THE ROYAL SOCIETY

Policy document 41/06

# Royal Society submission to the House of Commons Education & Skills Committee inquiry into the future sustainability of the higher education sector: purpose, funding and structures

**Summary of key points**

- Any discussion about the role of higher education (HE) needs to take into account the varied nature of HE provision and the wide diversity of qualifications, students and learning modes encompassed by HE learning. This diversity is good: it shows a healthy sector in which institutions are able to 'play to their strengths' and offer a wide range of students the learning opportunities that are appropriate for them.

- The prime responsibilities of a university are to teach, to maintain and develop the corpus of knowledge and to transfer this knowledge, both through teaching students and through other activities such as interaction with business. While there are changes to the ways in which universities deliver these aims, for example their developing role in transferring knowledge to business, we believe that this broad role is constant.

- Universities are dependent on the funding that they receive for both research and for teaching. It is important that the funding regime adequately funds both functions and does not inadvertently provide incentives to concentrate on one activity over the other. It is also important to recognise that there are interdependencies between teaching and research, such as the need for scholarship.

- We believe that the UK should be exploring more broadly whether our current HE system is delivering what students, employers, the economy and wider society need from its graduates and how this will change over the next decade. The Society's *Science HE 2015 and beyond* study is considering these wider issues and how the structure, content and purpose of the different stages of our current HE system may need to evolve in the future. The Bologna Process has the potential to act as one driver for such change.

1 The Royal Society welcomes the opportunity to submit evidence to the House of Commons Education & Skills Committee inquiry on *The future sustainability of the higher education sector: purpose, funding and structures*. This submission has been prepared with the advice of the Society's higher education (HE) working group and has been approved by Professor Martin Taylor FRS, Vice President and Physical Secretary, on behalf of the Council of the Royal Society. We are also submitting evidence to the Committee's inquiry on *The Bologna Process.*

2 HE is a vital component of the UK's education system and plays a major role in maintaining the nation's intellectual vitality and culture, preparing its students for their future contribution to society and building a leading knowledge-based economy. The Society's HE working group has recently published a report entitled *A degree of concern? UK first degrees in science, technology and mathematics* (Royal Society 2006b), from which many of the points in this submission are drawn. A copy of the report is enclosed with this submission. The group is currently engaged in a broader study considering the fitness for purpose of UK science, technology and mathematics (STM) HE into the middle of the next decade and beyond, *Science HE 2015 and beyond* (see Annex A for further details). This study will report in autumn 2007 and the group will be developing its thinking on these questions over the coming months. We would be happy to expand further on the points in this submission or to give oral evidence to the Committee.

3 The Committee's inquiry is very broad. While we welcome the ambition of the inquiry, and appreciate that many issues relating to HE are inter-related, we would caution that such a wide scope will involve considerable time and effort if each issue is to be considered with the care that it requires. In this submission we focus on the role of universities over the next 5–10 years and university funding, and consider briefly the structure of the HE sector. Our response is organised under these main headings. As the UK's national academy of science, our response focuses on science in its broad sense, encompassing technology, engineering and mathematics. However, we also elicit key principles about the HE sector and its purpose, funding and structures wherever possible.

## The role of universities over the next 5–10 years

### The diversity of the HE sector

4 We believe that any discussion about the role of universities needs to take sufficient account of the varied nature of HE provision and the wide diversity of qualifications, students and learning modes encompassed by HE learning.

5 HE is supplied by universities, university colleges and further education colleges. These institutions all position themselves in different ways and have different levels of engagement with their communities, and with local, national and multi-national businesses.

6 HE is delivered at undergraduate and postgraduate levels. Undergraduate qualifications can be further divided into first degrees (those leading to the award of bachelors or integrated masters degrees, typically taking the equivalent of three or four years full-time study) and other undergraduate qualifications, such as two-year Foundation Degrees and Higher National Diplomas and Certificates (HNDs/HNCs). In 2004/05, while over 65% of students studying first degree courses were under 21 years old, over 85% of students studying for other undergraduate qualifications were over 21 and just over 60% were 30 years old and over. Students can study full-time, part-time, through distance learning or through mixed-modes of learning, for example a combination of work-based learning and university attendance. In 2004/05, 85% of UK domiciled first-year students studying for a first degree were studying full-time, while only 33% of UK domiciled first-year students studying for other undergraduate qualifications were full-time students (HESA 2006).

