UK DEANS OF SCIENCE

RESPONSE TO HOUSE OF LORDS SCIENCE AND TECHNOLOGY SUB-COMMITTEE

CALL FOR EVIDENCE: HIGHER EDUCATION IN STEM SUBJECTS

1. UK Deans of Science (UKDS, www.deansofscience.ac.uk) is a national body that seeks to represent the individuals (usually formally designated as Deans) who are responsible for science in HEIs across the UK and who generally hold the budgets for science including any research budgets. Its primary aim is to ensure the health of the science base through the promotion of science and scientists and of scientific research and science teaching in the UK's HEIs. For clarity this response attempts to reply to the individual questions posed, though, of course, there is considerable overlap between the issues raised. UKDS would be pleased to supply additional information and commentary if required.

General questions

Question 1. What is the definition of a STEM subject, and a STEM job?

2. Whilst not wishing to propose a definition for the wide set of disciplines as those covered by STEM, we trust that the Committee will take into account the particular nature of all STEM disciplines in that, unlike many other areas of study, they build upon a hierarchy of knowledge. Thus STEM university education relies on knowledge gained from early schooling through to 16-19 education and, for mature students, their later education and experiences. It frequently also requires a deep understanding of, and an ability to manipulate, numbers and mathematical concepts. Thus pre-university STEM education needs high quality laboratory and other facilities and must be assessed by rigorous and demanding qualifications.

Question 2. *Do we understand demand for STEM graduates and how this could be used to influence supply?*

3. There seems to be no single source of credible data on the demand for STEM graduates. However, we respectfully suggest that this is a non-question as it presupposes a straightforward and agreed definition of 'demand'. Regardless of numbers graduating in STEM, until there is no shortage of subject-qualified graduates wishing to train to teach certain science disciplines in schools there is clearly a shortage in supply. We would counsel the Committee against proposing any form of manpower planning that attempts to predict the number of STEM graduates (including postgraduates) needed by the UK.

16-18 Supply

Question 3. Are schools and colleges supplying the right numbers of STEM students and do they have the right skills to study STEM first degrees?

4. It is important to recognise that the supply, particularly in some universities, is not just at 18+/19+, but includes more mature candidates. We are very concerned that such students will be differentially discouraged from study as a result of changes in funding.

5. Questions have been raised about the quality of the intake, for example, the mathematical ability and subject knowledge of some students. The recent allegations relating to the competitive methods of Awarding Bodies again highlighted the concerns we have previously expressed as to whether there is a need for several Awarding Bodies.

6. It has been suggested that the new Curriculum for Excellence in secondary schools in Scotland may result in a reduction in the number of STEM subjects taken at school level. We believe that the Government should monitor this carefully in case any lessons can be learnt that are applicable to the rest of the UK.

Question 4. What have been the effects of earlier government initiatives on the uptake of STEM subjects at advanced level?

7. The independent Curtis and Cartwright report for HEFCE (http://www.hefce.ac.uk/pubs/rdreports/2011/rd05_11/rd05_11.pdf) strongly suggests that funding for strategically important and vulnerable subjects, combined with the strong commitment of professional bodies and many individual scientists has at least managed to sustain, and in some cases increase, the proportion of students wishing to study some STEM degrees. We do, however, have a major concern about the limited extent to which home students wish to continue their studies of science at postgraduate level.

Question 5. What effect, if any, will the English Baccalaureate have on the study of STEM subjects in higher education?

8. No comment

Graduate supply

Question 6. 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?

9. While universities have been very successful at attracting EU and international students to STEM subjects there is evidence that the Border Agency controls are now having a very negative effect. The Committee needs to be aware that several of the countries from which many students have come in the past are becoming increasingly attractive to them as locations where they believe they will have very rewarding STEM careers when they complete their studies.

Question 7. *Is the quality of STEM graduates emerging from higher education sufficiently high, and if not, why not?*

10. Although Faculties of Science employ STEM graduates we would prefer that employers outside the education sector respond to this question.

Question 8. Do STEM graduates have the right skills for their next career move, be it research, industry or more broadly within the economy?

11. Undergraduate science degrees have adapted considerably over the past decade to ensure that graduates recognise and develop their broader personal, professional, innovation and career development skills and are much more employable in a fuller range of roles than has previously been the case. Industry does generally find the graduates it needs, evidence that we are 'producing' the skills that are needed. Notwithstanding this, there is a continuing challenge to produce graduates with the higher skills necessary to undergo doctoral study. Different industries often demand very specific skills at different times in addition to broader subject knowledge and generic skills. However, we believe that STEM graduates are generally very adaptable and capable of progression through a very wide range of careers across the UK economy.

