[212]

166. The British Computer Society (BCS) told us that "computer science students do not always have the range of transferable skills required by industry, which includes entrepreneurial skills". The BCS, therefore, encouraged the "inclusion of transferable skills training in Computer Science degrees via its accreditation process".[213] There are clearly concerns in this area for forensic science students too. LGC, for example, commented:

> "due to their broad and necessarily superficial coverage of multiple disciplines the majority of … courses do not equip students with the right fundamental technical skill-set for employment in our laboratories; it is therefore an issue of quality rather than number of graduates … The broadened interdisciplinary nature of many UK degrees means that the new recruits with these degrees rarely have sufficient practical laboratory skills or in-depth knowledge of fundamental science concepts to deliver the required quality of service, and need additional training in-house … It would appear that this position has arisen due to academic institutions interpreting what is required by industry without sufficient proactive industry involvement in stating requirements for recruits and the opportunities available to them."[214]

We therefore welcome the fact that the Forensic Science Society has a programme of accreditation of forensic science courses, currently accrediting courses in 23 HEIs[215] out of 51 HEIs that offer courses in that subject.[216]

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209 Society of Biology.

210 Q 230.

211 *Ibid.*

212 The Engineering Council.

213 BCS.

214 LGC.

215 http://www.forensic-science-society.org.uk/Accreditation/AccreditedUniversityCourses.

167. Employers also supported accreditation as a mechanism through which industry could influence the outcomes of courses to ensure that graduates had the required skills for employment.[217] In addition, many commented on the importance of accreditation in driving up quality of provision more generally, above that provided by the QAA.[218] The Wellcome Trust, for example, said that "the introduction of accreditation should help improve the quality of STEM graduates, promote best practice in STEM teaching and harmonise course content across institutions".[219] Dr Sudworth from Cogent also noted that the professional bodies had "a role in ensuring greater quality than in the QAA benchmark statements".[220] However, accreditation is not currently available for all courses or subject areas.

168. Efforts have also been made to improve engagement with employers at the postgraduate level through such accreditation schemes and through Vitae. The Research Councils fund Vitae to support the professional and career development of postgraduate researchers and research staff in HEIs. Vitae produce the RDF which describes the knowledge, behaviours and attributes of successful researchers.[221] The RDF was developed after consultation with HEIs and employers. It is endorsed by over 30 stakeholders including the Research Councils, UK funding bodies and Universities UK. Several witnesses praised the RDF and use it when mapping or reviewing training and courses in order to provide the skills in the RDF.[222]

169. **Given the limitations on the role that the QAA plays in sign posting high quality provision, we believe that accreditation of courses by professional bodies would be a sensible way forward. Accreditation may not be possible for courses in areas where there are no professional bodies. However, for those that have professional bodies and do not already have an accreditation scheme, we would urge them to consider setting up such a scheme.**

### *Kite-marking*

170. In their 2011 Autumn Statement, the Government expressed their support for "the kite-marking of courses that employers value by science, technology, engineering and maths Sector Skills Councils supported by the Confederation of British Industry".[223]

171. The Science Council, however, argued that kite-marking of degrees for particular employers or sectors "could become bureaucratic, costly and fragmented and thereby fail to respond to the needs of either students and a very broad range of science employers". They suggested that kite-marking might be appropriate for vocational degrees but in reality very few STEM

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216 http://search.ucas.com/cgi-bin/hsrun/search/search/StateId/Qkf68opbd4JTsEPNu-4GK0JZCk_iI-4Kzz/HAHTpage/search.HsKeywordSuggestion.whereNext?query=1088&word=FORENSIC+SCIENCE&single=N.

217 ABPI, the Wellcome Trust, GSK.

218 Institute of Physics.

219 The Wellcome Trust.

220 Q 237.

221 Vitae.

222 ABPI, Aston University, Professor Bogle, Open University, Oxford Brookes University, University of Bristol, University of Greenwich, University of Warrick, Cardiff University.

223 HM Treasury, *2011 Autumn Statement*, November 2011.

degrees fitted such criteria.[224] The Engineering Council also expressed considerable concern over kite-marking:

> "The creation of a kite-marking scheme alongside the well-established arrangements for accreditation by professional bodies could well cause confusion, not least to potential students and their advisers. If the proposal is to be implemented then it is important that there is clarity about what it is intended to do and how it differs from professional body accreditation."[225]

172. When we asked the Rt Hon David Willetts MP for his views on the potential overlap in the aims of accreditation and kite-marking, he said: "we are moving to a much more open environment. ... I can imagine a university that was very keen to be able to say, 'Rolls-Royce approves of our engineering course' ... A lot more of that will be going on, and a good thing, too".[226] Rolls Royce, however, disagreed: "we are really not convinced that [kite-marking] will significantly enhance the quality or visibility of good courses, and would be concerned if this became either a bureaucratic exercise, or a distraction to universities".[227]

173. In our view, it would be overly burdensome for employers to kite-mark individually hundreds of courses in the UK. A better approach would be to involve industry through the accrediting bodies and for companies to state whether they supported the accreditation. **Given the tension between accreditation and kite-marking, we invite the Government to explain the aim of kite-marking and what it is expected to achieve beyond that which accreditation by professional bodies already provides.**

174. **We recommend that professional bodies, such as the Institute of Physics or the Institute of Mechanical Engineers, should make further efforts to provide accreditation of different STEM subject areas to ensure that students have confidence in the quality of their chosen course and that they will achieve high quality outcomes in terms of skills and knowledge. For those courses where there is less of a clear link with a profession, we recommend that the Science Council consider whether it would be possible to develop a broader system of accreditation to ensure that graduates have the core skill set required of a STEM graduate. We further recommend that the Government should provide support for such activities in the early stages of development until they are fully established.**

### *Placements and internships for undergraduates and postgraduates*

175. Many of the submissions we received commented on work placements as a key factor in ensuring that graduates acquired suitable employability skills.[228] The Wilson Review also noted that placements, internships and other forms of work experience were extremely valuable to students in terms of academic performance and employability skills, and that they improved employability

224 The Science Council.

225 Engineering Council.

226 Q 401.

227 Rolls Royce.

228 ABPI, Institute of Engineering and Technology, Royal Society of Chemistry, Semta, Royal Academy of Engineering, Russell Group, Society of Biology, SEPNet, Syngenta, University Alliance, University of Cambridge, Vitae, Vectura.

opportunities. A report commissioned by HEFCE and published in 2011 found that “there appears to be evidence, clearest for sandwich placements, that a benefit of structured work experience is improved employment outcomes after graduation”, and argued that “the priority for activity/interventions by the HE sector should therefore be to support work experience placements for students during their period of HE study so that they develop the employability skills employers require and begin to build a body of work experience in advance of entering the employment market proper”.[229] Both the Dearing Report in 1997 and the Roberts Review in 2002 also recommended that more undergraduate courses should offer student placements.

176. The Russell Group, and many others, agreed: “a key aspect of developing employability skills for many students is the opportunity to gain first-hand experience of the workplace during their studies”.[230] Southampton University told us that work-related experience “can be highly relevant and beneficial … for the student and a significant factor to bring them into STEM-related employment. It is also beneficial for the employer to identify new talent”.[231]

177. Our student panel told us that carrying out a placement helped them to decide which career route to follow, as well as preparing them for the world of work.[232] Imperial College Union raised a similar point with regard to placements for postgraduate students. They told us that the quality of a placement can have a major impact on a student’s decision about whether to pursue a career in research: “if the placement is poorly designed or uninteresting ... their perceptions of a career in research or industry can be changed permanently.”[233]

178. The findings from a recent Science Council report support these views:

> “research identified that for graduate internships, the number of vacancies in STEM industries seems to be much lower than in many other sectors, including finance and business and that it is easier for a STEM graduate to find an internship in a business-oriented environment than in a scientific or technical one. The research also identified that ... STEM graduates appear to be less likely than other graduates to pursue internships. Given the call from employers for graduates with higher levels of practical and technical skills, it was surprising therefore that there are very few genuinely scientific or technical internships for graduates”. [234]

179. A number of submissions suggested that employers should be encouraged to offer internships.[235] The Wilson Review said that “to enhance graduate skills levels and ensure a smooth and effective transition between university and business environments, there is a need to increase opportunities for students to acquire relevant work experience during their studies”, and that “ideally,

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[229] Oakleigh Consulting Ltd and CRAC for HEFCE, *Increasing opportunities for high quality higher education work experience*, July 2011.

[230] The Russell Group.

[231] University of Southamton.

[232] Q 339, QQ 362–365.

[233] Imperial College Union.

[234] The Science Council, *Work experience for STEM students and graduates*, April 2011.

[235] ABPI, SEPNet, Society of Biology, University of Cambridge, Syngenta, University of Manchester.

every full-time undergraduate student should have the opportunity to experience a structured, university-approved undergraduate internship" and made a number of recommendations about how this might be achieved.[236] Placements should also be available for postgraduates.[237] The Wilson Review further suggested that the Government should support companies that host students on full sandwich placement years, or provide internships, through a tax credit or grant mechanism. For unpaid internships it recommended that HEIs use their Office for Fair Access (OFFA) funds to support students.

180. When we spoke to the Rt Hon David Willetts MP about the Wilson Review recommendations, he said that "there is striking evidence that industrial placements ... are concentrated in a very small number of universities ... [therefore] if they can do it other universities ought to be able to do it as well".[238] He also said that BIS were in the process of assessing the feasibility of the recommendations, but that he was not sure whether they would be sustainable.[239]

181. Alternative mechanisms for exposing students to the work environment need to be explored. The businesses to which we spoke emphasised the benefits of building better relationships and collaborations between HEIs and employers as a way of encouraging employers to take part. The Royal Society and the Wilson Review made similar points.[240] We are aware, however, that this issue is a particular challenging for SMEs.[241] Semta noted that "whilst the majority of large companies in the sector actively engage with universities, provide placements and employ undergraduates, graduate and postgraduates, this is not the case for the majority of SMEs who make up 99% of the sector. The problem for SMEs is one of perception in terms of barriers: e.g. relevance of HE engagement to an SME; value and return on investment by SMEs in recruiting a graduate; resources to support an undergraduate, work placement, internship, graduate training and post-graduate support". They were currently looking at mechanisms to encourage SMEs to engage.[242]

182. Our panel of employers indicated that economic incentives for employers to offer placements would be welcome but that more had to be done in terms of aligning the needs of students with those of the employers. Professor Chris Wise, founder of Expedition Engineering, suggested that what students were learning at universities had to dovetail with the work experience that employers had to offer and this would require a close collaboration between HEIs and employers.[243]

183. It is widely recognised that good quality, well-supervised work placements and internships increase the employability of undergraduates and postgraduates. Their availability is almost non-existent in the case of postgraduate provision and in recent years, placements for undergraduates have been in decline, from 9.5% of the total full-time cohort in 2002–03 to

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236 *Op. cit., A review of business-university collaboration*.

237 *Ibid.*

238 Q 406.

239 *Ibid.*

240 *Op. cit., A review of business-university collaboration;* Royal Society, QQ 159–161.

241 Engineering Professors' Council, Semta, Vitae, Q 52.

242 Semta.

243 Q 159.

7.2% in 2009–10.[244] The Wilson Review recommended that all undergraduates and postgraduates should be offered internships and that more sandwich courses should be offered. Whilst right in principle, given the current economic climate, it is unclear how this provision would be funded. In July 2012, the Government's response to the consultation on the Higher Education White Paper stated that fees for a sandwich course should be no more than 15% of the normal fees.[245] This is a welcome development. However, the Government did not specify how they intended to encourage or incentivise employers to offer placements.

184. **We recommend that the Government, employers and HEIs find a way to incentivise employers, particularly SMEs, to offer more work placements, and encourage more students to take them up.**

185. **In order to assist HEIs in engaging with employers and in securing placements for their undergraduate and postgraduate students, we further recommend that a central database should be established to post opportunities for placements for undergraduates and postgraduates. We recommend that the Government extend the remit of the Graduate Talent Pool service to include undergraduates and postgraduate placement opportunities.**

### The role of the Research Councils and HEFCE in the quality assurance of postgraduate provision

186. The Research Councils fund around 25% of all doctoral students from UK universities of which around 76% are studying STEM subjects.[246] HEFCE also provide funding to HEIs for postgraduate provision through the research degree programme supervision fund (equivalent to £205 million in 2011–12).[247] They have a responsibility, therefore, in conjunction with HEIs, to ensure the quality of the provision they fund. They also have a role in ensuring both that high quality STEM applicants enter STEM doctoral training and that doctoral graduates have the necessary skills that employers demand. (PhD teaching funding is also allocated from several other sources, which have different methods to assess the quality of provision. These are not discussed in this report.)

187. The Research Councils use their own methods to assess an institution's ability to supply high quality of doctoral provision and the quality of the candidates they fund. For example, some Research Councils only consider applications from first degree graduates who have achieved a 2:1 or a first class degree.

188. Different types of doctoral training have distinct proxies of quality measures, for example Doctoral Training Centres (DTCs) have to meet certain criteria in order to receive funding from the Research Councils. They are reported to have improved the quality of doctoral training because of the criteria for setting up a DTC. These include a strong research environment, critical mass of PhD positions, delivery of set learning outcomes, and conditions for

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244 *Op. cit., A review of business-university collaboration.*

245 *Op. cit., Response to the consultation on the Higher Education White Paper.*

246 RCUK.

247 HEFCE.

learning.[248] There are also other forms of high quality doctoral provision[249] ABPI told us, for example, that DTCs are valued by employers and by the students who undertake PhDs through them because they provide a critical mass of students who learn from each other and benefit from access to different disciplines in a general area of science and technology.[250] The Engineering and Physical Sciences Research Council (EPSRC) mid-term review of their DTCs concluded that the DTC approach was an effective way of training a cohort of students, and leveraging substantial industrial funding. RCUK noted that the Economic and Social Research Council (ESRC) centres have provided clear evidence that they can deliver the highest quality training provision.[251]

189. On the other hand, from 2012–13, HEFCE will use the Research Assessment Exercise (RAE) rating of HEIs, a process carried out every five years in order to assess the quality of research undertaken by HEIs to allocate a block grant to fund postgraduate provision according to an institution's research quality star rating.[252] The use of the RAE rating to allocate funding for doctoral teaching provision, as opposed to the number of students and the cost of course provision, was supported by RCUK, because it links quality of research to doctoral provision more explicitly.[253] However, it is considered by many to be controversial because it does not ensure that the teaching provision is of a high quality. Oxford Brookes University, for example, told us that "we are unaware of any evidence that demonstrates a correlation between quality outputs and the quality of postgraduate training", indicating that the existence of internationally recognised research at an HEI does not necessarily mean a high quality postgraduate learning environment. [254] Other universities and the QAA agree that research output should not be the only quality measure and that other factors, such as completion rates and quality of teaching, should also be taken into account.[255]

190. Based on the evidence we have received, we find it difficult to judge the processes used for the assessment of quality in postgraduate provision. Our impression is, however, that the quality of postgraduate provision is measured in an inconsistent way across funding bodies and warrants further scrutiny.