7 This diversity is good: it shows a healthy sector in which institutions are able to 'play to their strengths' and offer a wide range of students the learning options that are appropriate for them. However, this range is not equally available to all students, and puts a premium on giving good advice to young people making degree choices from among this array of options.

8 We also strongly support efforts to widen participation in HE. In common with virtually every other country in the world, participation in UK HE has dramatically increased over the past century, with much of this expansion taking place over the past 40 years. However, it is important to recognise that some of this expansion is due to changing definitions of HE participation – for example, until the 1990s only under-21 year-olds entering full-time or sandwich degree courses were counted in HE participation statistics, with students undertaking other HE qualifications such as HNDs and HNCs omitted. These changes in definition bring a fuller picture of the true level of participation in HE.

9 Since the late 1980s, successive UK governments have pursued policies to widen access to HE and increase overall participation. The present Government's aim of increasing participation in HE towards 50% of those aged 18-30 by 2010 is largely being tackled through an expansion in other undergraduate qualifications such as the two-year Foundation Degrees introduced in 2001. Figures from the Higher Education Statistics Agency

(HESA 2006) show that there was a 25% increase in the number of UK-domiciled first-year undergraduates studying for first degrees between 1995/96 and 2004/05, while the number of UK-domiciled first-year undergraduates studying for other undergraduate qualifications increased by 105%. Again, this emphasises the valuable diversity of the HE sector.

**The role of universities**

10 We consider this question under the Committee's three headings of students, employers, and government and society more broadly, though there are naturally links between the needs of these groups, particularly as their membership is not mutually exclusive.

***What do students want from universities?***

11 Higher education, in any subject, should provide students with:

i intrinsic value – developing critical and analytical thinking and an inquiring mind
ii preparation for life – enabling people to contribute to civic life and democratic debate
iii preparation for work – developing the skills, knowledge and experience desirable for employment and further study, and preparing graduates for the ongoing learning and development that will be necessary throughout their careers.

12 With the introduction of tuition fees, students are increasingly 'consumers' of HE: there are more options than ever open to them and they rightly expect to receive value-for-money for their education. For science courses, which often last four years and require a time-commitment to practical work which can reduce the opportunity for term-time working, this could have adverse implications for future student numbers. This issue is considered further in paragraphs 32-34.

13 Concern has been expressed about the level of mathematical skills and practical experience with which students are starting first degree courses in the sciences (see, for example, Engineering Council 2000, Ove Arup 2003). From a student perspective, it is highly demotivating to achieve the A-level or equivalent qualifications necessary to enter HE and then arrive and find that your level of knowledge or experience is considered insufficient. Against a background of increasing student choice within the 14–19 curriculum and widening participation in HE, it is imperative that universities recognise the multiplicity of entry qualifications and subject combinations with which students are starting their courses and actively help students bridge the gap between 16–19 qualifications and degree-level study. HE curricula therefore need to adapt to reflect changes in the 14–19 curriculum. In parallel with this, it is important for the HE community to articulate the skills, knowledge and experience that are perceived to be desirable in new undergraduates and to be involved, alongside other stakeholders including employers, in shaping the future development of 14–19 education. However, there have been many changes to 14–19 education over the past decade and greater long-term stability is necessary to create a sustainable situation in which the gap between 16–19 education and university study is minimised.

14 Finally, we believe that policy makers should give greater consideration to ensuring that HE courses at all levels are satisfactory as a start to lifelong learning, and that they equip their graduates with the flexibility to change career direction as required.

***What do employers want from graduates?***

15 We believe that it is crucial to maintain the high standard of all UK honours degree courses. These degrees encourage students' critical thinking and, particularly in science, engineering, technology and mathematics, expose students to the generation and critical analysis of experimental data.

16 Graduates from science and engineering degrees will enter a wide range of occupations, some of which will directly use the technical knowledge gained through their degrees and some of which will draw mainly on wider skills. The main recruiters of science and engineering graduates have traditionally looked for technical knowledge and intellectual capability in those that they employ. There appears to have been an increased emphasis in recent decades on combining subject expertise with good interpersonal skills, practical employment experience and commercial understanding. The respective roles of the HE system, employers and the students themselves in developing these attributes have been less clearly articulated.