Question 9. 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?

12. UK Deans of Science have already given their views to the Government on the Higher Education White Paper, 'Students at the Heart of the System'. Whilst welcoming the recognition that higher education is of fundamental value in itself we have concerns about:

- the almost singular emphasis on funding rather than on the fundamental nature of a university as a place for the creation and dissemination of knowledge and learning (this being in direct contrast to the main thrust of the Schools White Paper)

- the emphasis on undergraduate education
- the risks to science of the application of the rules for contestable student numbers
- the intention to allow use of the university title to organisations (whether for-profit or not) which have no discernible research activity
- a lack of any obvious plan to monitor the effects of all the changes in order to pick up and act on any adverse effects before they cause irreversible damage.

13. UK Deans of Science have deliberately not formed a view of the decision to increase the ceiling on fees but have deep concerns about the potential deterrent effect of the new fee regime on:
    - increasing social mobility that is part of the Government's agenda
    - the study of science, especially the extended four year Masters programmes (please see also paragraphs 14 and 25)
    - undergraduate students' willingness to progress to Masters degrees and/or PhDs, both of which are essential steps towards many STEM careers, especially in research and development (please see also paragraph 25).

14. There is a major risk to long term STEM student numbers and the quality of the STEM degrees from the reduction in the HEFCE teaching grant for Band B programmes. Two possibilities exist: universities may decide to maintain a policy to keep fees for all subjects approximately the same or over time some classroom-based subjects may adjust fees downwards below £9,000 to reflect their true costs. In the former case, while the substantial research base of STEM Faculties may be superficially attractive to Vice-Chancellors we are very concerned that very small amount of Band B funding promised by HEFCE will be insufficient to be able to deliver as good a student experience in laboratory-based subjects as that in classroom-based disciplines. Any initial cross-subsidy to STEM subjects is likely to be transient as departments work to protect their student and staff numbers. Alternatively, if fees are lowered for some classroom-based disciplines we expect some students from less well off backgrounds and those with an aversion to debt to gravitate away from STEM towards the cheaper alternatives. One action that could be taken to help science disciplines would be for HEFCE Band B funding to better reflect the nature and cost of teaching STEM subjects as is the case for medicine, dentistry and veterinary science.

Question 10. What effect does "research assessment" have upon the ability to develop new and cross-disciplinary STEM degrees?

15. The effect of research assessment is almost certainly negligible. Where a market for a new or cross-disciplinary programme is recognised a Faculty will offer it, subject, of course, to appropriate facilities and staff expertise. Of course, the relationships between student demand, what universities believe might be popular and what is useful for employment, are very complex and require carefully considered business plans. However, even a well designed, business-facing programme will not necessarily attract students.

Question 11. What is the relationship between teaching and research? Is it necessary for all universities to teach undergraduates and postgraduates and conduct research? What other delivery model should be considered?

16. We believe that an undergraduate in science can only be inspired or taught to an appropriate level in a 'community of scholars' within an environment enriched by high quality research, where the progression from undergraduate to postgraduate can be seen to be a seamless process. It is often the research of a Faculty presented by passionate, enthusiastic researchers during open days that persuades potential students that they should study science.

Question 12. Does the UK have a sufficient geographical spread of higher education institutions offering STEM courses?

17. There is reasonable coverage at present but if the higher education reforms mean that many more students decide to live and study at home action will be needed to maintain an appropriate spread of STEM provision and not allow it to become concentrated only in major centres of population. Interestingly STEM subjects are geographically well represented across Scotland.

Question 13. 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?

18. Many of the outreach activities to encourage students to study science have targeted various under-represented groups. We have no magic bullet that we believe would significantly alter the current position. However, it is worth noting that most studies of under-representation have concentrated on single disciplines. We suggest there is a need for a major project to look across all STEM disciplines, including medicine, dentistry and veterinary science investigating both negative and positive factors that affect student choice, taking account of both over- and under-representation of certain groups in certain disciplines and professions. Notwithstanding this the funding reforms are likely to impact negatively on diversity.

Post-graduate supply

Question 14. Is the current training of PhD students sensitive to the range of careers they subsequently undertake?

19. The changes that have taken place, encouraged by Roberts' funding, mean that most STEM students are well prepared for, and aware of, many different careers.

Question 15. Are we currently supporting the right number of PhD studentships to maintain the research base and are they of sufficient quality?

20. We feel that PhD funding by Research Councils is currently being squeezed and that this may ultimately have a detrimental effect on STEM disciplines. The reductions in grants for PhD studentships and the corralling of PhD places into DTCs are both having a negative effect on staff morale. In the past academics were able to apply for funding and maintain their own PhD students and contribute to the health of their laboratories. This is becoming more centralised with DTCs and other actions so the research base may no longer be driven from the bottom. It is difficult to predict whether this will lead to better outcomes.