191. **We recommend that the expert group proposed to be established to look at postgraduate provision should examine how the quality of postgraduate teaching provision is assessed to ensure quality and consistency of approach across funding bodies, and consider how measures of quality of postgraduate education that go beyond research excellence might be developed. In particular, we would urge**

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248 ESRC, *Postgraduate training and development guidelines*, 2009.

249 Russell Group, Imperial College London, RCUK, 1994 Group, University of Oxford, Engineering Professors' Council, Medical Schools Council, ABPI, Institute of Physics, University Alliance, The Wellcome Trust.

250 ABPI.

251 RCUK.

252 The RAE will be succeeded by the REF with similar principles as the RAE for the allocation of funding.

253 RCUK.

254 Oxford Brookes University.

255 University of Greenwich, University of Kent, University of Salford.

**the Research Councils and other postgraduate funding bodies to expand the quality principles that underpin the DTC model to other types of postgraduate funding provision.**

*Doctoral provision models*

192. Research Councils split their provision into the following broad categories:

- Collaborative doctoral studentships allocated through a variety of routes, such as for example Collaborative Awards in Science and Engineering (CASE) whereby an industrial sponsor collaborates through the co-supervision and sponsorship of a postgraduate researcher.
- Doctoral training grants which are allocated according to evidence about the excellence of the research environment or in response to peer-reviewed proposals including a business case.
- Research council proposals for a small number of projects in particular subject areas (otherwise known as project studentships).
- Doctoral Training Grants or industrial doctorate centres.

193. Recently, some Research Councils have chosen to increase their provision through DTCs and industrial doctorate centres. DTCs enable concentration of effort within centres of research excellence with the flexibility to allow HEIs to offer four year postgraduate training to cohorts of students—thereby creating critical mass and the ability for students, as Professor Sir Adrian Smith noted, to "develop the advanced skills and knowledge they need to be successful in their career" over a longer period.[256]

194. There is considerable support for the concentration of postgraduate research provision within centres of excellence through the development of DTCs. Arguably postgraduate provision through DTCs has improved the standards of PhD training for students.[257] However, there is concern that PhD funding by the Research Councils is being squeezed as a result of the move to the provision of PhD positions through DTCs, with fewer grants available for PhD studentships.[258] The provision for each individual student through DTCs is more expensive than other forms of provision due, in part, to the flexibility and option to offer four year courses. For example, it has reportedly reduced the overall number of STEM PhD students funded by EPSRC.[259] In addition, EPSRC plans to discontinue the provision of project studentships on research grants and fellowships as a result of efforts to concentrate research funding in centres of excellence with a critical mass of research. Many believe that the removal of project studentships is a backwards step.[260]

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[256] *Op. cit., One step beyond: Making the most of postgraduate education.*

[257] Russell Group, Imperial College London, RCUK, 1994 Group, University of Oxford, Engineering Professors Council, Medical Schools Council, ABPI, Institute of Physics, University Alliance; *Op. cit., One step beyond: making the most of postgraduate education.*

[258] Royal Society of Chemistry, Royal Academy of Engineering, Institute of Physics, Heads of Departments of Mathematical Sciences, Institute of Engineering and Technology, Professor Michael Singer, UK Deans of Science.

[259] Council for Mathematical Sciences, Royal Academy of Engineering, University of Oxford, Science Council.

[260] Institution of Engineering and Technology, University of Manchester, Imperial College London.

195. This shift towards DTCs and away from project studentships has raised a number of concerns because it will be difficult to allocate students to small-scale projects which often lead to research breakthroughs. This will impact disproportionally on UK and EU students which make up the majority of project studentship placements.[261] There are also concerns that DTCs are too narrowly focused and skewed in terms of areas of science and geographical location which could have a negative impact on specific areas of research. For example, there is only one DTC for synthetic organic chemistry[262] and there are no DTCs for physics in the South East of England.[263] We note, however, that the other HEIs are able to collaborate with the DTCs.

196. There is concern, therefore, that DTCs will have a negative impact on the breadth of research that takes place outside of the centres, given that PhD students are often involved in new areas of research through project studentships on grants.[264]

197. It has been suggested that DTCs should be just one element of PhD provision, because there are high quality PhDs in universities that do not have DTCs (those, for example, funded through CASE Studentships).[265] Other proposals have been put forward. They include increasing industry collaborations;[266] the use of regional alliances to offer joint training to postgraduates;[267] the use of cohort-based training and four year funding but applied to wider subject areas;[268] and, the maintenance of an element of project-based funding for PhDs to provide additional opportunities in emerging research areas.[269]

198. RCUK assured us, however, that "research council funding for postgraduate research is not restricted to DTCs", and that "a range of modes of delivery of postgraduate research training are likely to continue to be needed to address research capacity, the requirements of specific disciplines, or the needs of users and beneficiaries of research".[270] Over the last ten years, the Research Councils have increased their overall spend on doctoral provision, and the number of students that they fund from 4,243 in 2000–01 to 5,430 in 2010–11, although there has been a decrease from a peak of 6,065 in 2007–08.[271] **The DTC model for delivering postgraduate provision is a welcome development and we understand the rationale to focus on centres of excellence. But the DTC model should not be the only model if we are to retain a breadth of research excellence—not only within our centres of excellence focused on strategic research objectives—but also excellence in smaller research projects which often lead to important scientific**

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261 Institute of Physics, Professor Michael Singer, Institution of Engineering and Technology.

262 Royal Society of Chemistry.

263 SEPnet.

264 UK Deans of Science, Institute of Physics, Council for the Mathematics Sciences, the Physiological Society, Engineering Professors' Council.

265 Engineering Professors' Council.

266 ABPI.

267 Institute of Physics, SEPnet.

268 University of Oxford.

269 Imperial College London.

270 RCUK.

271 *Ibid.*

breakthroughs. We question, therefore, why the EPSRC has removed the small, but vital, 2.4 %[272] of its doctoral funding from project studentships, given the important role they play in maintaining the breadth of excellence in the UK. It is not possible to tell from the data available whether other sources of funding give HEIs the flexibility to fund such studentships by other means.

199. **We recommend that the Government encourage the Research Councils to preserve a variety of PhD delivery models to ensure that the UK's current breadth of expertise in science is maintained and that new areas of science are able to grow. We also recommend that the proposed expert group set up to consider the supply and demand for STEM postgraduate provision considers whether the current provision for funding doctoral study across funding bodies is sufficient to cover the breadth of excellent research across the UK.**

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[272] *Ibid.*

# CHAPTER 6: POLICY REFORMS

200. Two recent policy reforms—on higher education and immigration—are likely to have a significant impact on the HE sector. Although it is too early to assess the effect with any accuracy, the evidence we received indicated significant concern about the outcome of the reforms.

## Higher education reforms

201. The Higher Education White Paper, *Students at the Heart of the System*, was published in June 2011. It was intended to put HE on a sustainable footing by introducing repayable tuition loans, delivering a better student experience (by improving teaching, assessment, feedback and preparation for the world of work), and increasing social mobility. The reforms also sought to increase competition within the market so that, to succeed, HEIs would have to appeal to prospective students and be respected by employers.[273] In addition, the Government made a commitment to improve and expand the information available to prospective students, including more information about individual courses and about graduate employment prospects. The White Paper also called on HEIs to "look again at how they work with business across their teaching and research activities, to promote better teaching, employer sponsorship, innovation and enterprise," and introduced a new risk-based approach to quality assurance (see paragraph 118).[274] Another important aspect of the reforms was a substantial reduction in teaching grants from HEFCE and a sharp rise in the maximum tuition fees.

### *Student numbers in STEM*

202. One possible effect of the HE reforms is that students may be discouraged from entering HE because of the level of debt they may incur. STEM subjects are generally more expensive to teach than others and, with a system of variable fees, it is possible that STEM courses may end up being more expensive to study. Employers are worried about the effect that the reforms may have on STEM student numbers. Rolls Royce told us: "we are very concerned that the new arrangements could result in a drop in graduate numbers at a time when our requirements are increasing".[275] Many others agreed.[276]

### *Control of student numbers*

203. Prior to 2011, each HEI had a limit on the number of students it was able to recruit. The limit was determined according to a formula and based on previous history.[277] As part of the HE reforms, and in order to encourage HEIs to keep tuition fees low, the Government have introduced the core and margin system whereby around 85,000 student places will be contestable between institutions from 2012–13, allowing unconstrained recruitment of

273 BIS, *Higher education—Students at the heart of the system*, June 2011.

274 *Ibid.*

275 Rolls Royce.

276 1994 Group, UK Deans of Science, Institute of Physics, Medical Schools Council, CaSE, Royal Academy of Engineering, Education for Engineering, Physiological Society, Institute for Engineering and technology, Society of Biology, Million+, National Higher Education STEM Programme.

277 HEFCE, *Guide to funding: How HEFCE allocates its funding*, September 2010.

students scoring the equivalent of AAB+ or above (65,000), with a flexible margin of about 20,000 places to reward HEIs that combine good quality courses with value for money (having an average tuition fee of below £7,500 a year).

204. The possible consequences of this initiative for STEM provision have caused a great deal of concern.[278] Some anticipated, for example, that uncapping recruitment of AAB+ students would inhibit, rather than expand, provision of STEM because, as Million+ put it: "STEM students are less likely to achieve AAB+ than their non-STEM counterparts; the higher costs associated with STEM and STEM-related provision will make it hard to support STEM subjects below the £7,500 threshold for access to margin places".[279]

205. In October 2011, HEFCE announced that they would "exclude numbers associated with currently identified ... [SIVS] from the calculation to create the margin, on condition that institutions at least maintain their entrant levels to SIVS courses".[280] Further to this, in May 2012, the Government announced that the threshold would be lowered from AAB+ to ABB+ and that, from 2013–14, an additional 5,000 places would be allocated to HEIs with lower fees. This means, in practice, that about one third of student places will be uncapped. It is not clear what effect these developments will have on STEM provision.

206. **The recent adjustments to the core and margin system may allay some of the concerns about the effect of the HE reforms on STEM provision. However, we invite the Government to explain in their reply to this report on what evidence this change of policy was based and the timescale in which it was implemented.**

### *Funding STEM subjects*

207. Imperial College London explained the different costs associated with STEM courses, compared with a humanities course, as follows:

> "in 2009–10, the full cost to the College of educating a HEFCE fundable taught student in some engineering subjects was £15.7K per annum. Hence, despite the rise in undergraduate tuition fees, leading institutions will still face a deficit on much of their taught STEM provision. In contrast, we calculate that the average cost to Russell Group institutions of educating a humanities student is around £7.1K per annum."[281]

208. There is, therefore, a real danger that, with variable fees, STEM courses may end up being more expensive than other courses which could, in turn, impact the number of students wishing to go on to postgraduate study.[282]

209. HEFCE told us that "following these reforms, the Government will maintain some public funding for teaching, around £2 billion, to fund additional costs

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278 Million+, National Higher Education STEM Programme, ABPI, Institute of Physics, Council for the Mathematical Sciences, UCAS.

279 Million+.

280 HEFCE, *Student number controls for 2012–13—invitation to bid for student places*, October 2011.

281 Imperial College London.

282 The Wellcome Trust, Royal Astronomical Society, Institute of Physics, Russell Group, Academy of Medical Sciences, CaSE, Society of Biology, Syngenta, University of Manchester.

and public policy priorities that cannot be met by a student-led funding system alone".[283] CaSE, and others, told us that this additional funding for high cost subjects would not be sufficient to cover the additional costs of STEM courses:[284] "£1,500 per student for resource-intensive subjects such as science and engineering ... is the equivalent of a 17% subsidy for HEIs which charge £9,000 per annum, or 20% for those charging £7,500 per annum".[285] Another way to avoid charging more for high cost subjects would be for HEFCE to subsidise some of the costs through their SIVS funding. However, as we have said (paragraph 89), the money available for SIVS funding is significantly limited. The Wellcome Trust suggested that 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".[286]

210. Another possible consequence of the new funding model is that cheaper humanities courses may end up cross-subsidising the generally more expensive STEM courses, "thus creating an unhealthy and unwelcome tension between different areas of academia".[287] Humanities students are likely to object strongly to their fees being used to subsidise other courses and STEM students may object to funding allocated to STEM being spent elsewhere. **We recommend that HEFCE publish the quantitative evidence on which they base their funding model for public subsidies for STEM subjects with a view of reassuring stakeholders that these subsidies, in conjunction with students' fees, are sufficient to cover the cost of STEM provision.**

### *Capital funding*

211. As part of the HE reforms and the efficiency drive across government, capital funding for universities has been reduced significantly: £1,040 million less in non-recurrent and capital funding from the 2009–10 position. These reductions are not offset by any increase in income to universities from regulated fees,[288] and are likely to have a disproportionate effect on STEM subjects because, for example, "the teaching of science and engineering often requires a significant injection of capital funding for equipment".[289] A number of HEIs and professional bodies expressed concern about the implications of reduced capital funding for the provision of STEM courses with a significant practical element.[290] The Open University, for example, said that it had "caused regrettable pressures on the ability of institutions to offer a state of the art laboratory experience".[291] This may, in turn, limit the number of STEM student places that HEIs can offer because "the ability to take additional students in the chemical sciences, and STEM subjects more

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283 HEFCE.

284 Royal Astronomical Society, Institute of Physics, Russell Group, Royal Academy of Engineering, CaSE, Society of Biology, Universities UK, Million+, the Physiological Society.

285 CaSE.

286 The Wellcome Trust.

287 Royal Astronomical Society.

288 HEFCE.

289 CaSE.

290 The Physiological Society, Russell Group, University of Oxford, ABPI, GlaxoSmithKline, Royal Society of Chemistry, Q 328.