17 The recently published report of the Leitch Review of Skills (Leitch 2006), commissioned by the Government in 2004 to provide an independent review of the UK's long term skills needs, considers the balance of responsibilities of Government, employers and individuals for investing in skills in the UK. The report recommends that the UK skills system should be fully demand led, flexibly delivering the skills that employers and individuals need, rather than trying to predict future demand for different skills. The report proposes the establishment of an employer-led Commission for Education and Skills to deliver greater leadership and influence in this area.

*Work experience*

18 Graduates who have gained work experience during their studies are highly valued by many employers, but in many subjects it is difficult to find enough employers willing to offer such work placements. For many smaller companies it can be particularly difficult to offer such experience. The pressure on graduates to arrive in first employment with prior practical experience partly reflects the intensification of competitive pressures facing employers in many sectors combined with the effects of 'delayering' in many organisations, resulting in fewer people being available to supervise inexperienced graduate recruits.

*Feedback mechanisms between HE & business*

19 Relationships between university departments and employers tend to involve primarily large firms, and be confined to only a few such relationships per department. They are often focused on research or knowledge transfer, rather than on curriculum development. In addition, most small and medium-sized enterprises lack the resources to engage in such relationships, although there are notable exceptions in highly science-dependent sectors. There is also an important role for university careers services to play in maintaining links between universities and employers.

20 It is vital that, as the needs of UK employers develop and change, the requirements of science and engineering employers are articulated to the HE sector effectively. In particular, HE institutions developing new courses, especially those that appeal to students hoping to enter particular careers or employment sectors, should seek employer involvement in the course design and structure.

*Quantitative demand for graduates*

21 Although any attempt at estimating the total number of graduates with particular skills is fraught with difficulties, we can be confident that the development of the UK as a major knowledge-based economy will require:

- an excellent and vibrant university research base, covering a wide spread of subjects
- a sustained supply of science, engineering, technology and mathematics professionals with appropriate skills, knowledge and experience, including school and college teachers, university faculty, researchers and technicians
- a good mix of discipline backgrounds, crucially including science and engineering, within the general graduate workplace

Any review of employer demand for STM graduates must take account of quality as well as quantity issues, considering the skills, knowledge and experience that it is desirable for STM graduates to develop through their studies.

***What should the government, and society more broadly, want from HE?***

22 The prime responsibilities of a university are to teach, to maintain and develop the corpus of knowledge and to transfer this knowledge, through teaching students and through other activities such as interaction with business. While there are changes to the ways in which universities deliver these aims, for example their developing role in transferring knowledge to business, we believe that this broad role is constant. The activities comprising this role are interconnected. There are obvious dangers in trying to make policies in one area without understanding the interdependence on other areas.

23 From these overlapping aims – teaching, developing knowledge and transferring knowledge – it is clear that universities' responsibilities to the nation include the following:

- supplying skilled graduates at all levels:
  - to build an adequate work force
  - to create an educated democracy, empowering people to contribute to civic life and democratic debate
  - to widen participation in higher education
  - to enhance the nation's quality of life
- carrying out research – in the UK the bulk of fundamental research is undertaken at universities and they are largely responsible for the high international standing of UK research
- providing appropriate career structures for future researchers
- providing advice and consultancy for, among others:
  - business
  - public sector services
  - policymakers – for example, in area studies or science policy
- attracting and retaining firms, both to local regions and to the UK
- providing public space for networking and debate
- contributing to the overall cultural vitality of the UK
- contributing to the economy as businesses themselves, for example as large employers and as purchasers of goods and services.

## University funding

24 Universities are dependent on the funding that they receive for both research and for teaching. Individual institutions are free to focus their efforts on research or teaching, and many seek to excel in both. It is important that the funding regime does not inadvertently provide incentives to concentrate on one activity over the other. It is also important to recognise that there are interdependencies between teaching and research. Scholarship, in the sense of a deep understanding and ongoing engagement with the concepts, ideas, methodology and analysis being taught, is necessary as a background to any professional activity in the universities, and indeed throughout education.

