



House of Commons
Science and Technology
Committee

Strategic Science Provision in English Universities

Eighth Report of Session 2004–05

Volume I

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Eighth Report of Session 2004–05

Volume I

Report, together with formal minutes

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The Science and Technology Committee

The Science and Technology Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Office of Science and Technology and its associated public bodies.

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Summary

The Government has placed graduates in science, technology, engineering and mathematics (STEM) subjects at the heart of its political and economic agendas. STEM graduates are needed to drive innovation, research and development, to support the financial services industry, to underpin policy-making, and to teach and inspire future generations of scientists. Yet the number of students choosing to take a STEM subject at undergraduate level has been in decline for several years. One of the most worrying symptoms of this decline is the recent closure of a number of important university departments, particularly in chemistry, mathematics, physics and engineering. Such closures have compounded the problem of declining student numbers. If they continue unchecked, the system may find it difficult to cater for the future increases in uptake that are so fundamental to the realisation of the Government's ambitions.

In the past, the problem of falling numbers of STEM graduates has been addressed through interventions to secure the supply of university places. However, these measures tend to be short term in impact and have only had the effect of patching up a system that continues to allow deterioration. Only by addressing the root cause of the decline in student numbers can further departmental closures be prevented. This means inspiring pupils in schools to study science—by employing teachers who can teach creatively and enthusiastically; by changing the curricula to make them more relevant to pupils; and by increasing the proportion of school science that is practically-based. These measures will not create a transformation overnight, but without them nothing will change. As an interim measure we have recommended that the Government provide bursaries for students to study STEM subjects at undergraduate level.

The problems experienced by university STEM departments of low and declining demand from students have been compounded by the funding arrangements for research and teaching. Both the Higher Education Funding Council for England (HEFCE) and the Research Councils fund research on the basis of excellence. The result of these policies in combination is the concentration of research in a small number of departments. Whilst this may be necessary to ensure the international research standing of the best-performing departments, it has left those departments that have not been similarly well rewarded struggling to cope. This financial problem has been compounded by the high cost of teaching STEM disciplines, a cost that is not adequately recognised in the teaching funding formula used by HEFCE. We have recommended that the teaching funding weightings be changed to reflect the costs of teaching STEM subjects, as revealed by using the new TRAC methodology. Teaching funding should be sufficient to meet the costs of teaching without cross-subsidy from funding intended for research.

In 2008, the research funding formula employed by HEFCE will change. This should go some way to reducing the steep funding differential between the departments which are deemed to have the best research performance (graded 5 or 5*), and the departments that are deemed not to have performed so well (graded 4 or below). Nonetheless, the new arrangements will not relieve the immediate plight of most struggling departments. Nor will they change the fact that there are too many departments competing for limited funds. Assuming that the Government is unlikely to increase the total money in the system in the

short term, no amount of tinkering with the funding allocations will ensure that all departments can become financially sustainable on the basis of their research income. Furthermore, we may jeopardise those departments that are currently our strongest assets.

The solution that the Committee proposes is radical. Instead of allowing 130 universities to compete on the same basis for research and teaching funding, to the benefit of a small proportion but the detriment of many, the Government should seek to encourage a system in which each institution can play to its strengths. We recommend that a “hub and spokes” model is employed, to be coordinated on a regional basis by a new Regional Affairs Committee, located within HEFCE and including representatives from each of the Regional Development Agencies. This new Committee would ensure that each region had at least one major “research hub” in each of the core disciplines. Departments would be awarded this status on merit through open competition. Other departments would be free to determine their own focus on the basis of their strengths, whether it be on research, teaching or knowledge transfer, and could bid for funds accordingly. The work of teaching students would be shared out within each region between research and teaching departments, as appropriate. Instead of all competing for the same limited number of prizes, institutions would collaborate and pool their strengths to provide the best possible experience for all their students. The Government is currently passively pursuing a policy of research concentration that will call the financial viability of some universities into question. A far better policy would be a one of *actively* encouraging diversity within the university sector, and providing the means for this to happen.

The short term approach to university funding has led to a worrying decline in the number of students graduating with STEM degrees and a number of departmental closures. Unless some important long term measures are taken to ensure the sustainability of the sector, the Government may find that it does not have enough STEM graduates to meet its economic goals.