291 Open University.

widely, is restricted by the capacity of laboratory space and facilities that are available to any one institution".[292]

*Longer undergraduate courses*

212. Higher fees may deter some students from taking well-regarded and important courses in STEM, such the MEng, which last four years instead of the more usual three.[293] The MEng "offers a fast track route towards professional qualification as a Chartered Engineer.[294] Rolls Royce told us that they were "concerned that there could be a particular disincentive to participation in four year programmes".[295] (They currently require engineering applicants in the UK to be qualified to MEng or to engineering Masters level.)[296] The Council for the Mathematical Science said: "the quality of UK undergraduate degrees in the mathematical sciences is high. At the 'top' end, quality has been enhanced by the increasing popularity of Integrated Masters degrees. There is a serious risk to the viability of these in the era of high fees",[297] and the Institute of Physics expressed the worry that the HE reforms "may also have an adverse impact on the uptake for the four-year integrated Masters degrees—the MPhys/MSci—which are now the norm for those considering a career in university or industrial R&D".[298]

*Placements and sandwich courses*

213. As we have noted (in paragraph 179), the Wilson Review recommended that all undergraduates should have the opportunity to undertake some sort of internship during their period of study as a way to "enhance graduate skills levels and ensure a smooth and effective transition between university and business environments".[299] Under the new fees regime, there is a risk that students may be discouraged from doing placements because of the fees that they would have to pay during the placement and the interest that would be accumulated on the student debt—a point made by GlaxoSmithKline: "students would be deterred from applying to do a sandwich year, as this would be seen as leading to an additional year of debt".[300]

*Conclusion*

214. **It is too early to assess the impact of HE reforms on the sector. We recommend that the Government have particular regard to the effect of the reforms on STEM provision. We support the role that the Government have given to HEFCE to monitor unintended consequences and to intervene, as appropriate, to protect strategic or vulnerable provision that will not be supported by the market. However, we have some concern that HEFCE may not have sufficient funds to intervene should it be necessary and recommend that the**

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292 Royal Society of Chemistry.

293 Engineering Council.

294 Royal Academy of Engineering.

295 Rolls Royce.

296 *Ibid.*

297 Council for the Mathematical Sciences.

298 Institute of Physics.

299 *Op. cit., A review of industry-university collaboration.*

300 GlaxoSmithKline.

**Government ensures that HEFCE will have the necessary resources should these circumstances arise.**

## Immigration reforms

215. International students contribute significantly to the UK economy. Between 2010 and April 2012, the Government made a number of changes to their immigration policies as part of their commitment to reduce net migration "from the hundreds of thousands to the tens of thousands".[301] They included, for example, the introduction of a new category under Tier 1, capped at 1,000 visas, for persons of exceptional talent and achievement in science or the arts (with applications subject to endorsement by the Royal Society, the Royal Academy of Engineering, the British Academy or the Arts Council). The immigration reforms likely to be of most concern to students are:

- Tier 2 (skilled workers): the introduction of a cap on the number of visas available to skilled workers of 20,700 (down from 28,000 in 2009) although "high-quality graduates—including those in STEM subjects ... will not count against the numerical limit"[302];
- Tier 4 (student visas): the introduction of accreditation requirements for colleges, changes to the standards of English required, working rights, dependants' sponsorship and restrictions on working hours (but no overall restriction on the number of visas available); and
- Tier 1 (post-study work route): closure of the route from April 2012 and replacement with more selective arrangements under Tier 2.

216. These changes are intended principally to tackle "bogus colleges"[303] and students who use the student visa system simply to gain access to the UK. To this extent, we support the Government in their efforts to address a problem that gives a bad name to our HE system and to *bona fide* overseas HE students who intend to return to their countries of origin after their studies.[304]

217. As with the HE reforms, it is too early to assess the full effects that the immigration reforms will have on HE. However, substantial anecdotal evidence from HEIs, professional bodies, employers and others suggests that they are already having a significant impact on STEM provision in some areas. In May 2012, 68 Vice-Chancellors, governors and university presidents wrote a letter to the Prime Minister warning that the immigration reforms could lead to foreign students going elsewhere, costing the economy billions.

### *Number of STEM overseas students*

218. In 2010, the Home Office carried out a study in which they estimated that around half of overseas students in the UK were studying at HEIs, of which around half were studying postgraduate courses and the rest a mixture of

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301 The Conservative Party, *The Conservative Party Manifesto*, April 2010.

302 The Government.

303 Q 432.

304 Home Office, *The migrant journey*, 2010.

undergraduate or pre-university courses.[305] Data from HESA shows that, between 2009–10 and 2010–11, there was an 8% rise in non-EU undergraduates and a 5% rise in non-EU postgraduates.[306] Within STEM subjects, in 2009–10, 13% of first degree qualifiers, 55% of Masters degree qualifiers and 42% of PhD qualifiers were from overseas.[307]

219. The Wellcome Trust, the AMS, and the University of Southampton each argued that restrictions on skilled immigration from outside the EEA presented a significant threat to the sector. In evidence to a House of Commons Home Affairs Committee inquiry into student visas, Professor David Wark from Imperial College London said that 29% of the student body at Imperial College London were non-EEA, and they accounted for 62% of their fee income. Therefore, he said, "from a purely financial point of view, it would be devastating to Imperial to have any significant cut in the number of students".[308]

220. At a recent Universities UK event, Professor Julia King, Vice-Chancellor for Aston University, said that the university had experienced:

> "a dramatic reduction in overseas student applications and admissions, leading to a significant reduction in income to the university. Comparing 2011/12 with 2010/11, the biggest impact on applications was on India, with a 39% decline, followed by Nigeria at 27%, resulting in a 30% drop in admissions from India [equal to 200 less overseas students than planned]. In the current academic year about £3million less income—on a university turnover of £120 million, and it looks as if it is happening again for the coming year."[309]

221. The University of Salford also told us that most of their Masters courses depend on overseas students and that, without them, many would be closed on economic grounds.[310]

222. Within the discipline of engineering, where the UK is particularly reliant on overseas students, Professor Wark said that 40% of their students were non-EEA students and that if they were to lose them "it would have a severe impact on our ability to perform research that keeps Imperial College as a world-leading institution".[311] In 2009–10, 34% of engineering first degree qualifiers and 64% of engineering postgraduate qualifiers were from overseas (including other EU countries)[312]. The Engineering Professors' Council told us that "almost all engineering departments in the UK would be running at a loss if it were not for overseas students' fees",[313] and that, in a poll they had conducted, 16 out of 27 HEIs reported a reduction in overseas applications to Masters courses.[314] Professor King, speaking at the UK Universities event with reference to Aston University, said that "48% of engineering PhDs were

305 The Government.

306 http://www.hesa.ac.uk/content/view/1897/239/ —Table 1.

307 The Government—data from Tables 1–6 in Appendix 6.

308 House of Commons Home Affairs Committee, 7th Report (2010–12), *Student Visas*, (HC 773).

309 Universities UK Immigration debate, 29 February 2012.

310 University of Salford.

311 *Op. cit.*, *Student Visas*.

312 Data from the Government's evidence.

313 Engineering Professors' Council.

314 *Ibid.*

obtained by non-EU students, up from 43% in 2004, compared to an average across all courses of 29%". She went on to say: "We are highly dependent on overseas students to keep our engineering courses running and solvent!".[315]

223. In addition to the fee income provided by overseas students, they also have a positive effect in the classroom. Professor Cantor told us: "I believe fiercely that having international students and home students at the same time, not only in my institution but also in others, enriches the educational experience."[316]

224. We should congratulate ourselves that our HEIs are able to attract substantial numbers of overseas students in such a competitive international market. We are concerned, however, that some HEIs rely too heavily on the income derived from international students. We question the long-term viability of such an approach. HEIs must ensure that their business model is truly sustainable.

225. **We are concerned that changes to the immigration rules may reduce the number of overseas students coming to study to the UK and, therefore, the income that HEIs derive from these students to support other activities. This may result in a general reduction of provision of STEM courses that rely on this income to make them viable.**

### *Post study work route*

226. Another area of concern raised by witnesses related to the closure of the post study work (PSW) route.[317] The PSW visa enabled foreign graduates to work in the UK, for up to two years, after obtaining a UK degree.[318] This visa had been highly valued by overseas students as a way of gaining work experience before returning to their countries of origin, and to help to fund their study. According to a National Union of Students survey, 94% of overseas students said that availability of the PSW route was a very important factor in deciding to study in the UK and nearly three-quarters of those surveyed said they would not have come to the UK without the option for PSW.[319] Professor King made a similar point;[320] and Jo Doyle, Director of the International Office at the University of Southampton, said:

> "When the changes to the post-study work regulations were announced this time last year, we were running at a 23% increase in applications. By the end of the recruitment cycle, that had reduced to 11%, and I think that that is probably a direct result of the post-study work change. This year, our applications are up only 3%, so that is quite a big shift. In the three years that I have been talking about, the biggest growth has been in postgraduate applications, with 47%, 44% and 32% respectively. Again, it was running at 32% at the time of the post-study work announcement last year, and it then reduced to 13% by the end of the year. This year,

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315 *Op. cit., Universities UK Immigration debate.*

316 Q 61.

317 Professor Edward Acton, Aston University, Imperial College London, Queen Mary's, University of London, the Wellcome Trust, Academy of Medical Sciences, University of Southampton, QQ 282–284, Q 467.

318 House of Commons library note, *Immigration Tier 1 (Post study work) visas*, 28 March 2011.

319 http://www.nusconnect.org.uk/news/article/nus/1357/.

320 *Op. cit., Universities UK Immigration debate.*

our growth in postgraduate taught applications at this stage is only 4%. So I am looking at the same period over four years."[321]

227. The Government have replaced the PSW route with more selective arrangements under Tier 2,[322] notably making a job offer paying more than £20,000 a year a requirement for a visa. Several witnesses suggested that this could make it much more difficult for talented international graduates of UK universities to enter the UK workforce.[323] The UK Border Agency (UKBA) told us that the limit was set following guidance from the Migration Advisory Committee.[324] It is not, however, clear if this guidance was intended specifically for graduates. **We would ask the Migration Advisory Committee to reconsider its advice. We would further ask the Committee to monitor the impact of the changes on both the number of graduates who stay on to work in the UK and on the number who decide not to study here, due to the real or perceived barriers created by the closure of the PSW route.**

*Perception*

228. Perhaps the most worrying aspect of the immigration reforms is the message it conveys to overseas students that the UK does not welcome them.[325] Professor George told us that "especially in India … there is a perception that we are closed for business and that it is difficult to get in".[326] Professor King said: "the UK is seen as no longer welcoming overseas students … whereas other English-speaking countries are trying hard to be welcoming".[327]

229. In 2011, the UK Council for International Student Affairs (UKCISA) recommended in their student survey that "given all the recent negative publicity surrounding student visas, UK Border Agency (UKBA) needs to work with the Foreign and Commonwealth Office and British Council to develop a positive communications strategy clarifying areas of concern and uncertainty and emphasising that the UK, after a period of visa reform, continues to encourage, value and positively welcome well-qualified students".[328]

230. Other barriers identified during the inquiry include: the lengthy and cumbersome bureaucracy associated with gaining a visa and the high cost; and the challenges of dealing with changes to visa policies throughout the duration of a student's course. Also of concern is the UKBA website which is perceived as unwelcoming. The Home Office conceded that more could be done: "on the website, I take your point that we could probably make that a friendlier, more welcoming place to be".[329]

231. HE is a global market and the UK has to compete with other countries that are positioning themselves to attract international students. The perception

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[321] Q 283.

[322] Which are exempt from the total restriction on numbers for Tier 2.

[323] The Wellcome Trust, University of Southampton, AMS.

[324] Q 289.

[325] AMS, University of Southampton.

[326] Q 467.

[327] *Op. cit., Universities UK Immigration debate.*

[328] UKCISA, *Tier 4 student survey*, 2011.

[329] Q 299.

that the UK does not welcome students may be having a detrimental effect on recruitment from some countries such as India. The UK must be seen to welcome the brightest and the best and the Government must increase their efforts to dispel perceptions that the UK does not welcome students. We recommend that the Government develop a strategy to send out a more positive message through the UKBA website, immigration agencies and the British Council.

### *Data*

232. Several witnesses were critical of the available data on migration and suggested that better co-ordination of data between UKBA and HEIs was needed to enable them to track students. The Home Office conceded that it was "not possible to routinely disaggregate visa statistics by institution-type, educational establishment or subject".[330]

233. A House of Commons Home Affairs Committee report into student visas noted that the Office for National Statistics used data from a variety of sources to compile net migration figures. This was because the Government did not have a simple method of counting people in and out of the country.[331] A 2011 briefing note by the UK Statistics Authority on immigration statistics stated that: "the currently available statistics on immigration and emigration fall some distance short of painting the comprehensive picture that Parliament would want to be available to inform the public policy debate".[332]

234. The UKBA is currently implementing an e-borders scheme, an electronic system to carry out checks on travellers before they begin their journey, which is anticipated will improve data collection. However, it will still not enable linkage of entry and exit information. It will also not be possible to produce direct migration counts because the information collected from carriers will not routinely include country of residence of the traveller.[333]

235. The lack of reliable statistical data is a concern because the Government are not able to identify problems with their visa system soon enough to put in place a mitigation plan. Data from HESA is more accurate but by the time it is published it is 18 months out of date (see paragraph 70). This problem is particularly acute for the HEIs that we spoke to who are reporting that the HE reforms are having a significant impact upon their recruitment of overseas students already.

236. **We recommend that the Government, working with HEIs, as a matter of urgency, make further efforts to co-ordinate data collection and ensure that data is shared between UKBA and HEIs. In addition, the Government should collect real time data on the effects of changes to immigration policies in HEIs with a view to setting up a mitigation plan, if necessary, and to enable policy decisions to be based on the latest information. This should be achieved by September 2014.**

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330 The Government.

331 *Op. cit., Student Visas.*

332 UK Statistics Authority, *Immigration Statistics Monitoring Brief 5,* 2011.

333 *Op. cit., Student Visas.*

### *Classification of overseas students as migrants*

237. The Government define migrant, using a United Nations definition, as someone who comes to the UK for a period longer than 12 months. As a result, most overseas students who come to the UK to study undergraduate courses will be classified as migrants. This classification is particularly significant because of the Government's commitment to reduce net migration. Since "students now represent the largest proportion of non-EU net migration" (around three quarters),[334] a reduction in net migration means, in effect, a reduction in the number of overseas students. The classification fails, however, to acknowledge that most overseas students return to their countries of origin soon after finishing their studies.[335] Oxford Brookes University warned of the consequences of this approach as follows: "by including students in the definition of 'immigrants' the UK is threatening approximately £20bn worth of exports. International students are a free good. They are educated at somebody else's expense and pay us large sums of money to be educated here. The vast majority return home at the end of their course. The current policies are a calamity that will cost UK Plc billions of pounds and severely damage UK HEIs."[336]

238. This policy is also contrary to the BIS policy of expansion of the HE sector to promote economic growth. Damian Green MP told us that the Rt Hon David Willetts MP was leading a task force to maximise opportunities for HE.[337] Lord Clement-Jones, on 30 April 2012, told the House of Lords that: "the Home Office is targeting net migration figures that include overseas students, which is directly contrary to the policy of the Department for Business, Innovation and Skills".[338] Professor Edward Acton of the University of East Anglia, commented: "it is vital that the tension between the Government's net migration target and its support for university-level recruitment is addressed."[339]

239. A possible solution, suggested by several witnesses, would be to follow the example of other countries in classifying migrants as either "temporary" or "permanent". The efforts of the Home Office, in tackling net migration, would then be concentrated on permanent migrants. According to a recent report by the Institute of Public Policy Research (IPPR), the UK's three most obvious competitors in the global market for overseas students—the United States, Australia and Canada—"measure student flows in a way that does not contribute to permanent net migration figures, even though they show up in net migration statistics".[340] Lord Henley, Minister of State for the Home Office, told the House of Lords, however, that it was "not appropriate to discount [overseas students] from net migration statistics" because they are consumers of public services". Furthermore, he warned, the Government would be accused of "fiddling the figures" if they were to follow this suggestion.[341] We strongly disagree with this assessment. Making a

334 House of Commons briefing note, *Immigration: Tier 4 (student visa) reforms*, June 2011.

335 *Op. cit., The migrant journey.*

336 Oxford Brookes University.

337 Q 298.

338 HoL Hansard, Col 1934, 30 April 2012.

339 Professor Edward Acton.

340 IPPR, *International students and net migration in the UK*, April 2012.

341 HoL Hansard, Col 1935, 30 April 2012.

distinction between temporary migration (which would include study at a sponsoring HEI) and other forms of migration would reconcile the contradictory policies emanating from BIS and the Home Office, and also send the right signal to the world that the UK welcomes the brightest and the best to the UK. Given the significant contribution that overseas students make to the economy and that the majority leave the UK following their studies and do not therefore contribute significantly to net migration, **we recommend that the Government make a distinction in the immigration statistics between HE students and other immigrants and uses only the latter category to calculate net migration for policy-making purposes.**

## Policy reforms and their compound effect on taught Masters provision

240. In addition to the consequences of the HE and immigration reforms which we have already described, the evidence we received suggests that there is a danger that they could have a compound impact on stand-alone Masters provision producing a "triple whammy" effect due to higher fees, a lack of student finance and a decline in overseas students choosing to study in the UK.