### Funding teaching

25 A recent study by PricewaterhouseCoopers (PwC) for the Royal Society of Chemistry and Institute of Physics (PricewaterhouseCoopers LLP 2004) considered the economic costs and benefits (to the individual and the state) associated with education to first degree standard. These were compared with those for an individual with two or more A-levels as their highest qualification. The study concluded that, as well as the substantial

economic benefits to individual graduates over their working life, there are economic benefits of HE to the state. Although the state bears significant costs during the period of study itself, there are substantial tax benefits to the Exchequer, particularly later in a graduate's working life, as earnings and related taxation payments increase. It currently costs the state approximately £21,000 to provide higher education to first degree level for the 'average' graduate, but the additional return to the state in terms of the tax and national insurance associated with earnings following qualification is approximately £93,000. However, the economic benefits of HE to the country are primarily in the form of GDP growth and the payback to government is clearly much larger than the tax graduates pay.

26 In addition to these returns to the public purse, there are clearly social and cultural imperatives for the state to fund HE teaching to the extent that it does.

27 Universities receive their funding from a variety of sources, and the proportion of a university's income intended for its teaching activities varies considerably across the sector. In the four universities with the highest overall income in 2003/04 (Cambridge, Oxford, Imperial College and University College London), funding dependent on teaching represented only 22% of total income. However, in the post-1992 institutions, teaching income represented, on average, 67% of total income. This variation has several important consequences, including the need to cover the full costs of teaching. These costs not only include the direct cost of teaching students, but also the costs of the necessary scholarship to enable staff to keep up with developments in their subject, and liaison activities with, for example, potential employers of graduates appropriate for the particular subject.

28 Despite the significant increases in the Higher Education Funding Council (HEFC) teaching grant since 1998/99, this now represents a decreasing share of the total funding, with course fees from non-EU overseas students becoming, proportionately, an increasingly important source of funding (Royal Society 2006b). The number of international students choosing to study in the UK is highly dependent on several factors including exchange rates, UK Government policy and the policy of the government in the student's home country; for these reasons income from overseas course fees is likely to be volatile and universities should resist becoming over-reliant on it.

*Cost of laboratory-based subjects*

29 Universities will be aware of the overall costs of their various activities, including teaching, and some will have disaggregated information to departmental level and to various levels of courses. However, sector-wide comparable figures will not be available until the new Transparent Approach to Costing (TRAC) exercise for teaching is completed. A pilot implementation is taking place in 2006/07, with robust figures expected to be reported by early 2008. The need for full costing for the teaching function is particularly important in the UK because, almost uniquely, the UK public funding for HE has separate streams for teaching and underpinning research.

30 Laboratory-based subjects have been particularly badly hit when research income from the Funding Councils has been cut. The funding of science and engineering courses in England has been reduced after the change from 2.0 to 1.7 in the weighting used in the formula for calculating the block teaching grant for laboratory based subjects (HEFCE 2004). In response to the House of Commons Science and Technology Committee inquiry into strategic subjects, we expressed the view (Royal Society 2005) that teaching, particularly in science and engineering subjects, was under-funded and subsidised from research activities, and possibly from lower-cost teaching activities in other subjects. Recent studies of the finances of samples of physics (IOP 2006) and chemistry (RSC 2006) departments have shown that on a TRAC basis all of the departments considered were in deficit.

31 We welcome the news that the Higher Education Funding Council for England (HEFCE) is to provide £75 million in additional funding to support very high cost science subjects, which are defined as strategically important to the economy and society but vulnerable because of relatively low student demand or by a concentration of the subject in institutions which may be particularly vulnerable to change. However, it is vital to know how much it really costs to teach different subjects at university level, so that more expensive disciplines, including the sciences, can be funded appropriately in the long-term. The additional HEFCE funding should help to support the more expensive lab-based subjects until the TRAC data are available, but it is vital that this temporary measure is then replaced by a sustainable long-term set of arrangements.

*Student fees*

32 At present, the additional year of fees for four year science and engineering courses can be a disincentive for some students and we are concerned that additional disincentives to studying science and engineering subjects are avoided.

33 In our response to the White Paper on the future of HE (Royal Society 2003) and more recently in evidence to the House of Commons Science and Technology Committee inquiry into strategic science provision (Royal Society 2005), we have warned about the possibility of science and engineering subjects being disadvantaged by differential student fees. As noted in paragraph 28, course fees are an increasingly important source of teaching income for institutions and this has implications for the level of compensatory fee that could be levied on students studying more expensive lab-based subjects. Even if science and engineering subjects are not disadvantaged through differential fees, their students might find it relatively difficult to minimise debt and supplement their income because of the content and length of their courses.