1 Introduction

1. The Science and Technology Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Office of Science and Technology (OST) and its associated bodies. One of OST's principal roles is to oversee science and technology policy across Government. The Committee explores this aspect of OST's work by inquiring into the work of other Government departments where their policies have a significant science and technology dimension. Universities fall within the remit of the Department for Education and Skills (DfES). However, the provision of university science, technology, engineering and mathematics (STEM) courses, and the resulting supply of STEM graduates, has a significant impact on the health of the UK's Science and Engineering Base (SEB) in particular, and on the national economy in general.¹ Our decision to inquire into strategic science provision in English universities was based on the premise that good scientific education leads to a thriving scientific and innovative culture. This Report builds on our earlier Report on *Science Education from 14 to 19*, which looked at science teaching at secondary school level.² As is outlined in chapter 4, many of the recommendations of this earlier Report would, if successfully implemented, lead to an increase in the number of students choosing to study STEM subjects at university, and consequently in the supply of STEM graduates entering the workforce.

2. Education is a devolved issue: university funding is distributed via the four national funding councils, of which the Higher Education Funding Council for England (HEFCE) is one. Although many of the issues explored in our inquiry are undoubtedly applicable to university STEM departments in Scotland, Wales and Northern Ireland, our conclusions and recommendations are confined to universities in England. Where a policy area is not devolved, for example trade and industry, the Report refers to the UK as a whole.

3. The Committee announced its inquiry into strategic science provision in English universities on 21 December 2004.³ The inquiry was launched in response to a number of closures of university STEM departments. In particular, in November 2004, Exeter University announced that it would close its chemistry department, a decision that was subsequently questioned in Parliament. Other disciplines, notably some modern languages, have experienced departmental closures too.⁴ In this inquiry we have looked at the issue of strategic science provision as a whole, and have not dealt with individual departmental closures.

4. The Committee's terms of reference for the inquiry were:

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- 1 Throughout this Report, the acronym STEM has been used to refer comprehensively to science, technology, engineering and mathematics. The same acronym is sometimes used elsewhere to refer to science, technology, engineering and *medicine*. We have chosen to use this particular acronym to avoid the pitfalls caused by usage of the terms STM (science, technology, medicine) and "science", which are sometimes perceived to exclude key disciplines (for example, mathematics).
 - 2 Third Report from the Science and Technology Committee, Session 2001–02, *Science Education from 14 to 19* (HC 508)
 - 3 Press notice 12 of Session 2004–05.
 - 4 Exeter University also announced that it would close its Italian and music departments.

- The impact of HEFCE's research funding formulae, as applied to Research Assessment Exercise ratings, on the financial viability of university science departments;
- The desirability of increasing the concentration of research in a small number of university departments, and the consequences of such a trend;
- The implications for university science teaching of changes in the weightings given to science subjects in the teaching funding formula;
- The optimal balance between teaching and research provision in universities, giving particular consideration to the desirability and financial viability of teaching-only science departments;
- The importance of maintaining a regional capacity in university science teaching and research; and
- The extent to which the Government should intervene to ensure continuing provision of subjects of strategic national or regional importance; and the mechanisms it should use for this purpose.

5. In the course of our inquiry we held four oral evidence sessions. At these sessions we took evidence from:

- a panel of students, the Higher Education Policy Institute (HEPI) and HEFCE on 7 February 2005;
- OST, Research Councils UK (RCUK), the Regional Development Agencies (RDAs) and the Association for University Research and Industry Links (AURIL) on 28 February 2005;
- a panel representing learned societies and the Association of University Teachers (AUT) on 2 March 2005; and
- a panel of university Vice Chancellors and a Minister from the Department for Education and Skills (DfES) on 9 March 2005.

The transcripts of these sessions are published with this Report, along with the 98 written submissions we received in response to our call for evidence and as answers to supplementary written questions. We would like to place on record our thanks to OST and DfES for their prompt and helpful responses to our many queries throughout the course of this inquiry. We would also like to thank our specialist adviser, Professor Michael Elves, formerly the Director of the Office of Scientific and Educational Affairs at Glaxo Wellcome Plc.

Time constraints

6. Strategic science provision in English universities is a weighty and complex subject. Many of the individual issues raised in our terms of reference, and that arose subsequently during the course of the inquiry, could form the basis for entire Reports in themselves. By contrast, the time available for the Committee to conduct its inquiry has been limited by

our aim to publish a Report before the Dissolution of Parliament, widely expected to take place in April 2005. This Report is necessarily concise and we acknowledge that we have not been able to pursue every thread of our inquiry as fully as we would have liked had time permitted. The Committee was, however, fortunate that the bulk of the evidence that it took, both orally and in writing, revealed a broad consensus on many of the key issues relating to the provision of STEM disciplines in English universities. Whilst it has not been possible in the time available to make reference in the body of the Report to every aspect of the evidence that we collected, the basis for our conclusions and recommendations can clearly be traced in the material published in volume II.