### *Higher fees and less public funding*

241. The Browne Review suggested that funding from HEFCE for stand-alone Masters should be reduced on a similar basis to undergraduate support. In January 2012, however, HEFCE agreed to provide an additional £39 million to maintain funding for these courses at levels prior to the HE reforms. For STEM subjects, other than medicine, this translated to around £1,500 got each student. [342] However, this is a "transitional"[343] arrangement and it is unclear what the funding arrangements for stand-alone Masters courses are going to be post 2013–14. Many Research Councils are also reducing or removing their provision for taught Masters provision.[344]

242. Several witnesses noted that neither the HE reforms nor the Browne Review had paid much attention to postgraduate provision, in particular to the funding of taught Masters.[345] Since fees for stand-alone Masters courses are unregulated,[346] there is a real danger that, if funding from HEFCE and others dries up, fees for STEM courses will be increased in line with undergraduate degrees. This could act as a deterrent for students already burdened with large undergraduate debt. Million+ told us that, as a result of funding cuts, "universities will have no option but to increase postgraduate fees with effect from 2012".[347] The Physiological Society warned:

> "if the costs are excessive then fewer students are likely to apply. The resulting reduced intake is quite likely to render the course uneconomic to run, leading either to its withdrawal or to an increase in the, at

342 The Government.

343 *Ibid.*

344 RCUK Supplementary evidence.

345 UK Deans of Sciences, Imperial College London, 1994 Group.

346 The Government.

347 Million+.

present, unregulated fees charged. Consequently there may be a serious loss of stand-alone Masters training provision."[348]

243. Professor Michael Farthing, Vice-Chancellor of the University of Sussex, said: "it could take years to re-establish Masters courses if they are wiped out by falling demand ... [because] the development time to re-establish those programme is years, not weeks or months".[349] This is of particular concern with regard to provision in those areas where skills are required to support economic growth in the UK and where the UK is lacking such skills (for example, in the geological sciences, environmental sciences, and toxicology) and many witnesses suggested that public funding should be provided in strategic areas.[350]

244. Oxford Brookes University said that, as a result of public funding cuts, "the UK tends only to run stand-alone Masters courses that are clearly instantly profitable".[351] A similar warning comes from IET which warned that "the new fees regime will discourage students from doing a Masters as to not to incur greater debt. Fees are putting off UK students now and the supply of researchers is already drying up".[352] Reduced provision in stand-alone Masters could have significant impact on employability skills and, in turn, on economic growth. The Institute of Physics, therefore, called for public funding to support Masters courses "in areas that are of national importance".[353]

*Lack of student finance for Masters courses*

245. The Browne Review stated that student finance provision for Masters courses "was not necessary as the private benefits to individuals would be sufficient to generate investment".[354] It is too early to say whether this will be the case following the HE reforms. However, some witnesses were concerned that the lack of student loans to finance Masters courses would further erode student numbers in Masters courses. This situation is in stark contrast to the availability of student loans for undergraduate courses that include an integrated Masters course. The Wilson Review recommended that "HEFCE should monitor 'postgraduate taught' enrolments and identify any barriers to enrolment that have been created by the new student loan system and advise the government of its conclusions".[355]

246. Fees for Masters courses will have to be paid in advance. Students will, therefore, have to rely on commercial loans or private wealth to finance their studies, which will restrict access to this type of postgraduate provision.[356] CaSE warned that, since undergraduate fees are rising to £9,000 a year, they "expect postgraduate fees to rise above that, given they are for higher

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348 The Physiological Society.

349 http://www.timeshighereducation.co.uk/story.asp?storycode=418203.

350 ABPI, University of Central Lancashire, British Computer Society, UK Deans of Sciences, Institute of Physics, Science Council, Geological Society, the Physiological Society, British Medical Association, University of Oxford, Royal Society of Chemistry.

351 Oxford Brookes University.

352 Institution of Engineering and Technology.

353 Institute of Physics.

354 HEFCE.

355 *Op. cit., A review of industry-university collaboration.*

356 CaSE.

qualifications. This will exacerbate the access problem if financial support is not introduced".[357]

247. The lack of finance available to students, and the higher fees payable from September 2012, will act as a further disincentive for UK domiciled students to study STEM Masters degrees. This will have a marked impact across the STEM industry but particularly to those employers which have to recruit UK—rather than foreign—nationals (such as defence and within Government more widely).[358]

248. At present, students can apply for professional career development loans. But, although subsidised by Government, their terms and repayment conditions are considered to be fairly onerous. Fewer than 2% of current Masters students fund their studies in this way.[359] As an alternative, it has been suggested that private finance schemes could be developed in a more targeted way to support some form of student loan to postgraduate students.[360] Other proposals include some form of government-backed income contingent loan scheme to some groups of postgraduate study;[361] making available postgraduate loans, to be repaid by the student once salaries exceeded £15,000;[362] and qualifying postgraduate level STEM as SIVS.[363]

249. We recommend that the Government extend the student loan scheme currently available to undergraduates to cover STEM Masters degrees and that payment starts when the graduate earns over £15,000 with a view to recovering the debt fully.

### *Conclusion*

250. **There is a potential compound effect of policy reforms on stand-alone Masters provision. The new higher fees regime combined with the lack of student finance is a threat to the number of UK domiciled students who decide to pursue postgraduate education. Added to which, immigration reforms are already having an impact on certain HEIs who may in turn reduce Masters provision significantly. Little is known of the effect that this "triple whammy" will have on postgraduate provision. By the time the effect is quantified and analysed, it may be too late to put remedial action in place. This reinforces the importance of our recommendation (in paragraph 107) to set up an expert group to consider the supply and demand for postgraduate provision.**

251. **The risks associated with the HE and immigration reforms are high and potentially costly. The anxieties expressed to us by employers, HEIs and professional bodies are real and we urge the Government to heed them.**

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357 *Ibid.*

358 Sygenta, University of Surrey.

359 Centre Forum, *Mastering postgraduate funding*, 2011.

360 Russell Group.

361 1994 Group.

362 *Op. cit.*, *Mastering postgraduate funding.*

363 1994 Group, Geological Society.

# CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

## Definition of STEM

252. We recommend that, given the importance that the Government attach to STEM skills in stimulating economic growth and the wider importance of a STEM-literate society, the Government should work together with HESA, the Research Councils, HEIs and professional bodies to formulate and apply a standard definition of STEM. The definition should derive from a statement of the competencies and skills that a STEM graduate should possess and the characteristics that a STEM course should contain, including direct STEM content. (paragraph 23) (**Recommendation 1**)

## The school and higher education interface, and maths

### *Maths study post-16*

253. The number of students taking maths post-16 is insufficient to meet the level of numeracy needed in our society, and the level at which it is taught often fails to meet the requirements for studying STEM subjects at undergraduate level. We share the view that all students should study some form of maths post-16, the particular area of maths depending on the needs of the student. For example, prospective engineering students would require mechanics as part of their post-16 maths, whereas prospective biology students would benefit from studying statistics. (paragraph 30)

254. We recommend that, as part of their National Curriculum review, the Government make studying maths in some form compulsory for all students post-16. We recommend also that maths to A2 level should be a requirement for students intending to study STEM subjects in HE. (paragraph 32) (**Recommendation 2**)

### *Maths A level course content and structure*

255. We support the Government's efforts to involve HEIs in setting the curriculum and we urge HEIs to engage fully and make every effort to smooth the transition from school to HE, particularly in maths. In order to inform this process, we urge that HEIs work together to establish where the skills gaps are and which areas of the maths syllabus are essential for STEM undergraduate study. We would expect this work to be completed by July 2014. (paragraph 39) (**Recommendation 3**)

256. We support the recommendation by the House of Commons Education Committee that there should be a single comprehensive national syllabus, accredited by Ofqual, to offset the risk that competing examination boards will tend to drive down standards. We would expect the national syllabus for maths to meet the needs of all students post-16 as per our conclusion and recommendation in paragraphs 30–32. The proposed national subject committees will be critical to the success of the new scheme. Should the scheme go ahead therefore, we would seek assurance that the HEIs would have a significant role within the committees and that the committees would be given the capacity to be fully effective in ensuring that standards, particularly at A2, are maintained. (paragraph 40)

257. The Education Committee recommended that the Government should pilot a national syllabus in one large entry subject as part of the forthcoming A level reforms. We would recommend that maths should be the subject of such a pilot. (paragraph 41) (**Recommendation 4**)

*Qualified teachers*

258. We recommend that the Government increase their efforts to boost specialist STEM teacher recruitment. The Government should assess which existing initiatives have yielded positive results and which have not worked, so that resources can be concentrated on those schemes that produce the best outcomes. (paragraph 43) (**Recommendation 5**)

*Careers advice and education*

259. We recommend that the Government should direct the new National Careers Service to ensure that appropriate advice is given to young people about the following: STEM subject choice at school and its possible consequences for future study and careers; the choices available within STEM subjects at HE level and beyond and the advantages of pursuing a STEM degree; and, relevant careers advice that highlights the jobs available to STEM graduates both within STEM and in other industries. In order to make STEM careers and subject choices more accessible to students, parents and teachers, we would encourage the Government to use new technologies by, for example, commissioning a STEM careers App. (paragraph 46) (**Recommendation 6**)

260. Schools should ensure that support for careers education through continuing professional development (CPD) is provided to those offering careers advice to students. (paragraph 47) (**Recommendation 7**)

*Higher education maths requirements at university entry*

261. The lack, or low level, of maths requirements for admission to HEIs, particularly for programmes in STEM subjects, acts as a disincentive for students to take maths and high level maths at A level. We urge HEIs to introduce more demanding maths requirements at entry for STEM courses. The proposed change should be introduced within a time frame that would allow current school pupils to adapt their subject choices at school to the new requirements. The benefits of this policy would be two-fold: it would send the right signal to young people of the importance of maths for their future career choices, therefore increasing the number of pupils studying maths at A level; and maths knowledge and skills at university entry are likely to improve. We further recommend that HEIs should work together to ensure that entry requirements for the same course are consistent across different HEIs. (paragraph 49) (**Recommendation 8**).

## Supply and demand in STEM higher education

*Lack of data on the supply and demand for STEM graduates and postgraduates*

262. The lack of reliable data on the supply and demand for STEM graduates and postgraduates makes it very difficult to assess whether there is a shortage of STEM graduates and postgraduates, and in which sectors. More needs to be done to identify areas of shortage so that remedial action can be taken and to

enable students to make informed choices about whether the courses they are considering will equip them with the skills needed by employers. (paragraph 72)

263. We recommend that the Government appoint a single body (or amalgamates the efforts of existing bodies such as HESA, UCAS, UKCES, CIHE, the Higher Education Careers Services Unit (HECSU) or the new National Centre for Universities and Business) to be a repository of relevant information currently collected by different agencies on the supply and demand for STEM graduates with a view to providing comprehensive, real time data analysis and a commentary with market intelligence of where STEM shortages exist, broken down by sector. This body should provide yearly updates to HEFCE, Government and other stakeholders on skills shortages so that remedial action could be taken to protect, or grow, those STEM areas which are needed to support economic growth and where market failure means that supply does not meet demand. All these data should be accessible to all stakeholders in order, amongst other things, to inform student choice. (paragraph 73) (**Recommendation 9**)

264. We recommend that this body should also be responsible for holding, monitoring and analysing data for postgraduate education, including the employment of qualifiers from postgraduate courses on an ongoing basis—disaggregated into PhD, research Masters and taught Masters, and by subject areas. (paragraph 74) (**Recommendation 10**)

265. We urge HEIs to contribute to the provision of data to this body by putting in place a robust, long-term tracking system for postgraduate provision and destination data. (paragraph 75)

*Supply and demand in undergraduate provision*

266. We recommend that the Government commission a study to find out the first destination of STEM graduates with a first degree (by degree class) as well as postgraduates. The study should also attempt to find out the reasons that lie behind students' career choices. This information would help to explain what makes STEM graduates and postgraduates choose non-STEM jobs and allow STEM employers to take action to attract the best and brightest into STEM careers, particularly research. (paragraph 83) (**Recommendation 11**)

267. Given the significant number of students choosing to study "softer" science courses, we recommend that HEFCE and HEIs collaborate in conducting a study into the career progression of students of new STEM courses (such as some sports science and forensic science courses) to enable those undertaking these courses to decide whether they are being equipped with the skills graduates need to succeed in the STEM job market. (paragraph 87) (**Recommendation 12**)

*The role of Government and HEFCE in ensuring supply of STEM graduates and postgraduates meets demand in terms of quantity*

268. It appears that SIVS policy has had a positive impact on STEM and the Government should therefore continue to support the initiative. There are concerns that the HE reforms may erode STEM provision in favour of cheaper subjects. The SIVS policy is an important tool to help counteract that. The new approach to SIVS proposed by HEFCE is to be welcomed in

that it will allow other subjects, such as computer science, to be offered support if they are deemed vulnerable. (paragraph 97)

269. We recommend that the body in charge of collecting and analysing data (see the recommendation in paragraph 73) should, by providing evidence and analysis to HEFCE and the Government, contribute to the process of establishing which subjects should be given SIVS status. (paragraph 98) (**Recommendation 13**)