34 We are also concerned that if there were any differential between course fees this could be a disincentive to middle/lower-income students studying more expensive subjects. It is not yet clear how effective bursaries will be at alleviating such problems.

**Funding research**

35 There are seven overlapping reasons for funding fundamental research:

i to support the basic interest that exists in all advanced civilisations in scientific discovery and the pursuit of understanding
ii to maintain and develop knowledge, skills, and long-term research infrastructure, both for unforeseen eventualities and also to maintain a capacity to keep in touch with, and understand, developments occurring elsewhere in the world
iii to solve problems – for example, to underpin solutions to societal challenges such as those in the health, social, economic and environmental areas
iv to fuel economic activity, creating new and better/cheaper products and new and better/more efficient services
v to train PhDs and post doctoral researchers and to provide within universities an exciting and challenging learning environment for first degree and masters students
vi to retain existing expertise in the UK, and to attract inward migration of skilled people
vii to retain business investment and to attract 'foreign' companies/capital.

Implicit in many of these are the key roles that fundamental research plays in maintaining culture and a community's standing within the world. Martin and Tang (Martin & Tang 2006) at SPRU in Sussex, identify seven similar such channels of benefit from publicly-funded basic research to the economy or to society more generally and argue, that, taking all seven together, university research offers an incontrovertible benefit to the economy and to society.

36 From these reasons it can be seen that there are significant localised benefits from fundamental research activity including:

- maintaining expertise across a wide range of disciplines, with people able to pick up and run with new ideas wherever they are generated – this capacity includes being available to provide advice to regional and national governments
- providing the entry ticket to the international research community, sometimes through formal collaborations, but at other times just through attendance at conferences and informal contacts
- maintaining an interface between universities and the business and wider community
- educational benefits of a research-active department.

37 Research in the UK receives public investment selectively, via the dual support mechanism which sustains high quality research and nurtures promising projects and individuals. Research Council (RC) funds are distributed on the basis of specific grant applications, judged on promise, while HEFC Quality Related (QR) funds are allocated on the basis of past achievements, as assessed by the Research Assessment Exercise (RAE). RC funds must be spent on the project for which they were awarded, whereas HEFC QR funds can be used at the discretion of the institution.

38 In our recent submission to the Department for Education and Skills consultation on the reform of higher education research assessment and funding (Royal Society 2006a), we stated that we agree with Government (HM Government 2006) that dual support is an effective mechanism to sustain excellent research. The vital plurality of judgement, which is a central feature of dual support, is lost if either funding stream is directly dependent on the other.

39 We welcomed Government's decision to review the current RAE, recognising that the assessment process needs to be more efficient and streamlined for institutions and assessors, and that user-focused and interdisciplinary research should be better recognised and rewarded. However, we were very concerned about the proposal to allocate QR funding via a metrics-based formula, particularly where the metrics to be used were all income related.

40 The recent announcement in the 2006 Pre-Budget report and associated documents (HMT 2006) set out new proposals for research assessment. We are pleased that the 2008 RAE round will go ahead as planned, and the timetable for change appears satisfactory. We are also pleased that expert review will remain part of the assessment for non science, engineering and technology (non-SET) subjects, which are here defined as including mathematics.

41 However, we are very disappointed that there is no proper role for peer review in the evaluation of SET subjects, and that a decision has been taken to assess different subjects in different ways. The majority of responses to consultation were against this, including that of the Society. Interdisciplinary work is a significant, important and increasing part of UK research effort, and measures that may discriminate against areas that bridge SET and non-SET are concerning.

42 We are also very concerned about the £60 million of QR funding that will be allocated to university/business research. The mechanism for distributing this money will be of prime importance. We look forward to discussing proposals with relevant parts of Government and HEFCE.

43 The Society remains strongly committed to the need for subject-based review panels. These should be, as now, informed by a series of qualitative and quantitative indicators. We also believe that any reward-linked assessment will influence individual and institutional behaviour, so behavioural responses to any system will need to be monitored to identify negative effects.

### The relationship between teaching and research – the fundamental importance of scholarship

44 A key feature of HE teaching is the high level of scholarship required, defined here as a deep understanding and ongoing engagement with the concepts, ideas, methodology and analysis being taught. The necessary staff time for this activity is insufficiently taken account of in central funding, exacerbating the shortfall in the funding of teaching. The issue is complicated by the relationship of scholarship with other activities that enhance it, such as: active research; and professional development, including close interaction with innovative employers of relevant graduates, attendance at international meetings, and collaboration with professional colleagues in the public services and business sectors.