Working assumptions

7. Throughout the inquiry we have heard many calls for extra funding to be injected into the university system to support the provision of STEM subjects at both undergraduate and postgraduate levels. Many submissions saw this as key to the continuing financial viability and academic excellence of university STEM departments. However, we believe that it is extremely unlikely that the Government will commit to further increasing the value of the total pot of money available to such departments in the immediate future. Indeed, in oral evidence, Dr Kim Howells MP, Minister of State for Lifelong Learning, Further and Higher Education in the Department for Education and Skills, told us that “we are increasing the quantum but in a way that it has never been increased by any other government previously. [...] The universities have never had more cash than they have got now”.⁵ **Given the unlikelihood of increased overall funding, this Report focuses on ways in which existing funds can be used more effectively to ensure good provision of STEM subjects in English universities.**

2 The current situation

Why do we need STEM graduates?

8. In 2004, the Government placed science at the heart of its political and economic agendas with the publication of its *Science and Innovation Investment Framework 2004–2014* and the announcement of significant increases in funding for UK science.⁶ The *Investment Framework* is one of a series of recent Government publications that explicitly link the health of the UK’s Science and Engineering Base (SEB) with the maintenance of a vibrant economy. In the introduction to the *Innovation Report*, published by the Department of Trade and Industry (DTI) in December 2003, Lord Sainsbury, the Minister for Science and Innovation, stated that “our vision is that we should be a key hub in the global knowledge economy. This means that the UK should be a country famed not only for its outstanding record of discovery but also for innovation, a country that invests heavily in business R&D [research and development] and education and skills, and exports high-tech goods and services to the world”.⁷

9. Universities, and the students that they educate, are central to the Government’s vision. The *Investment Framework* establishes a link between the volume of STEM graduates and the health of the economy, stating that “to support the UK’s ambition to move to a higher level of [R&D] intensity, it is crucial to ensure that the UK has the right stock and flow of skilled scientists, technologists, engineers and mathematicians, as well as technicians and other R&D support staff, generated from the UK and attracted from abroad”.⁸ STEM graduates are needed for:

- a) **Research and Development.** The *Innovation Report* explains that, “for the economy as a whole innovation is the key to higher productivity and greater prosperity for all”.⁹ The seventh annual statistical digest published jointly by the Engineering Council (UK) and the Engineering and Technology Board (etb) in July 2004 states that “in order for the UK to compete in products and services requiring technical innovation, it is crucial that we continue to produce high quality engineers and scientists in sufficient quantity to supply the needs of industry”.¹⁰ A strong national R&D base plays an important role in attracting businesses and investment from abroad.
- b) **Academic research.** The *Lambert Review of Business-University Collaboration* states that “research-intensive universities play a central role in the most dynamic economic regions of the UK, and it is rare to find a business cluster which is not associated in some way with one or more local universities”.¹¹ Not only does research in the higher

6 HM Treasury, Department of Trade and Industry and Department for Education and Skills, *Science and Innovation Investment Framework 2004–2014*, July 2004

7 Department of Trade and Industry, *Innovation Report: Competing in the global economy: the innovation challenge*, December 2003, p 5

8 HM Treasury, Department of Trade and Industry and Department for Education and Skills, *Science and Innovation Investment Framework 2004–2014*, July 2004, p 81

9 Department of Trade and Industry, *Innovation Report: Competing in the global economy: the innovation challenge*, December 2003, p 9

10 The Engineering Council (UK) and the Engineering and Technology Board (etb), *Digest of Engineering Statistics 2003–04*, July 2004, p 27

11 HM Treasury, *The Lambert Review of Business-University Collaboration*, December 2003, p 9

education sector help to drive the economy through links to business, it also helps to improve quality of life, for example through medical and social research; it enhances the national knowledge base; and it equips researchers with valuable transferable skills. Furthermore, if the UK produces a high number of researchers, it is able to send a proportion of them abroad to tap into global research networks, bringing their knowledge and skills back with them when they return, and building the international reputation of the UK.