270. While HEFCE has a legitimate role in determining which subjects are vulnerable and should be supported as part of the SIVS programme, we recommend that the Government should decide which subjects are strategic and should therefore be given SIVS status. The Government's decision could be included in the Secretary of State's annual letter to HEFCE. (paragraph 99) (**Recommendation 14**)

### *Demand and supply in postgraduate provision*

271. It is clear that STEM postgraduates are valued and in demand amongst employers, and that they play a significant role in driving innovation, undertaking research and development, and providing leadership and entrepreneurship. It appears to us that, although the Government recognise the central role that STEM plays in their strategy for growth, they fail to articulate how they intend to highlight to students the benefits of postgraduate study, to reduce the decline in STEM qualifiers in some STEM subjects, or to improve our understanding about the demand for postgraduates and the value they offer to the economy. They also fail to make clear what support they will give to postgraduate STEM provision in order to realise their vision. This is, in our view, a mistake. (paragraph 106)

272. We recommend that the Government set up an expert group to consider the supply and demand of STEM postgraduate provision in the UK and to identify weaknesses and areas of skills shortage. The Government, as the strategic leader, should agree the terms of reference of this group with a view to formulating a strategy for STEM postgraduate education in the UK which will underpin their strategies for growth. As part of the expert group, we urge employers to spell out their needs to Government and to identify skills shortages at STEM postgraduate level. (paragraph 107) (**Recommendation 15**)

## Quality, standards and benchmarks

### *Quality assurance*

273. The Government's response to the Higher Education White Paper consultation stated that they will "not at this stage be seeking to introduce changes to primary legislation" but they would move their reform agenda forward "primarily through non-legislative means". It is not clear to us, therefore, if Parliament will be given the opportunity to scrutinise the proposed changes to quality assurance and HEFCE's power. We recommend that the Government clarify in their response to this report what opportunity Parliament will be given to scrutinise further the proposed changes to quality assurance, as set out in the Higher Education White Paper. The Government should also set out a timetable for when the changes will take place and outline the form they will take. (paragraph 120) (**Recommendation 16**)

*The role of the QAA and the role of HEIs in driving up quality*

274. Given the skills gaps that exist in key areas across the graduate pool, the QAA has a long way to go in ensuring that industry is sufficiently involved in setting standards and benchmarks. We recommend that the QAA should do more to recruit employers, SMEs in particular, to engage with HEIs and take part in setting QAA standards and benchmark statements. The QAA should be in a position to report back on how it plans take this recommendation forward by July 2013. (paragraph 131) (**Recommendation 17**)

275. We further recommend that the remit of the QAA should be reviewed with a view to introducing a system to assure quality, standards and benchmarks in HEIs that is fit for purpose. This should include the development (and achievement) of objectives for the inclusion of employers in the setting of standards and benchmarks, and a yearly list of thematic problem areas, accompanied by an action plan, where consistent skills gaps occur. (paragraph 132) (**Recommendation 18**)

*Funding to develop the employability skills of postgraduates*

276. We recommend that the Research Councils monitor the impact of embedding Roberts' Money into the standard funding mechanisms. (paragraph 136) (**Recommendation 19**)

*Quality of teaching*

277. We considered whether the Government or HEFCE should play a greater role in improving the quality of teaching in HEIs. We concluded that they should not on the grounds that HEIs were primarily responsible for the quality of teaching. However, we look to HEFCE to take steps to ensure that the REF does not act as a disincentive to HEIs to promote quality in teaching. (paragraph 145)

278. We recommend that the number of lecturers that have received teacher training during the course of their careers should be set out in the Key Information Set (KIS), along with information about the training received, and we urge HEIs to offer an accredited course on teaching which all academic staff would be required to complete. (paragraph 146) (**Recommendation 20**)

279. Student assessment of staff performance and teaching quality should be applied across all HEIs. We recommend that HEIs should have a robust system in place for assessing the quality of teaching including an anonymised and standardised assessment by students. The anonymised results of such assessments should be published in the KIS at a departmental level. QAA should be charged with reviewing whether HEIs have appropriate systems in place to achieve this and that the assessment of teaching quality is fit for purpose. (paragraph 147) (**Recommendation 21**)

*The role of students in driving up quality of provision*

280. The KIS is a good starting point to help to ensure that students have the information they need to make an informed decision about their courses. However, the value of some of the information offered is not clear or sufficient to enable a student to make an informed choice about the quality of provision delivered by their course. The Government should ensure that the information provided in the KIS gives students the information they need

to make an informed choice about the quality of their course. We recommend that the KIS should contain more detailed information on destination data beyond six months, as well as career paths; other measures of quality (including teaching); and more information on outcomes (that is, the skills that students will acquire during their studies). A similar KIS should also be available to postgraduate students with equivalent information on postgraduate provision. (paragraph 159) (**Recommendation 22**)

*Increasing industry involvement to ensure that graduates leave HEIs with the right employability skills*

281. Given the limitations on the role that the QAA plays in sign-posting high quality provision, we believe that accreditation of courses by professional bodies would be a sensible way forward. Accreditation may not be possible for courses in areas where there are no professional bodies. However, for those that have professional bodies and do not already have an accreditation scheme, we would urge them to consider setting up such a scheme. (paragraph 170)

282. In our view, it would be overly burdensome for employers to kite-mark individually hundreds of courses in the UK. A better approach would be to involve industry through the accrediting bodies and for companies to state whether they supported the accreditation. Given the tension between accreditation and kite-marking, we invite the Government to explain the aim of kite-marking and what it is expected to achieve beyond that which accreditation by professional bodies already provides. (paragraph 175) (**Recommendation 23**)

283. We recommend that professional bodies, such as the Institute of Physics or the Institute of Mechanical Engineers, should make further efforts to provide accreditation of different STEM subject areas to ensure that students have confidence in the quality of their chosen course and that they will achieve high quality outcomes in terms of skills and knowledge. For those courses where there is less of a clear link with a profession, we recommend that the Science Council consider whether it would be possible to develop a broader system of accreditation to ensure that graduates have the core skill set required of a STEM graduate. We further recommend that the Government should provide support for such activities in the early stages of development until they are fully established. (paragraph 176) (**Recommendation 24**)

*Placements and internships for undergraduates and postgraduates*

284. We recommend that the Government, employers and HEIs find a way to incentivise employers, particularly SMEs, to offer more work placements, and encourage more students to take them up. (paragraph 186) (**Recommendation 25**)

285. In order to assist HEIs in engaging with employers and in securing placements for their undergraduate and postgraduate students, we further recommend that a central database should be established to post opportunities for placements for undergraduates and postgraduates. We recommend that the Government extend the remit of the Graduate Talent Pool service to include undergraduates and postgraduate placement opportunities. (paragraph 187) (**Recommendation 26**)

### *The role of the research councils and HEFCE in the quality assurance of postgraduate provision*

286. Based on the evidence we have received, we find it difficult to judge the processes used for the assessment of quality in postgraduate provision. Our impression is, however, that the quality of postgraduate provision is measured in an inconsistent way across funding bodies and warrants further scrutiny. (paragraph 192)

287. We recommend that the expert group established to look at postgraduate provision should examine how the quality of postgraduate teaching provision is assessed to ensure quality and consistency of approach across funding bodies, and consider how measures of quality of postgraduate education that go beyond research excellence might be developed. In particular, we would urge the Research Councils and other postgraduate funding bodies to expand the quality principles that underpin the DTC model to other types of postgraduate funding provision. (paragraph 193) (**Recommendation 27**)

### *Doctoral provision models*

288. We recommend that the Government encourage the Research Councils to preserve a variety of PhD delivery models to ensure that the UK's current breadth of expertise in science is maintained and that new areas of science are able to grow. We also recommend that the expert group set up to consider the supply and demand for STEM postgraduate provision considers whether the current provision of funding for doctoral study across funding bodies is sufficient to cover the breadth of excellent research across the UK. (paragraph 201) (**Recommendation 28**)

## Policy reforms

### *Higher education reforms*

289. The recent adjustments to the core and margin system may allay some of the concerns about the effect of the HE reforms on STEM provision. However, we invite the Government to explain in their reply to this report on what evidence this change of policy was based and the timescale in which it was implemented. (paragraph 208)

290. We recommend that HEFCE publish the quantitative evidence on which they base their funding model for public subsidies of STEM subjects with a view to reassuring stakeholders that these subsidies in conjunction with students' fees are sufficient to cover the cost of STEM provision. (paragraph 212)

291. It is too early to assess the impact of HE reforms on the sector. We recommend that the Government have particular regard to the effect of the reforms on STEM provision. We support the role that the Government have given to HEFCE to monitor unintended consequences and to intervene, as appropriate, to protect strategic or vulnerable provision that will not be supported by the market. However, we have some concern that HEFCE may not have sufficient funds to intervene should it be necessary and recommend that the Government ensures that HEFCE will have the necessary resources should these circumstances arise. (paragraph 216) (**Recommendation 29**)

*Immigration reforms*

292. We are concerned that changes to the immigration rules may reduce the number of overseas students coming to study to the UK and, therefore, the income that HEIs derive from these students to support other activities. This may result in a general reduction of provision of STEM courses that rely on this income to make them viable. (paragraph 227)

293. The Government have replaced the PSW route with more selective arrangements under Tier 2, notably making a job offer paying more than £20,000 a year a requirement for a visa. The UK Border Agency (UKBA) told us that the limit was set following guidance from the Migration Advisory Committee. It is not, however, clear if this guidance was intended specifically for graduates. We would ask the Migration Advisory Committee to reconsider its advice. We would further ask the Committee to monitor the impact of the changes on both the number of graduates who stay on to work in the UK and on the number who decide not to study here, due to the real or perceived barriers created by the closure of the PSW route. (paragraph 229) (**Recommendation 30**)

294. HE is a global market and the UK has to compete with other countries that are positioning themselves to attract international students. The perception that the UK does not welcome students may be having a detrimental effect on recruitment from some countries such as India. The UK must be seen to welcome the brightest and the best and the Government must increase their efforts to dispel perceptions that the UK does not welcome students. We recommend that the Government develop a strategy to send out a more positive message through the UKBA website, immigration agencies and the British Council. (paragraph 233) (**Recommendation 31**)

295. The lack of reliable statistical data is a concern because the Government are not able to identify problems with their visa system soon enough to put in place a mitigation plan. Data from HESA is more accurate but by the time it is published it is 18 months out of date. This problem is particularly acute for the HEIs that we spoke to who are reporting that the HE reforms are having a significant impact upon their recruitment of overseas students already. (paragraph 237)

296. We recommend that the Government working with HEIs, as a matter of urgency, make further efforts to co-ordinate data collection and ensure that data is shared between UKBA and HEIs. In addition, the Government should collect real-time data on the effects of changes to immigration policies in HEIs with a view to setting up a mitigation plan, if necessary, and to enable policy decisions to be based on the latest information. This should be achieved by September 2014. (paragraph 238) (**Recommendation 32**)

297. Given the significant contribution that overseas students make to the economy and that the majority leave the UK following their studies and do not therefore contribute significantly to net migration, we recommend, therefore, that the Government make a distinction in the immigration statistics between HE students and other immigrants and uses only the latter category to calculate net migration for policy-making purposes. (paragraph 241) (**Recommendation 33**)

*Policy reforms and their compound effect on taught Masters provision*

298. There is a potential compound effect of policy reforms on stand-alone Masters provision. The new higher fees regime combined with the lack of student finance is a threat to the number of UK domicile students who decide to pursue postgraduate education. Added to which, immigration reforms are already having an impact on certain HEIs who may in turn reduce Masters provision significantly. Little is known of the effect that this "triple whammy" will have on postgraduate provision. By the time the effect is quantified and analysed, it may be too late to put remedial action in place. This reinforces the importance of our recommendation (in paragraph 107) to set up an expert group to consider the supply and demand for postgraduate provision. (paragraph 252)

299. The risks associated with the HE and immigration reforms are high and potentially costly. The anxieties expressed to us by employers, HEIs and professional bodies are real and we urge the Government to heed them. (paragraph 253)

## APPENDIX 1: MEMBERS AND DECLARATIONS OF INTERESTS

### Members:

Lord Broers
Lord Cunningham of Felling
Baroness Hilton of Eggardon
Lord Krebs
† Lord Lucas
† Baroness Neuberger
Lord Patel
Baroness Perry of Southwark
Lord Rees of Ludlow
Lord Willis of Knaresborough (Chairman)
Lord Winston

† Co-opted Members

### Declared Interests

Lord Broers
*Past Vice-Chancellor, University of Cambridge*
*Chairman, University of Cambridge Engineering Department, International Visiting Committee*
*Fellow, Royal Society*
*Fellow, Royal Academy of Engineering*

Lord Cunningham of Felling
*None*

Baroness Hilton of Eggardon
*None*

Lord Krebs
*Principal, Jesus College Oxford*
*Fellow, Royal Society*
*Former CEO, NERC*
*Trustee, Nuffield Foundation*

Lord Lucas
*Editor, 'The Good Schools Guide'*
*Founder, Behind the Screen a STEM project in schools*

Baroness Neuberger
*Former Chancellor, University of Ulster (1994–2000)*

Lord Patel
*Chancellor, University of Dundee*
*Member of Council, Medical Research Council*
*Fellow, Royal Society Edinburgh*

Baroness Perry of Southwark
*Former Vice-Chancellor, London Southbank University*
*Former President, Lucy Cavendish College, University of Cambridge*
*Former Pro-Chancellor, University of Surrey*
*Former Chair of Council, University of Roehampton*

Lord Rees of Ludlow
*Master, Trinity College, University of Cambridge*
*Fellow, Royal Society*

*Member, other scientific societies*

Lord Willis of Knaresborough

*Board Member, NERC*

Lord Winston

*Professor, Imperial College*
*Director, Reach Out Laboratory, Imperial College*
*Member, Royal Society inquiry in STEM education*
*Member, EPSRC*
*Council Member, University of Surrey*
*Chancellor, Sheffield Hallam University*
*Director, Atazoa Ltd; University Spin-out Company*
*Continuing Education Advisory Committee, Oxford University*
*FREng, FCGI*

A full list of Members' interests can be found in the Register of Lords Interests: http://www.publications.parliament.uk/pa/ld/ldreg.htm

Professor Sir William Wakeham, Specialist Adviser

*Non-executive Director, Ilika plc*
*Chairman, Exeter Science Park Company*
*Scientific Advisory Board of American Process Incorporated*
*Emeritus Professor, University of Southampton*
*Visiting Professor, Imperial College London*
*Visiting Professor, Exeter University*
*Visiting Professor, Insituto Superior Tecnico, Lisboa, Portugal*
*Council Member, Universidade Nova de Lisboa, Portugal*
*Chair, South East England Physics Network*
*International Secretary, Senior Vice-President, Royal Academy of Engineering*
*President and Fellow, Institution of Chemical Engineers*
*Fellow, Institute of Physics*
*Fellow, Institution of Engineering and Technology*
*Trustee, Royal Anniversary Trust*
*Trustee, Rank Prizes*

## APPENDIX 2: LIST OF WITNESSES

Evidence is published online at www.parliament.uk/hlscience and available for inspection at the Parliamentary Archives (020 7219 5314)

Evidence received by the Committee is listed below in chronological order of oral evidence session and in alphabetical order. Those witnesses marked with * gave both oral evidence and written evidence. Those marked with ** gave oral evidence and did not submit any written evidence. All other witnesses submitted written evidence only.