21. The acceptability and national and international profile of Professional Doctorates need some attention from Government and the Research Councils. These qualifications can have a major impact on those in mid career and can lead to substantial changes in practice in the workplace.

Question 16. What impact have Doctoral Training Centres had on the quality and number of PhD students? Are there alternative delivery models?

22. DTCs can be of benefit in increasing critical mass of researchers and raising the profile of research and other training. However, there is probably insufficient experience of DTCs to make definitive comment on their usefulness in relation to the resources they consume. There is also some worry that DTCs are being located in only a few centres across the country which may ultimately mean that research activity in STEM disciplines gravitates towards these centres.

Question 17. Should state funding be used to promote Masters degrees and is the balance right between the number of Masters degree students and PhD students?

23. The simple answer to this question is: 'Yes'. As indicated elsewhere there is deep concern that the increase in undergraduate fees may reduce the numbers of UK students willing to undertake Masters degrees and four year MSci qualifications. We expect that when this is finally recognised by the Government in the period around 2014-16 it will be panicked into measures to deal with the crisis.

24. A three year undergraduate degree is insufficient in many areas of science to educate students to international graduate levels. Taught one year Masters and/or the four year integrated MSci programmes are necessary to achieve world competitive standards, both in terms of the research 'pipeline', that is, preparing people for PhD study, and in delivering high level skills at exit from university education.

Integrated masters programmes are necessary to maintain high quality competitive science and engineering education and as the academic requirement for professional levels of accreditation for scientific and engineering professional bodies. Where STEM graduates have taken 3 year degrees, Masters programmes allow them to specialise, enhance skills, and have an edge in the jobs market because they offer something extra for the employer. MSc programmes can also be successfully targeted at areas where there is societal/industrial need more quickly and with more efficiency than UG programmes - but only if these places are funded. To give just one example, funded MSc places are needed to deliver enough qualified statisticians to enable pharmaceutical companies to develop drugs through appropriate clinical trials.

Question 18. What impact will higher education reforms have on the willingness of graduates to pursue a research career?

25. Although this issue is addressed in several paragraphs of this response it is very difficult to give a definitive reply to this question. When UG fees were introduced earlier, taught PG numbers continued to rise (though significantly through increased numbers of international candidates and not home students). However, the economic situation is different now and the changes in fees are much greater. We therefore have major concerns about the future supply of UK postgraduate taught and postgraduate research candidates. We believe the reforms were introduced with no thought for the four year STEM Masters programmes. A student from a family of relatively modest means, who studies away from home, is charged the full £9,000 fee and borrows the full amount allowed would graduate with a debt between £58,000 to £66,700 before any interest begins to be added. Whatever way the repayment of such a debt is 'spun' this is bound to act as a huge disincentive to continue into a doctorate and postdoctoral work.

Industry

Question 19. What incentives should industry offer to STEM graduates in order to attract them?

26. Most of the scientifically based industries offer interesting employment for those wishing to pursue their scientific interests with reasonable career progression. However, to compete with banks and others keen to employ the very best science graduates we believe that industry needs to offer substantial 'golden hellos' and display a readiness to help the paying off of debts incurred during undergraduate study.

Question 20. 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?

27. A science degree is an excellent preparation for a range of jobs. Many subjects produce graduates that are highly regarded, but who don't follow a career 'in their subject' (e.g. History, English). The question seems to assume that, perhaps because lab-based subjects are costly, the graduate numbers in science should match the graduate jobs *in science*. The UK needs scientifically literate people across all sectors of the economy.

28. There is still a need to put industry, the professional bodies and universities together to thrash out, once and for all, a blueprint for STEM undergraduate and postgraduate programmes that will give industry what it believes it needs to succeed in the UK.

International comparisons

Question 21. 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?

29. No comment

Final Comments

30. Although some data is collected on student numbers (for example, by the Higher Education Statistical Agency on undergraduate and postgraduate students and by HEFCE on doctoral completion rates) we are

not aware of any detailed data being collected and properly analysed on an annual basis. Following the recent reforms of funding of higher education the Government must begin to monitor very closely to check for any unintended consequences caused by the new student funding arrangements. This should include detailed analysis of changes in numbers of students, both part-time and full-time, in each year of each type of undergraduate and postgraduate taught and postgraduate research programme detailed separately for each subject area.

31. One specific area that would benefit from attention is computer science. There is an argument for the development of a robust curriculum for schools in computer science (not computer appreciation) programmes that might encourage more of the most able students to study the subject at university.

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December 2011