- c) **Teaching.** Good teaching in STEM disciplines, at school, college and university level, creates and inspires new generations of scientists. Less tangibly, it raises the level of scientific literacy in the population as a whole, helping to inform the public response to, and influence the likely take-up rate of, emerging technologies such as genetic modification and nanotechnology. The *Investment Framework* states that “it is important that we enthuse and inspire young people and enable them to become informed citizens or scientists of the future, willing and able to engage with science”.¹²
- d) **Policy formation and implementation.** Science is used across Government departments to inform and underpin new policies, or as part of the policies themselves. Our Report on *The Use of Science in UK International Development Policy* demonstrated that good use of science can be crucial to effective policy delivery.¹³
- e) **Infrastructure.** The School of Civil Engineering and the Environment at the University of Southampton, for example, states that its researchers are working on topics such as “transportation, infrastructure, sustainable urban environments, waste and resource management, coastal and marine engineering and sustainable energy”.¹⁴ STEM graduates also have an increasing role to play in ensuring the sustainability and environmental suitability of new technologies.
- f) **Transferable skills.** Graduates with science, engineering, technology and numerical skills are prized in a wide variety of organisations and sectors. For example, financial services, property and business services are the sectors where the amount of GDP generated by the science, engineering and technology community is estimated to be the highest.¹⁵ The inquiry by Professor Adrian Smith into mathematics education post-14, *Making Mathematics Count*, demonstrated the versatility of mathematics and numerical skills, and the importance of their contribution to the economy across all sectors.¹⁶

10. The need for STEM graduates can also be expressed in negative terms. A 2002 study by the National Institute of Economic and Social Research showed that “where the UK loses out in terms of skills levels of engineers (and scientists) and in the associated innovative

12 HM Treasury, Department of Trade and Industry and Department for Education and Skills, *Science and Innovation Investment Framework 2004–2014*, July 2004, p 85

13 Thirteenth Report from the Science and Technology Committee, Session 2003–04, *The Use of Science in UK International Development Policy* (HC 133)

14 Ev 144

15 The Engineering and Technology Board (etb), *The Frontiers of Innovation: Wealth Creation from Science, Engineering and Technology in the UK*, April 2004, p 14

16 Department for Education and Skills, *Making Mathematics Count, The Report of Professor Adrian Smith’s Inquiry into Post-14 Mathematics Education*, February 2004

activity, then a loss of competitiveness occurs in terms of a loss of domestic market share, loss of international trade share and in lower productivity levels”.¹⁷ If the UK does not get its supply of STEM skills right, the damage to the economy could be substantial. **STEM graduates help to maintain the healthy operation of society at all levels—by driving the economy; by generating knowledge and innovating; by raising the scientific literacy of the population as a whole; by informing Government policy; and by aiding participation in international research networks.**

11. Whilst the need for STEM graduates is self-evident, its extent (“the right stock and flow” described in the *Investment Framework*) is difficult to quantify. Sir Howard Newby, Chief Executive of HEFCE, told us that “I do not think there is a one-to-one relationship between the volume of science graduates and the performance of the economy, but there certainly is a relationship”.¹⁸ This lack of clarity is partly due to the relative intangibility of the benefits of a scientifically-literate population. It also derives from uncertainty on questions of self-sufficiency: does the UK *itself* need to produce enough STEM graduates to meet all of its economic needs, or is it acceptable, or desirable, for it to recruit some of its scientific, engineering and technical workforce from abroad? Whilst there is clearly a minimum level of domestic graduates required to maintain the capacity of the SEB in the long term, these are not questions for which there are straightforward answers, as will be seen in Chapter 3 of this Report.

Departmental closures

12. The announcement made by Exeter University of its decision to close its chemistry department, and the subsequent campaign—by students, staff and parents—to keep it open, focussed public attention on the financial difficulties experienced by some university STEM departments. Boxes 1 and 2, below, use the closure of the chemistry department at Exeter University as a case study. The evidence we have collected suggests that the problems experienced by university STEM departments are at their worst in the physical and chemical sciences, engineering and mathematics. In general, biological sciences departments have tended to experience fewer difficulties, possibly because of a combination of higher student numbers and lower teaching and research costs. However, as Professor Tom Blundell of the Biosciences Federation told us, the situation is “very uneven in biology [...] within the biological sciences, we have less biochemists and more psychologists and brain scientists. The total numbers hide the real problems”.¹⁹

17 G. Mason and K. Wagner, National Institute of Economic and Social Research, “Skills, Performance and New Technologies in the British and German Automotive Component Industries”, July 2002. See the Engineering Council (UK) and the Engineering and Technology Board (etb), *Digest of Engineering Statistics 2003–04*, July 2004, p 50