### Oral evidence in chronological order

| | | |
|---|---|---|
| * | QQ 1–39 | Sir Adrian Smith, Director-General of Knowledge and Innovation, Department for Business, Innovation and Skills (BIS) |
| * | | David Russell, Director, Curriculum and Behaviour Group, Department for Education |
| ** | QQ 40–67 | Dr David Grant, Vice-Chancellor, Cardiff University |
| ** | | Professor Malcolm Grant, Vice-Chancellor, University College London (UCL) |
| ** | | Professor Les Ebdon, Vice-Chancellor, University of Bedford |
| * | | Professor Sir Leszek Borysiewicz, Vice-Chancellor, University of Cambridge |
| * | | Dr Malcolm McVicar, Vice-Chancellor, University of Central Lancashire |
| * | | Professor Dame Julia Goodfellow, Vice-Chancellor, University of Kent |
| * | | Professor Martin Hall, Vice-Chancellor, University of Salford |
| * | | Professor Sir Christopher Snowden, Vice-Chancellor, University of Surrey |
| * | | Professor Brian Cantor, Vice-Chancellor, University of York |
| * | QQ 68–92 | Research Councils UK (RCUK) |
| * | QQ 93–119 | Higher Education Funding Council for England (HEFCE) |
| * | QQ 120–145 | GlaxoSmithKline |
| ** | | Microsoft Ltd |
| * | | Rolls-Royce |
| ** | | Siemens |
| ** | QQ 146–166 | Expedition Engineering |
| * | | LGC |
| * | | Vectura |

| | | |
|---|---|---|
| * | QQ 167–215 | Higher Education Academy |
| * | | Quality Assurance Agency (QAA) |
| * | | Vitae |
| * | QQ 216–245 | Dr Caroline Sudworth, Higher Education Manager, Cogent |
| * | | Engineering Council |
| * | | Institution of Chemical Engineers |
| * | | Society of Biology |
| ** | QQ 246–280 | Professor Stephen Caddick, Vice-Provost (Engineering), University College London (UCL) |
| ** | | Professor Chris Rudd, Professor of Mechanical Engineering and Pro-Vice Chancellor for Knowledge Transfer, University of Nottingham |
| * | | Dr Phil Clare, Associate Director, Research Services and Head of Knowledge Exchange, University of Oxford |
| * | QQ 281–312 | Home Office |
| * | | University of Manchester |
| * | | University of Southampton |
| ** | QQ 313–347 | Will Evans, 3rd year biochemistry student at Imperial College London |
| ** | | Fabio Fiorelli, 4th year MEng chemical engineering student at University College London (UCL) |
| ** | | Adam Hawken, 4th year PhD student at University College London (UCL) |
| ** | | Amran Hussain, biomedical sciences graduate of Durham University and Quality Co-ordinator at Imperial College Healthcare NHS Trust |
| ** | | Jennifer Newman, 4th year building services engineering student at London South Bank University |
| ** | QQ 348–365 | Dr Elizabeth Wasey, Safety Assessment Engineer, EDF Energy Nuclear Generation |
| ** | | Eva MacNamara, Engineer, Expedition Engineering |
| ** | | Dr Simona Parrinello, Group Head at the MRC Clinical Sciences Centre |
| ** | | Dr Gustav Teleberg, Cryogenic Engineer, Oxford Instruments |
| ** | | Dr Sukhbir Kaur, Trainee Healthcare Scientist, Clinical Chemistry, Sandwell and West Birmingham Hospitals NHS Trust |
| * | QQ 366–390 | Damian Green MP, Minister of State for Immigration, Home Office |

| | | |
|---|---|---|
| * | | Carolyn Bartlett, Student Migration Policy Team, Home Office |
| * | QQ 391–433 | David Willetts MP, Minister of State for Universities and Science, Department for Business, Innovation and Skills (BIS) |
| ** | QQ 434–468 | Professor Clifford Friend, Deputy Vice-Chancellor, Cranfield University |
| * | | Professor Andrew George, Professor of Molecular Immunology and Director of the Graduate School and the School of Professional Development, Imperial College London |
| ** | | Professor David Bogle, Professor of Chemical Engineering and Head of University College London Graduate School (UCL) |

## Alphabetical list of all witnesses

1994 Group

Academy of Medical Sciences (AMS)

Professor Edward Acton, University of East Anglia

Association of British Pharmaceutical Industry (ABPI)

Aston University

British Academy

British Computer Society (the Chartered Institute for IT)

British Geological Survey

British Medical Association (BMA)

Professor Harry Bryden, The Challenger Society for Marine Science

Cambridge Assessment

Campaign for Science and Engineering in the UK (CaSE)

Cancer Research UK

* Cardiff University

Careers Research & Advisory Centre (CRAC)

City and Islington College

* Cogent

Committee of Heads of University Geosciences Departments

Confederation of British Industry (CBI)

Council for the Mathematical Sciences

Council of Professors and Heads of Computing (CPHC)

** Cranfield University

Professor Peter Dobson, University of Oxford

** EDF Energy Nuclear Generation

Education for Engineering (E4E)
Education Foundation
* Engineering Council
Engineering Development Trust (EDT)
Engineering Professors' Council
Engineering UK
Equality Challenge Unit
** Will Evans, Imperial College London
** Expedition Engineering
Expert Group for Women in STEM
** Fabio Fiorelli, University College London (UCL)
Geological Society
* GlaxoSmithKline
* Government
** Adam Hawken, University College London (UCL)
Headmasters' and Headmistresses' Conference (HMC)
Heads of Departments of Mathematical Sciences (HoDoMS)
* Higher Education Academy
* Higher Education Funding Council for England (HEFCE)
Professor Sir John Holman, University of York
** Amran Hussain, Imperial College Healthcare NHS Trust
* Imperial College London
Imperial College Union
Institute of Education (IoE)
Institute of Physics (IoP)
* Institution of Chemical Engineers (IChemE)
Institution of Engineering and Technology (IET)
Joint Council for Qualifications (JCQ)
* LGC Limited
Professor Averil Macdonald, University of Reading
Professor John MacInnes, University of Edinburgh
Medical Schools Council
** Microsoft Ltd
Million+
** Medical Research Council Clinical Sciences Centre
MyScience
National Higher Education STEM Programme

New Engineering Foundation (NEF)
** Jennifer Newman, London South Bank University
Office fir Standards in Education (Ofsted)
Open Engineering Solutions
Open University
Oxford Brookes University
** Oxford Instruments
Pearson Centre for Policy and Learning
The Physiological Society
* Quality Assurance Agency (QAA)
Queen Mary, University of London
* Research Councils UK (RCUK)
* Rolls-Royce
Royal Academy of Engineering
Royal Astronomical Society
Royal Geographical Society
The Royal Society
Royal Society of Chemistry (RSC)
Russell Group
Lord Sainsbury of Turville
** Sandwell and West Birmingham Hospitals NHS Trust
The Science Council
Scottish Qualifications Authority
Semta
** Siemens
Professor Michael Singer, University of Edinburgh
Cathy Smith, Institute of Education
* Society of Biology
Society of Motor Manufacturers and Traders (SMMT)
South East Physics Network (SEPnet)
South Eastern Regional College
Syngenta
Training and Development Agency for Schools (TDA)
Universities and Colleges Admission Service (UCAS)
UK Computing Research Committee (UKCRC)
UK Deans of Science
UKRC

Universities UK
University Alliance
** University College London (UCL)
** University of Bedfordshire
University of Bristol
* University of Cambridge
University of Cambridge Careers Service
* University of Central Lancashire
University of Greenwich
* University of Kent
* University of Manchester
** University of Nottingham
* University of Oxford
* University of Salford
* University of Southampton
* University of Surrey
University of Warwick
* University of York
* Vectura
* Vitae
Wellcome Trust

## APPENDIX 3: CALL FOR EVIDENCE

The House of Lords Science and Technology Sub-Committee I, under the chairmanship of Lord Willis of Knaresborough, are conducting an inquiry into higher education in STEM subjects (science, technology, engineering and mathematics).

### Scope

A healthy science base and a supply of suitably trained STEM graduates are vital for our economy to enable the UK to do well as a nation. STEM graduates are required both to allow the country to address scientific problems such as climate change and responding to global pandemics, and also to provide high level numeracy and quantitative skills for industries such as the financial services and the civil service. A very wide range of business groups and government view the supply of STEM graduates as a key part of economic growth and UK competitiveness.

Nevertheless, university recruitment to some STEM subject areas continues to prove a major challenge, so much so that most STEM subjects are identified as "strategically important and vulnerable subjects". Industry continues to report shortages of STEM graduates in some areas and yet at the same time a substantial proportion of STEM graduates end up working in jobs that do not require a STEM degree. The focus of this inquiry is to explore the reasons for this mismatch and how to ensure that the UK is producing a sufficient supply of STEM graduates to meet all its needs. The deadline for written evidence submissions is **Friday, 16 December 2011**.

### Questions:

The Committee invite submissions on the following points and also on the combined effect that these issues have or will have on the provision of higher education in STEM subjects:

*General questions*

- What is the definition of a STEM subject, and a STEM job?
- Do we understand demand for STEM graduates and how this could be used to influence supply?

*16–18 supply*

- Are schools and colleges supplying the right numbers of STEM students and do they have the right skills to study STEM first degrees?
- What have been the effects of earlier government initiatives on the uptake of STEM subjects at advanced level?
- What effect, if any, will the English Baccalaureate have on the study of STEM subjects in higher education?

*Graduate supply*

- Is the current number of STEM students and graduates (from the UK, EU and overseas) sufficient to meet the needs of industry, the research base, and other sectors not directly connected with STEM?
- Is the quality of STEM graduates emerging from higher education sufficiently high, and if not ,why not?
- Do STEM graduates have the right skills for their next career move, be it research, industry or more broadly within the economy?
- What effect will higher education reforms have on the quality of teaching, the quality of degrees and the supply of STEM courses in higher education institutions?
- What effect does "research assessment" have upon the ability to develop new and cross-disciplinary STEM degrees?
- What is the relationship between teaching and research? Is it necessary for all universities to teach undergraduates and post graduates and conduct research? What other delivery model should be considered?
- Does the UK have a sufficient geographical spread of higher education institutions offering STEM courses?
- What is being done and what ought to be done to increase the diversity of STEM graduates in terms of gender, ethnic origin and socio-economic background?

*Post-graduate supply*

- Is the current training of PhD students sensitive to the range of careers they subsequently undertake?
- Are we currently supporting the right number of PhD studentships to maintain the research base and are they of sufficient quality?
- What impact have Doctoral Training Centres had on the quality and number of PhD students? Are there alternative delivery models?
- Should state funding be used to promote Masters degrees and is the balance right between the number of Masters degree students and PhD students?
- What impact will higher education reforms have on the willingness of graduates to pursue a research career?

*Industry*

- What incentives should industry offer to STEM graduates in order to attract them?
- What steps are industry and universities taking together to ensure that demand for STEM graduates matches supply in terms of numbers, skills and quality of graduates?

*International comparisons*

- What lessons can be learnt from the provision of higher education in STEM subjects in other countries? Which countries provide the most helpful examples of best practice?

## APPENDIX 4: SEMINAR HELD AT THE HOUSE OF LORDS

### 29 November 2011

Members of the Sub-Committee present were Lord Broers, Baroness Hilton of Eggardon, Lord Krebs, Lord Lucas, Baroness Neuberger, Baroness Perry of Southwark, Lord Rees of Ludlow, Lord Willis of Knaresborough (Chairman) and Lord Winston.

Presentations were heard from:

- Professor Sir William Wakeham (Visiting Professor at Imperial College London and the University of Exeter, Senior Vice-President and International Secretary of the Royal Academy of Engineering): Introductions to the higher education in STEM subjects landscape.
- (1) Dr Stephen Axford (Head of Science and Society, BIS) and (2) Christopher Millward (Associate Director and Skills Policy, HEFCE): The BIS view of higher education in STEM subjects and sources of income in higher education institutions.
- Peter Bedford (Group SVP and Head of Talent, ABB): Industry's perspective.

Professor David Maguire (Vice-Chancellor of the University of Greenwich): Vice-Chancellor's perspective.