45 The importance of research activity within departments has featured in the discussions on recent closures of science departments. However, research activity can take many forms, including: the collection and analysis of new data; modelling; and the analysis and synthesis of existing data. Although the cost of such activities can vary greatly, at a minimum it is necessary to cover the relevant cost of faculty time. The relationship between teaching and research was the subject of a review by the HE Research Forum, which was set up jointly in 2003 by the then Minister for Lifelong Learning and Minister for Science and Innovation (DfES 2004). This reported that those students who are not learning in an HE environment that is informed by research, and in which it is not possible to access research-related resources, are at a disadvantage compared with those who are. Accordingly it recommended that universities that have a low level of HEFCE research funding should receive funding to support research-informed teaching. This recommendation was accepted by the Government and subsumed within the HEFCE funding calculations for the Teaching Quality Enhancement Fund (HEFCE 2006). It is important to monitor whether the level of research-informed learning improves as a result of this initiative.

## The structure of the HE sector

46 The Committee raises a number of important questions about the structure of the HE sector and its future development. The Society's *Science HE 2015 and beyond* study (see Annex A for further details) is considering whether the overall structure of the UK HE system will be fit for purpose in 2015 and beyond. The study will consider this question in the light of many of the issues raised by the Committee and will report in autumn 2007.

47 We believe that the Bologna Process has the potential to act as a driver for change more generally in UK HE. Aside from the opportunity the process provides for the UK to consider how the structure, content and purpose of the different stages of our current HE system compare to the arrangements in other countries, we should anyway be exploring more broadly whether our current system is delivering what students, employers, the economy and wider society need from its graduates and how this will evolve over the next decade.

### Strategic subjects

*Science department closures*

48 Ensuring that the education system as a whole will provide the education and trained individuals to maintain economic and social well-being in the UK into the future is clearly the responsibility of Government. Equally, it is the responsibility of individual universities to determine their own future development. While we strongly believe in the autonomy of individual institutions, it is vital for Government to have the right incentive structure in place to ensure the future health of vulnerable disciplines.

49 It is notable that many closures have occurred in departments with low research income. This supports our belief that teaching is under-funded in science and engineering subjects and has to be cross-subsidised with

research income. The science and innovation investment framework (HMT 2004) stated that approximately 15 physics and 11 chemistry departments have closed over the past ten years, based on data from several sources including the research assessment exercise (RAE) and UCAS.

50 More recently, the 2001 RAE created a large gap in funding between 5 and 4 rated departments. Since then high-profile withdrawals of physics undergraduate teaching have occurred at the Universities of Reading and Newcastle, both rated 4 in the 2001 RAE. The Chemistry Department at the University of Sussex also came close to closure this year, reportedly because the university was concerned that it might not retain its 5 rating in the 2008 RAE and would therefore lose research funding. This threat appears to have been lifted, and applications are reported to be buoyant.

51 As noted in paragraph 31, we welcome HEFCE's recent announcement of an extra £75 million to support very high cost science subjects, which are defined as strategically important to the economy and society but vulnerable because of relatively low student demand or a concentration of the subject in institutions which may be particularly vulnerable to change. We are also supportive of the programmes designed to both increase and widen student participation in science and engineering subjects, which have been developed in collaboration with the relevant professional bodies and communities and in engineering, physics, chemistry and mathematics, with a similar programme for computing in development.

*Geographical provision*

52 Science provision can be considered at a range of levels – Europe-wide, UK-wide, by country or by region. To some students and large firms the location of a particularly attractive university course or research programme is irrelevant. However, the advent of a mass HE system, the reduction in individual student support, and the imperative to provide equal opportunity of access to HE mean that local teaching provision is very important. The formation of regional 'deserts' created by closures of university departments increases the risk of discrimination against those who may need to stay near home because of family commitments, cultural or financial pressures. Furthermore, without local university departments in the physical sciences and engineering, the opportunities for increasing university–school links in these subjects, as promised in the Government's science and innovation investment framework (HMT 2004), will be severely reduced in some areas.

53 Although larger companies can access information on a worldwide basis, small and medium-sized enterprises (SMEs) can be very dependent on their local universities for access to research or expertise and consultancy, as well as for the provision of public space for networking. Hence, it is still relevant to consider what provision is required at a regional level.