18 Q 190

19 Q 328

Box 1: Closure of chemistry at Exeter: Timetable of events*Imagining the Future*

In November 2004 the Vice Chancellor of Exeter University, Professor Steve Smith, produced a document entitled *Imagining the Future*, in which he set out the financial challenges faced by the university. In it he said that “our growth needs to be selective. We are currently spreading our jam too thinly and cannot sustain or achieve international excellence over the 37 subjects we submitted to the 2001 RAE”. He proposed that, other than at the interfaces with physics and biology, chemistry should be phased out as a separate discipline at Exeter.²⁰ Cuts were also planned for Italian and music.

Heads of Schools

The Heads of Schools most affected by the proposed changes met individually with the Vice Chancellor between 5–9 November 2004.

Meeting of Senior Management Group

The news was broken to all Heads of School and the Guild of Students at a meeting of the Senior Management Group (SMG) on 18 November 2004. SMG was asked to keep the information confidential until other groups had been told.

Media disclosure

The Royal Society of Chemistry issued a press release on 19 November 2004, ahead of the university’s own announcement, planned for 22 November. The story broke in the press.

Student updates

Students were updated on developments by letters sent on 25 November and 10 December 2004, and on 11 January, 17 January and 3 February 2005. Student visits to the chemistry departments at Bath and Bristol were organised for 11 February 2005, and students were offered one-to-one meetings with the Vice Chancellor on 14 February 2005.

Informal Committee meeting with Professor Steve Smith

On 14 December 2004, the Committee held an informal meeting with the Vice Chancellor of Exeter University to discuss the reasons underlying the closure of the chemistry department.

Oral evidence sessions

A first-year chemistry student from Exeter University, Danielle Miles, gave oral evidence to the Committee on Monday 7 February 2005. The Vice Chancellor, Professor Steve Smith, gave oral evidence to the Committee on Wednesday 9 March 2005. Each appeared as part of a panel of witnesses.

20 Professor Steve Smith, Vice Chancellor of Exeter University, *Imagining the Future*, November 2004

Box 2: Reasons underlying the closure of the chemistry department at Exeter

At Exeter, science subjects were being heavily cross-subsidised from other subjects. The following departments were operating at a loss:

- **Chemistry:** £0.8 million
- **Biology:** £0.8 million
- **Engineering:** £1 million
- **Geography:** £0.3 million

In an informal meeting with the Committee, Professor Smith provided data showing the changes in income to departments at Exeter University as a result of the Research Assessment Exercise (RAE) 2001 (see box 3, in chapter 5).

Exeter University did not have sufficient funds to support all its departments that had received a grade 4 in the RAE in 2001. It had to close one of them. Biology and engineering were perceived to be of greater strategic importance to the university than chemistry, although the engineering department did see substantial cuts.²¹

Campaigners to save the chemistry department at Exeter have reacted angrily to claims that the department had to close partly because of difficulties with student recruitment. The Royal Society of Chemistry, for example, states that demand for chemistry was “buoyant”.²²

The chemistry department at Exeter had met its target numbers and was not in clearing. However, its student quota had been reduced by 21% from 2000. Furthermore, although chemistry and biology at Exeter incurred similar staff costs for teaching, chemistry only had 201 students, whilst biology had 380. In oral evidence, Professor Smith told us that the quota for chemistry students had gone down because the university was finding it difficult to recruit sufficiently well qualified students.²³

13. The pace at which university STEM departments are closing has accelerated since 2001. As well as the chemistry department at Exeter, there have been high profile closures of chemistry departments at Kings College London, Queen Mary London and Swansea University; of physics departments at the University of Newcastle and Keele University; of mathematics at the University of Hull; and of civil engineering at Aston University. The Institute of Physics states that, since 2001, 30% of university physics departments have either merged or closed. There are currently 36 physics departments in England and 48 in the UK.²⁴ The Institution of Civil Engineers states that, between 1996 and 2001, the number of civil engineering departments submitting to the Research Assessment Exercise decreased from 40 to 29, a 37% decline.²⁵ For chemistry, Professor Michael Sterling, Vice Chancellor of Birmingham University and Chairman of the Russell Group of universities, told us that “as I understand it there are more than 40 chemistry departments nationally so

21 Q 423

22 Ev 183

23 Q 419

24 Ev 131

25 Ev 227

that is quite a long way from a crisis”.²⁶ However, there have already been several closures in this subject and, as is outlined below, many more are expected.