## APPENDIX 5: ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ABPI | Association of the British Pharmaceutical Industry |
| ACME | Advisory Committee on Mathematics Education |
| AMS | Academy of Medical Sciences |
| BCS | British Computer Society |
| BIS | Department for Business, Innovation and Skills |
| CaSE | Campaign or Science and Engineering |
| CASE | Collaborative Awards in Science and Engineering |
| CBI | Confederation of British Industry |
| CIHE | Council for Industry and Higher Education |
| CPD | Continuing Professional Development |
| CRAC | Careers Research and Advisory Centre |
| DTC | Doctoral Training Centre |
| EEA | European Economic Area |
| EPSRC | Engineering and Physical Sciences Research Council |
| ESRC | Economic and Social Research Council |
| EU | European Union |
| FCO | Foreign and Commonwealth Office |
| FHEQ | Framework for Higher Education Qualifications |
| GCSE | General Certificate of Secondary Education |
| GSK | GlaxoSmithKline |
| HE | Higher Education |
| HEA | Higher Education Academy |
| HECSU | Higher Education Careers Services Unit |
| HEFCE | Higher Education Funding Council for England |
| HESA | Higher Education Statistics Agency |
| HEI | Higher Education Institution |
| HMC | Headmasters' and Headmistress' Conference |
| HO | Home Office |
| IET | Institution of Engineering and Technology |
| IPPR | Institution for Public Policy Research |
| IUSS | Innovation, Universities, Science and Skills |
| JACS | Joint Academic Coding System |
| KIS | Key Information Set |
| NSS | National Student Survey |
| NUS | National Union of Students |

| | |
|---|---|
| OECD | Organisation for Economic Co-operation and Development |
| OFFA | Office for Fair Access |
| OFSTED | Office for Standards in Education, Children's Services and Skills |
| OIA | Office of the Independent Adjudicator |
| PSW | Post Study Work |
| QAA | Quality Assurance Agency |
| QCDA | Qualifications and Curriculum Development Agency |
| RAE | Research Assessment Exercise |
| REF | Research Excellence Framework |
| RCS | Royal Society of Chemistry |
| RCUK | Research Council UK |
| SEPNet | South East Physics Network |
| SIVS | Strategically Important and Vulnerable Subjects |
| SME | Small and Medium Enterprise |
| SSC | Sector Skills Council |
| STA | Standards and Testing Agency |
| STEM | Science, Technology, Engineering and Mathematics |
| UCAS | Universities and Colleges Admissions Service |
| UG | Undergraduate |
| UKBA | UK Border Agency |
| UKCES | UK Commission for Employment and Skills |
| UKCISA | UK Council for International Student Affairs |
| UK | United Kingdom |
| UN | United Nations |

## APPENDIX 6: HIGHER EDUCATION STATISTICS AGENCY DATA (HESA)

**First Degree Qualifiers from UK HEIs, excluding the Open University**[(1)]

| Subject of Study | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008/09 | 2009/10 | % change 02/03 to 09/10 | % change 08/09 to 09/10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Medicine and Dentistry | 6,175 | 7,005 | 7,445 | 7,700 | 8,260 | 8,470 | 9,100 | 9,335 | 51% | 3% |
| Subjects allied to medicine | 23,665 | 24,705 | 27,865 | 29,775 | 30,460 | 32,505 | 31,390 | 33,025 | 40% | 5% |
| Biological Sciences | 23,725 | 24,925 | 26,375 | 26,975 | 28,135 | 30,285 | 30,185 | 31,440 | 33% | 4% |
| (C1) Biology | 4,430 | 4,480 | 4,580 | 4,445 | 4,670 | 4,680 | 4,625 | 4,685 | 6% | 1% |
| (C6) Sports Science | 3,745 | 4,975 | 5,630 | 6,210 | 6,325 | 7,495 | 7,855 | 8,370 | 123% | 7% |
| (C8) Psychology | 8,900 | 9,680 | 10,615 | 11,345 | 11,655 | 12,615 | 12,175 | 12,650 | 42% | 4% |
| Veterinary Science | 560 | 660 | 690 | 680 | 645 | 740 | 810 | 780 | 39% | -4% |
| Agriculture and related subjects | 2,150 | 2,415 | 2,225 | 2,140 | 2,185 | 2,295 | 2,185 | 2,260 | 5% | 3% |
| Physical Sciences | 12,475 | 11,980 | 12,200 | 12,530 | 12,270 | 12,855 | 13,225 | 13,490 | 8% | 2% |
| (F1) Chemistry | 2,955 | 2,735 | 2,705 | 2,520 | 2,665 | 2,825 | 2,930 | 3,100 | 5% | 6% |
| (F3) Physics | 2,205 | 2,180 | 2,225 | 2,345 | 2,255 | 2,255 | 2,490 | 2,575 | 17% | 3% |
| (F4) Forensic and Archaeological Science | 385 | 520 | 745 | 1,195 | 1,445 | 1,640 | 1,710 | 1,710 | 344% | 0% |
| Mathematical Sciences | 5,100 | 5,150 | 4,990 | 5,260 | 5,385 | 5,560 | 5,840 | 6,305 | 24% | 8% |
| Computer Science | 18,240 | 20,010 | 19,775 | 18,495 | 16,255 | 14,735 | 13,860 | 14,090 | -23% | 2% |
| Engineering and Technology | 19,455 | 19,585 | 19,340 | 19,535 | 19,495 | 20,150 | 20,540 | 21,670 | 11% | 6% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engineering | 17,520 | 17,560 | 17,300 | 17,345 | 17,120 | 17,595 | 17,950 | 18,910 | 8% | 5% |
| Technology | 1,940 | 2,030 | 2,040 | 2,190 | 2,380 | 2,560 | 2,590 | 2,760 | 42% | 7% |
| Architecture, Building and Planning | 6,555 | 6,735 | 6,565 | 7,365 | 7,615 | 8,655 | 8,905 | 10,385 | 58% | 17% |
| TOTAL STEM | 118,105 | 123,165 | 127,475 | 130,450 | 130,705 | 136,260 | 136,035 | 142,785 | 21% | 5% |
| TOTAL NON-STEM | 156,340 | 161,825 | 169,540 | 175,460 | 179,960 | 189,850 | 189,160 | 199,060 | 27% | 5% |
| TOTAL | 274,445 | 284,990 | 297,015 | 305,910 | 310,665 | 326,110 | 325,195 | 341,845 | 25% | 5% |
| % ‘science’ | 43% | 43% | 43% | 43% | 42% | 42% | 42% | 42% | | |

Source: Higher Education Statistics Agency (HESA).

Notes: Figures are based on a qualifications obtained population and have been rounded to the nearest five.

(1) Figures exclude entrants from the Open University due to inconsistencies in their method of recording subject of study over the time period.

**UK Domiciled First Degree Qualifiers from UK HEIs, excluding the Open University**[(1)]

| Subject of Study | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008/09 | 2009/10 | % change 02/03 to 09/10 | % change 08/09 to 09/10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Medicine and Dentistry | 5,620 | 6,445 | 6,780 | 7,005 | 7,500 | 7,730 | 8,275 | 8,460 | 51% | 2% |
| Subjects allied to medicine | 22,355 | 23,485 | 26,360 | 27,885 | 28,500 | 30,565 | 29,140 | 30,615 | 37% | 5% |
| Biological Sciences | 22,270 | 23,425 | 24,945 | 25,310 | 26,240 | 28,200 | 28,010 | 29,010 | 30% | 4% |
| (C1) Biology | 4,155 | 4,230 | 4,335 | 4,135 | 4,345 | 4,335 | 4,215 | 4,275 | 3% | 1% |
| (C6) Sports Science | 3,650 | 4,860 | 5,520 | 6,055 | 6,150 | 7,305 | 7,645 | 8,120 | 122% | 6% |
| (C8) Psychology | 8,325 | 9,075 | 10,075 | 10,710 | 10,950 | 11,775 | 11,325 | 11,655 | 40% | 3% |
| Veterinary Science | 505 | 605 | 635 | 635 | 595 | 680 | 740 | 670 | 33% | -9% |
| Agriculture and related subjects | 1,950 | 2,235 | 2,075 | 1,970 | 2,000 | 2,065 | 1,935 | 2,020 | 4% | 4% |
| Physical Sciences | 11,770 | 11,240 | 11,455 | 11,670 | 11,440 | 11,915 | 12,280 | 12,380 | 5% | 1% |
| (F1) Chemistry | 2,760 | 2,550 | 2,525 | 2,325 | 2,420 | 2,525 | 2,655 | 2,750 | 0% | 4% |
| (F3) Physics | 2,055 | 1,995 | 2,075 | 2,145 | 2,055 | 2,005 | 2,210 | 2,290 | 11% | 4% |
| (F4) Forensic and Archaeological Science | 360 | 500 | 720 | 1,135 | 1,385 | 1,560 | 1,655 | 1,615 | 349% | -2% |
| Mathematical Sciences | 4,670 | 4,665 | 4,400 | 4,440 | 4,550 | 4,610 | 4,875 | 5,175 | 11% | 6% |
| Computer Science | 15,645 | 16,930 | 16,620 | 15,515 | 13,585 | 12,435 | 11,570 | 11,410 | -27% | -1% |
| Engineering and Technology | 14,050 | 14,445 | 14,065 | 13,655 | 13,750 | 13,900 | 14,055 | 14,350 | 2% | 2% |
| Engineering | 12,465 | 12,720 | 12,340 | 11,780 | 11,690 | 11,760 | 11,880 | 12,080 | -3% | 2% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 1,585 | 1,730 | 1,725 | 1,875 | 2,060 | 2,140 | 2,175 | 2,270 | 43% | 4% |
| Architecture, Building and Planning | 5,430 | 5,620 | 5,315 | 6,155 | 6,460 | 7,400 | 7,660 | 8,880 | 64% | 16% |
| TOTAL STEM | 104,260 | 109,095 | 112,640 | 114,240 | 114,620 | 119,500 | 118,535 | 122,970 | 18% | 4% |
| TOTAL NON-STEM | 138,145 | 142,380 | 148,195 | 151,565 | 154,685 | 163,245 | 160,645 | 167,050 | 21% | 4% |
| TOTAL | 242,405 | 251,480 | 260,835 | 265,805 | 269,305 | 282,745 | 279,180 | 290,015 | 20% | 4% |
| % ‘science’ | 43% | 43% | 43% | 43% | 43% | 42% | 42% | 42% | | |

Source: Higher Education Statistics Agency (HESA).

Notes: Figures are based on a qualifications obtained population and have been rounded to the nearest five.

(1) Figures exclude entrants from the Open University due to inconsistencies in their method of recording subject of study over the time period.

**Masters Degree Qualifiers from UK HEIs, excluding the Open University**[1]

| Subject of Study | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008/09 | 2009/10 | % change 02/03 to 09/10 | % change 08/09 to 09/10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Medicine and Dentistry | 1,525 | 1,855 | 2,015 | 2,255 | 2,350 | 2,415 | 2,535 | 2,775 | 82% | 9% |
| Subjects allied to medicine | 3,215 | 3,910 | 4,095 | 4,430 | 4,930 | 5,575 | 6,230 | 6,425 | 100% | 3% |
| Biological Sciences | 3,880 | 4,515 | 4,810 | 5,485 | 5,595 | 5,660 | 6,200 | 6,725 | 73% | 8% |
| Biology | 580 | 545 | 640 | 760 | 750 | 950 | 1,005 | 1,135 | 96% | 13% |
| Sports Science | 230 | 285 | 365 | 445 | 445 | 455 | 620 | 660 | 187% | 6% |
| Psychology | 1,990 | 2,305 | 2,370 | 2,855 | 2,780 | 2,825 | 3,045 | 3,285 | 65% | 8% |
| Veterinary Science | 55 | 45 | 75 | 75 | 80 | 80 | 90 | 80 | 45% | -11% |
| Agriculture and related subjects | 785 | 900 | 895 | 910 | 870 | 815 | 960 | 915 | 17% | -5% |
| Physical Sciences | 2,765 | 3,310 | 3,370 | 3,510 | 3,540 | 3,790 | 3,695 | 4,155 | 50% | 12% |
| Chemistry | 375 | 450 | 430 | 395 | 410 | 475 | 455 | 515 | 37% | 13% |
| Physics | 290 | 305 | 335 | 335 | 340 | 400 | 370 | 460 | 59% | 24% |
| Forensic and Archaeological Science | 295 | 350 | 440 | 575 | 595 | 535 | 555 | 570 | 93% | 3% |
| Mathematical Sciences | 760 | 975 | 1,265 | 1,120 | 1,200 | 1,230 | 1,285 | 1,310 | 72% | 2% |
| Computer Science | 6,490 | 6,365 | 6,790 | 6,485 | 6,145 | 6,590 | 6,015 | 7,625 | 17% | 27% |
| Engineering and Technology | 6,270 | 7,635 | 8,960 | 9,375 | 9,215 | 9,890 | 9,920 | 12,250 | 95% | 23% |
| Engineering | 5,435 | 6,835 | 8,145 | 8,555 | 8,430 | 8,870 | 8,870 | 11,125 | 105% | 25% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 830 | 800 | 810 | 825 | 790 | 1,015 | 1,045 | 1,125 | 36% | 8% |
| Architecture, Building and Planning | 1,850 | 2,225 | 2,630 | 3,290 | 3,305 | 3,905 | 4,220 | 5,060 | 174% | 20% |
| TOTAL STEM | 27,590 | 31,740 | 34,900 | 36,935 | 37,235 | 39,955 | 41,145 | 47,320 | 72% | 15% |
| TOTAL NON-STEM | 52,930 | 61,610 | 65,885 | 69,270 | 71,375 | 76,775 | 80,130 | 89,850 | 70% | 12% |
| TOTAL | 80,520 | 93,350 | 100,790 | 106,200 | 108,610 | 116,730 | 121,275 | 137,170 | 70% | 13% |
| % STEM | 34% | 34% | 35% | 35% | 34% | 34% | 34% | 34% | | |

Source: Higher Education Statistics Agency (HESA).

Notes: Figures are based on a qualifications obtained population and have been rounded to the nearest five.

(1) Figures exclude entrants from the Open University due to inconsistencies in their method of recording subject of study over the time period.

**UK Domiciled Masters Degree Qualifiers from UK HEIs, excluding the Open University**[1]

| Subject of Study | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008/09 | 2009/10 | % change 02/03 to 09/10 | % change 08/09 to 09/10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Medicine and Dentistry | 1,020 | 1,175 | 1,200 | 1,355 | 1,415 | 1,375 | 1,555 | 1,550 | 52% | 0% |
| Subjects allied to medicine | 2,500 | 2,900 | 3,005 | 3,250 | 3,575 | 3,805 | 4,200 | 4,005 | 60% | -5% |
| Biological Sciences | 2,830 | 3,130 | 3,245 | 3,715 | 3,855 | 3,750 | 4,070 | 4,260 | 51% | 5% |
| Biology | 435 | 385 | 420 | 500 | 470 | 610 | 630 | 635 | 46% | 1% |
| Sports Science | 180 | 255 | 290 | 355 | 320 | 350 | 480 | 490 | 172% | 2% |
| Psychology | 1,555 | 1,700 | 1,785 | 2,150 | 2,140 | 2,095 | 2,205 | 2,400 | 54% | 9% |
| Veterinary Science | 25 | 25 | 55 | 45 | 50 | 55 | 70 | 50 | 100% | -29% |
| Agriculture and related subjects | 435 | 445 | 450 | 415 | 425 | 385 | 415 | 410 | -6% | -1% |
| Physical Sciences | 1,845 | 2,140 | 2,140 | 2,105 | 2,155 | 2,180 | 2,070 | 2,270 | 23% | 10% |
| Chemistry | 250 | 270 | 245 | 210 | 215 | 200 | 190 | 220 | -12% | 16% |
| Physics | 185 | 205 | 215 | 200 | 215 | 235 | 215 | 265 | 43% | 23% |
| Forensic and Archaeological Science | 175 | 225 | 270 | 360 | 405 | 310 | 315 | 340 | 94% | 8% |
| Mathematical Sciences | 460 | 505 | 585 | 485 | 520 | 465 | 470 | 470 | 2% | 0% |
| Computer Science | 3,615 | 3,000 | 2,710 | 2,405 | 2,145 | 2,085 | 1,885 | 1,975 | -45% | 5% |
| Engineering and Technology | 2,395 | 2,430 | 2,635 | 2,605 | 2,480 | 2,610 | 2,720 | 3,035 | 27% | 12% |
| Engineering | 1,920 | 2,045 | 2,285 | 2,240 | 2,220 | 2,285 | 2,375 | 2,635 | 37% | 11% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 480 | 385 | 355 | 365 | 260 | 330 | 345 | 400 | -17% | 16% |
| Architecture, Building and Planning | 1,125 | 1,270 | 1,425 | 1,845 | 2,030 | 2,515 | 2,685 | 3,170 | 182% | 18% |
| TOTAL STEM | 16,245 | 17,025 | 17,455 | 18,215 | 18,650 | 19,230 | 20,135 | 21,195 | 30% | 5% |
| TOTAL NON-STEM | 26,900 | 28,720 | 29,315 | 30,525 | 31,100 | 32,130 | 33,560 | 36,180 | 34% | 8% |
| TOTAL | 43,145 | 45,745 | 46,770 | 48,740 | 49,745 | 51,360 | 53,695 | 57,375 | 33% | 7% |
| % STEM | 38% | 37% | 37% | 37% | 37% | 37% | 37% | 37% | | |

Source: Higher Education Statistics Agency (HESA).