*The supply network*

54 The future of university science departments also depends on the success of schools and colleges in supplying a sufficient quantity, quality and diversity of science students. While the traditional supply chain into universities has become a complex network of schools, Further Education Colleges, universities and employers, we are facing a long-term decline in the popularity of A-level subjects that provide young people with the most common route into the physical sciences, mathematics and engineering at university. While the 2006 A-level results showed improvements in entries to mathematics and further mathematics, and a more modest recovery in chemistry entries, the number of physics A-level entries fell to a new low with 2.7 per cent fewer UK students taking the subject than in 2005, or a 37 per cent decrease since 1991 during which time the total number of entries across all subjects have steadily increased, reaching a new record peak in 2006.

55 Major and fundamental changes have been introduced to GCSE science courses from September 2006 and A-level is currently under review by the Qualifications and Curriculum Authority. These and other changes

allow schools and colleges a very wide range of academic and applied courses from which to choose what they offer their students. While such range can be welcomed, it is not clear on what basis choices will be made and how this will differ across institutions. It is important therefore to monitor these and other changes in school science education to ensure that they do not have any negative effects on continuation into science in HE.

56 In March 2006, the Society held a stakeholder conference on increasing uptake of science post-16 from which arose a number of recommendations for action and research. The priority for increasing capacity in the school/college sector is to ensure science teachers with appropriate backgrounds are recruited, retained and given access and entitlement to professional development throughout their careers. A skilled, enthused and appropriately deployed teaching profession will be able to tackle some of the weak points in the supply network: maintaining interest in science through the often problematic transition from the end of Primary school into Secondary school; raising the profile of vocational science and engineering courses; and motivating students to continue with physics, chemistry and maths post-16 despite perceptions of their relative difficulty or relevance.

**Academic careers**

57 It is essential to ensure that sufficient high quality graduates are retained within universities. The Society has a range of programmes designed to help some of the highest quality scientists and engineers at key transitional stages (see paragraph 62), but we have major concerns about whether academic careers are now sufficiently attractive to secure the future faculty of the university system. While the Government's response to the Roberts recommendations (HMT 2002) has gone some way to improving the situation at postdoctoral level, more needs to be done to improve the attractiveness of permanent academic teaching posts.

## Relevant current and ongoing Royal Society activities

58 The Society's ongoing policy work in HE has already been mentioned (paragraph 2 and Annex A), and we will keep the Committee informed of progress. The Society also has a number of activities and schemes that are highly relevant to the issues underlying this inquiry.

59 The Society is committed to considering the education system in its entirety wherever possible. The future of science in the HE sector is dependent on the opinions formed and vital decisions made during Primary and Secondary education, and of course these sectors are directly linked through the supply of science graduates into initial teacher training. Our policy work therefore includes a focus on: maintaining quality and purpose for science and mathematics within the 14-19 curriculum; increasing supply and retention of specialist science teachers; and ensuring adequate provision for young people to undertake scientific investigations in schools and colleges.

60 The extent of the challenge is such that a major, coherent response to the challenges facing science and mathematics education is needed on the part of the science, engineering and education communities in collaboration with government, the devolved administrations and industry. The Society is playing a prominent role in bringing this about. Together with the Joint Mathematical Council we set up ACME, the Advisory Committee on Mathematics Education, which successfully brings coherence to the views of the mathematics community and helps chart the future of mathematics education. With a view to providing a similarly coherent and influential voice for the science community, we have taken the lead in establishing a partnership of key science community and science education organisations, SCORE (the **S**cience **Co**mmunity Pa**r**tnership Supporting **E**ducation). The group comprises the Association for Science Education, the Biosciences Federation, Institute of Physics, Institute of Biology, Royal Society of Chemistry, Science Council

and ourselves, and is devoting its collective resources to increasing the numbers of young people studying science at school and progressing to study science and engineering at further and higher education levels.

61 The Society also directly supports collaborations between universities and schools through its Partnership Grants scheme, offering up to £3,000 to schools wanting to undertake a creative science project in conjunction with a scientist or engineer. These experts can bring cutting-edge knowledge and enthusiasm into the classroom, and can act as motivators and role models for young people. Therefore we are also piloting a new training course for scientists interested in working with schools. Our Summer Science Exhibition also attracts around 1,000 post-16 students each year.