Notes: Figures are based on a qualifications obtained population and have been rounded to the nearest five.

(1) Figures exclude entrants from the Open University due to inconsistencies in their method of recording subject of study over the time period.

**PhD Qualifiers from UK HEIs, excluding the Open University**[1]

| Subject of Study | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008/09 | 2009/10 | % change 02/03 to 09/10 | % change 08/09 to 09/10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Medicine and Dentistry | 1,360 | 1,530 | 1,565 | 1,745 | 1,730 | 1,785 | 1,970 | 1,945 | 43% | -1% |
| Subjects allied to medicine | 885 | 875 | 930 | 905 | 955 | 1,005 | 965 | 1,080 | 22% | 12% |
| Biological Sciences | 2,350 | 2,380 | 2,470 | 2,470 | 2,595 | 2,475 | 2,600 | 2,925 | 24% | 13% |
| Biology | 680 | 630 | 610 | 625 | 670 | 620 | 710 | 655 | -4% | -8% |
| Sports Science | 45 | 70 | 70 | 80 | 85 | 55 | 80 | 120 | 167% | 50% |
| Psychology | 775 | 730 | 795 | 825 | 895 | 955 | 955 | 1,270 | 64% | 33% |
| Veterinary Science | 70 | 60 | 95 | 85 | 80 | 70 | 50 | 55 | -21% | 10% |
| Agriculture and related subjects | 230 | 260 | 215 | 230 | 175 | 125 | 175 | 160 | -30% | -9% |
| Physical Sciences | 2,160 | 2,265 | 2,315 | 2,275 | 2,385 | 2,190 | 2,280 | 2,495 | 16% | 9% |
| Chemistry | 995 | 1,035 | 1,020 | 965 | 1,040 | 885 | 900 | 1,025 | 3% | 14% |
| Physics | 605 | 565 | 555 | 630 | 660 | 590 | 655 | 675 | 12% | 3% |
| Forensic and Archaeological Science | 40 | 45 | 50 | 40 | 50 | 40 | 35 | 60 | 50% | 71% |
| Mathematical Sciences | 370 | 415 | 410 | 445 | 465 | 445 | 425 | 515 | 39% | 21% |
| Computer Science | 370 | 465 | 545 | 710 | 715 | 715 | 790 | 840 | 127% | 6% |
| Engineering and Technology | 2,005 | 2,030 | 2,005 | 2,190 | 2,385 | 2,130 | 2,380 | 2,520 | 26% | 6% |
| Engineering | 1,735 | 1,795 | 1,800 | 1,950 | 2,135 | 1,895 | 2,095 | 2,215 | 28% | 6% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 270 | 235 | 205 | 240 | 250 | 235 | 280 | 305 | 13% | 9% |
| Architecture, Building and Planning | 170 | 185 | 240 | 195 | 250 | 225 | 250 | 250 | 47% | 0% |
| TOTAL STEM | 9,970 | 10,465 | 10,780 | 11,255 | 11,730 | 11,160 | 11,885 | 12,780 | 28% | 8% |
| TOTAL NON-STEM | 4,785 | 4,680 | 4,860 | 5,130 | 5,680 | 5,355 | 5,660 | 5,865 | 23% | 4% |
| TOTAL | 14,755 | 15,145 | 15,640 | 16,385 | 17,405 | 16,520 | 17,545 | 18,645 | 26% | 6% |
| % STEM | 68% | 69% | 69% | 69% | 67% | 68% | 68% | 69% | | |

Source: Higher Education Statistics Agency (HESA).

Notes: Figures are based on a qualifications obtained population and have been rounded to the nearest five.

(1) Figures exclude entrants from the Open University due to inconsistencies in their method of recording subject of study over the time period.

**UK Domiciled PhD Qualifiers from UK HEIs, excluding the Open University[(1)]**

| Subject of Study | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008/09 | 2009/10 | % change 02/03 to 09/10 | % change 08/09 to 09/10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Medicine and Dentistry | 1,085 | 1,270 | 1,260 | 1,365 | 1,305 | 1,360 | 1,460 | 1,435 | 32% | -2% |
| Subjects allied to medicine | 640 | 660 | 685 | 635 | 685 | 675 | 630 | 685 | 7% | 9% |
| Biological Sciences | 1,780 | 1,835 | 1,835 | 1,860 | 1,905 | 1,800 | 1,855 | 2,120 | 19% | 14% |
| Biology | 490 | 465 | 430 | 435 | 445 | 425 | 470 | 410 | -16% | -13% |
| Sports Science | 35 | 55 | 55 | 70 | 65 | 45 | 65 | 90 | 157% | 38% |
| Psychology | 670 | 635 | 680 | 695 | 760 | 795 | 805 | 1,080 | 61% | 34% |
| Veterinary Science | 50 | 45 | 65 | 60 | 45 | 55 | 40 | 35 | -30% | -13% |
| Agriculture and related subjects | 115 | 125 | 110 | 105 | 80 | 55 | 85 | 70 | -39% | -18% |
| Physical Sciences | 1,505 | 1,590 | 1,565 | 1,560 | 1,640 | 1,445 | 1,455 | 1,535 | 2% | 5% |
| Chemistry | 680 | 740 | 705 | 660 | 710 | 580 | 585 | 605 | -11% | 3% |
| Physics | 425 | 390 | 370 | 445 | 455 | 400 | 415 | 445 | 5% | 7% |
| Forensic and Archaeological Science | 30 | 25 | 30 | 20 | 25 | 15 | 20 | 35 | 17% | 75% |
| Mathematical Sciences | 205 | 225 | 225 | 255 | 290 | 245 | 220 | 270 | 32% | 23% |
| Computer Science | 175 | 225 | 260 | 330 | 320 | 300 | 330 | 320 | 83% | -3% |
| Engineering and Technology | 910 | 885 | 845 | 845 | 960 | 810 | 920 | 940 | 3% | 2% |
| Engineering | 760 | 770 | 740 | 745 | 840 | 685 | 780 | 805 | 6% | 3% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 150 | 110 | 105 | 100 | 120 | 125 | 140 | 135 | -10% | -4% |
| Architecture, Building and Planning | 85 | 80 | 110 | 75 | 100 | 85 | 85 | 100 | 18% | 18% |
| TOTAL STEM | 6,540 | 6,940 | 6,960 | 7,095 | 7,330 | 6,825 | 7,085 | 7,505 | 15% | 6% |
| TOTAL NON-STEM | 2,585 | 2,595 | 2,545 | 2,650 | 2,935 | 2,675 | 2,760 | 2,925 | 13% | 6% |
| TOTAL | 9,125 | 9,535 | 9,505 | 9,745 | 10,265 | 9,500 | 9,845 | 10,435 | 14% | 6% |
| % STEM | 72% | 73% | 73% | 73% | 71% | 72% | 72% | 72% | | |

Source: Higher Education Statistics Agency (HESA).

Notes: Figures are based on a qualifications obtained population and have been rounded to the nearest five.

(1) Figures exclude entrants from the Open University due to inconsistencies in their method of recording subject of study over the time period.

## APPENDIX 7: JACS 3 LISTING

JACS 3 listing of the subject areas in the STEM highest level subject groups.

### A—Medicine and Dentistry

Pre-clinical medicine

Pre-clinical dentistry

Clinical medicine

Clinical dentistry

Others in medicine & dentistry

### B—Subjects Allied to Medicine

Anatomy, physiology & pathology

Pharmacology, toxicology & pharmacy

Complementary medicines, therapies & well-being

Nutrition

Ophthalmics

Aural & oral sciences

Nursing

Medical technology

Others in subjects allied to medicine

### C—Biological Sciences

Biology

Botany

Zoology

Genetics

Microbiology

Sport & exercise science

Molecular biology, biophysics & biochemistry

Psychology

Others in Biological Sciences

### D—Veterinary Sciences, Agriculture and related subjects

Pre-clinical veterinary medicine

Clinical veterinary medicine & dentistry

Animal science

Agriculture

Forestry & arboriculture

Food & beverage studies
Agricultural sciences
Others in veterinary sciences, agriculture & related subjects

### F—Physical Sciences

Chemistry
Materials science
Physics
Forensic & archaeological sciences
Astronomy
Geology
Science of aquatic & terrestrial environments
Physical geographical sciences
Others in physical sciences

### G—Mathematical Sciences

Mathematics
Operational research
Statistics
Others in mathematical sciences

### H—Engineering

General engineering
Civil engineering
Mechanical engineering
Aerospace engineering
Naval architecture
Electronic & electrical engineering
Production & manufacturing engineering
Chemical, process & energy engineering
Others in engineering

### I—Computer Sciences

Computer science
Information systems
Software engineering
Artificial intelligence
Health informatics
Games

Computer generated visual & audio effects

Others in Computer sciences

### J—Technologies

Minerals technology

Metallurgy

Ceramics & glass

Polymers & textiles

Materials technology not otherwise specified

Maritime technology

Biotechnology

Others in technology

### K—Architecture, Building and Planning

Architecture

Building

Landscape & garden design

Planning (urban, rural & regional)

Others in architecture, building & planning

## APPENDIX 8: JOINT STATEMENT BY THE RESEARCH COUNCILS

Skills training requirements for research students: joint statement by the research councils

### Research skills and techniques—to be able to demonstrate:

The ability to recognise and validate problems and to formulate and test hypotheses.

Original, independent and critical thinking, and the ability to develop theoretical concepts.

A knowledge of recent advances within one's field and in related areas.

An understanding of relevant research methodologies and techniques and their appropriate application within one's research field.

The ability to analyse critically and evaluate one's findings and those of others.

An ability to summarise, document, report and reflect on progress.

### Research environment—to be able to:

Show a broad understanding of the context, at the national and international level, in which research takes place.

Demonstrate awareness of issues relating to the rights of other researchers, of research subjects, and of others who may be affected by the research, eg confidentiality, ethical issues, attribution, copyright, malpractice, ownership of data and the requirements of the Data Protection Act.

Demonstrate appreciation of standards of good research practice in their institution and/or discipline.

Understand relevant health and safety issues and demonstrate responsible working practices.

Understand the processes for funding and evaluation of research.

Justify the principles and experimental techniques used in one's own research.

Understand the process of academic or commercial exploitation of research results.

### Research management—to be able to:

Apply effective project management through the setting of research goals, intermediate milestones and prioritisation of activities.

Design and execute systems for the acquisition and collation of information through the effective use of appropriate resources and equipment.

Identify and access appropriate bibliographical resources, archives, and other sources of relevant information. Use information technology appropriately for database management, recording and resenting information.

### Personal effectiveness—to be able to:

Demonstrate a willingness and ability to learn and acquire knowledge.

Be creative, innovative and original in one's approach to research.

Demonstrate flexibility and open-mindedness.

Demonstrate self-awareness and the ability to identify own training needs.

Demonstrate self-discipline, motivation, and thoroughness.

Recognise boundaries and draw upon/use sources of support as appropriate.

Show initiative, work independently and be self-reliant.

### Communication skills—to be able to:

Write clearly and in a style appropriate to purpose, eg progress reports, published documents, thesis.

Construct coherent arguments and articulate ideas clearly to a range of audiences, formally and informally through a variety of techniques.

Constructively defend research outcomes at seminars and viva examination.

Contribute to promoting the public understanding of one's research field.

Effectively support the learning of others when involved in teaching, mentoring or demonstrating activities.

### Networking and teamworking—to be able to:

Develop and maintain co-operative networks and working relationships with supervisors, colleagues and peers, within the institution and the wider research community.

Understand one's behaviours and impact on others when working in and contributing to the success of formal and informal teams.

Listen, give and receive feedback and respond perceptively to others.

### Career management—to be able to:

Appreciate the need for and show commitment to continued professional development.

Take ownership for and manage one's career progression, set realistic and achievable career goals, and identify and develop ways to improve employability.

Demonstrate an insight into the transferable nature of research skills to other work environments and the range of career opportunities within and outside academia.

Present one's skills, personal attributes and experiences through effective CVs, applications and interviews.

## APPENDIX 9: RECENT REPORTS FROM THE HOUSE OF LORDS SCIENCE AND TECHNOLOGY COMMITTEE

*Session 2006–07*

| | |
|---|---|
| 1st Report | Ageing: Scientific Aspects—Second Follow-up |
| 2nd Report | Water Management: Follow-up |
| 3rd Report | Annual Report for 2006 |
| 4th Report | Radioactive Waste Management: an Update |
| 5th Report | Personal Internet Security |
| 6th Report | Allergy |
| 7th Report | Science Teaching in Schools: Follow-up |
| 8th Report | Science and Heritage: an Update |

*Session 2007–08*

| | |
|---|---|
| 1st Report | Air Travel and Health: an Update |
| 2nd Report | Radioactive Waste Management Update: Government Response |
| 3rd Report | Air Travel and Health Update: Government Response |
| 4th Report | Personal Internet Security: Follow-up |
| 5th Report | Systematics and Taxonomy: Follow-up |
| 6th Report | Waste Reduction |
| 7th Report | Waste Reduction: Government Response |

*Session 2008–09*

| | |
|---|---|
| 1st Report | Systematics and Taxonomy Follow-up: Government Response |
| 2nd Report | Genomic Medicine |
| 3rd Report | Pandemic Influenza: Follow-up |

*Session 2009–10*

| | |
|---|---|
| 1st Report | Nanotechnologies and Food |
| 2nd Report | Radioactive Waste Management: a further update |
| 3rd Report | Setting priorities for publicly funded research |

*Session 2010–12*

| | |
|---|---|
| 1st Report | Public procurement as a tool to stimulate innovation |
| 2nd Report | Behaviour Change |
| 3rd Report | Nuclear Research and Development Capabilities |
| 4th Report | The role and functions of departmental Chief Scientific Advisers |
| 5th Report | Science and Heritage: a follow-up |

*Session 2012–13*

| | |
|---|---|
| 1st Report | Sports and exercise science and medicine: building on the Olympic legacy to improve the nation's health |