62 The Society also has a number of schemes, funded both from the Science Budget and from its own resources, to support academic research careers. The Society believes that the key to the highest scientific achievement lies in the recognition and fostering of individual quality. The Society's largest funding programme, the University Research Fellowships, aims to provide stability for promising researchers and the freedom to build independent research careers. The scheme has been running since 1994 and during this time over 800 researchers have been funded. Currently the scheme offers up to ten years' support in the form of salary and research expenses.

**Royal Society/Wolfson Research Merit Awards** aim to attract key researchers, with great potential or outstanding achievement, to this country or to retain those who might seek to gain higher salaries overseas. The awards provide funding for salary enhancement and some research expenses. The Society also aims to provide schemes to retain scientists within academic research at different points during their careers:

- **Dorothy Hodgkin Fellowships** provide a first step into an independent research career for excellent scientists and engineers for whom career flexibility is essential.
- **UK Relocation Fellowships** aim to help researchers who wish to move to follow a partner who has changed place of work and moved a significant distance.
- **Professorships** provide long-term support for world-class scientists, allowing them to focus on research and collaboration.

We are further supporting these exceptional individuals through new training and mentoring arrangements to help them play key roles in strengthening the UK science base. Increasing our emphasis on applied science and engineering, we are introducing new initiatives to enhance the transfer of knowledge from the science base into business. Through training in innovation and entrepreneurship, the research fellows will be better equipped to capitalise on research with the potential for commercialisation. The Royal Society is committed to supporting and recognising innovative science through a range of funding schemes and awards:

- **Brian Mercer Awards for Innovation** and the **Brian Mercer Feasibility Awards** provide funding to test the viability of an idea or concept through to near market commercialisation.
- **The Mullard Award** is an annual award recognising the scientific achievements of an individual and their contribution to the national prosperity of the UK.
- **Paul Instrument Fund** finances projects designing and constructing novel scientific instruments in the field of the physical sciences.
- **Industry Fellowships** support knowledge transfer between academia and industry.

UK science is strengthened by interaction with the best scientists and engineers worldwide and to facilitate this we are expanding our range of grant schemes which cater for **incoming and outgoing fellowships** and **visits**, **joint projects** and **conference attendance**. We hope soon, with government support, to supplement our existing exchanges with a **new international fellowship scheme** modelled along the lines of the Humboldt scheme in Germany.

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# Annex A Royal Society study: *Science HE 2015 and beyond*

## 1 Background

In 2005, the Royal Society responded to the House of Commons Select Committee on Science and Technology's inquiry into strategic subjects. This prompted the development of a pilot project, which explored the supply of and demand for graduates from first degree courses in science, technology and mathematics (STM). Work undertaken as part of the initial study has started to provide a better idea of the numbers of and skills, knowledge and experience of students joining the university system and has been reported in *A degree of concern? UK first degrees in science, technology and mathematics.* A number of issues identified in the report have resulted in the setup of this project to consider whether STM HE provision in the UK will be fit for purpose by the second half of the next decade and beyond.

## 2 Scope of the project

This phase of the project is considering whether the overall STM HE provision in the UK will be fit for purpose by the second half of the next decade. Considerations of whether UK STM HE is fit for purpose must include the needs of society and the economy for STM-trained individuals at all levels; the skills, knowledge, experience and intention of those entering the HE system; the international competitiveness of the UK HE system; and the political and economic context in which HE exists. Selected issues that have been identified for further investigation are:

- The demand for STM graduates from the economy and wider society, and how this demand is changing.
- The quantity of those graduating at all levels of the higher education system, and the quality, depth and breadth of their educational and training experiences
- The length of time HE studies should take, and how that time should be broken down (with reference to the Bologna proposals to standardise the structure of HE across Europe).
- The current discipline boundaries and whether a general science first degree option could be appropriate.
- The changes to the skills, knowledge and experience of those entering the HE system and how the HE system can accommodate such changes.
- The need to allow students to be flexible in their choices of occupation as they gain their qualification and afterwards.
- The impact, on the UK, of international flows of students and STM professionals.

The Society's HE working group issued a call for evidence on these issues in summer 2006. The group is now taking forward work in these areas and expects to report in autumn 2007.

## 3 Membership of the higher education working group

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Professor Alexander Halliday FRS, Professor of Geochemistry, Oxford University
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