14. It seems unlikely that the recent flurry of departmental closures will end soon. The Association of University Teachers states that currently “there are approximately 35 to 40 chemistry departments. However, the best case scenario put forward by the [Royal Society of Chemistry] is that 20 will survive and at worst only 6 (Durham, Cambridge, Imperial, UCL, Bristol and Oxford) will remain in 2014”.²⁷ The Royal Society of Chemistry (RSC) has found that chemistry departments tend to operate at a loss. Dr Simon Campbell, President of RSC, told us that “we have surveyed eight chemistry departments across the country and all of them are running at a loss. The loss range is between 20 and 60 per cent of their budget. In every case, research is subsidising teaching”.²⁸ Departments operating at a deficit are likely to be considered for mergers and cuts by universities needing to reduce their costs, leaving expensive STEM departments vulnerable. As will be shown in chapter 3 of this Report, the downward trend in the number of STEM departments is not reflected in the number of employment opportunities available to STEM graduates, particularly those from physics, chemistry, mathematics and engineering backgrounds. There will come a point beyond which the number of remaining university STEM departments will be unable to meet employer demand. This alone is a powerful argument for halting or reversing the current trend of departmental closures.

15. Whilst it may be exaggerating to say that university STEM departments are in crisis, it is clear that their numbers are experiencing a sharp decline. Since the financial situation faced by these departments is unlikely to change in the short term, it is reasonable to assume that there will be further closures. If this process continues unchecked, there is a very real possibility that the system will no longer be able to provide sufficient numbers of STEM graduates to meet the needs of the UK economy. Unless the Government takes action now, it will have a crisis on its hands in the foreseeable future.

Consequences of closures

16. Departmental closures set in motion a vicious cycle of events. As the number of departments teaching a particular subject decreases, so does the number of teachers of that subject produced by the university system. The lack of teachers and the negative impression created about the subject by departmental closures in turn cause a decline in demand from schoolchildren for university courses in the subject. As student demand declines, more departments struggle to survive financially, and more are forced to close (see chapter 4). The same negative trends can be seen at a regional level. Departmental closures in core STEM subjects make a region less attractive to business, thereby reducing the level of knowledge transfer and commercialisation activities that can take place there. One of the main concerns about the closure of STEM departments is that capacity in some subjects will drop so low that it will be impossible to accommodate any future, much needed, increases in student demand. The cost of re-equipping and re-staffing a previously

26 Q 426

27 Ev 282

28 Q 320

closed STEM department is prohibitive. Thus, the RSC told us that “a chemistry department that is closed and staff dispersed is unlikely to be reopened: the capacity is lost for ever”.²⁹ **Given the Government’s goal of increasing the number of students taking STEM courses, it is essential that sufficient capacity is maintained in the system to meet a possible future growth in student demand.**

17. We received evidence that suggested that claims about the irreversibility of departmental closures might be exaggerated. The panel of Vice Chancellors we saw on 9 March told us that, when a department closed, capacity tended to be transferred elsewhere rather than lost altogether. Thus, Professor Sterling said that “there is a misconception that chemistry only exists within a chemistry department. [...] What tends to happen is that if there is a decline in interest in one subject area you might dissolve the departmental boundary, but those chemists end up in other areas and that process can be reversed”.³⁰ This is increasingly true as the boundaries between disciplines become more blurred. At Exeter, for example, many of the current chemistry staff will be absorbed into the university’s growing biosciences department, where they will carry out work at the interface between the two disciplinary areas. Professor Alasdair Smith, Vice Chancellor of the University of Sussex, described a different way of retaining capacity: “we have coped with the effect of declining student numbers by reducing the size of mathematics, [...] physics, chemistry and engineering, and if there were a turnaround nationally then we would have very substantial capacity for expanding those departments back up”.³¹ Whilst these examples show that there is limited potential within the system to increase capacity in some subjects again should the need arise, we remain concerned about the disappearance of university departments in some core STEM subjects, whether or not their capacity has been absorbed by departments in other disciplines. The Association of the British Pharmaceutical Industry (ABPI), for example, told us that there were very few degrees, even those in core STEM subjects, that were an appropriate substitute for chemistry: “of particular concern is the supply of chemists [...] Although numbers following biological degrees have held up well, the relevance of the training has not”.³² A biology degree, however rigorous, will not equip a student with the same set of skills as a chemistry degree. By failing to provide specific chemistry training for students, universities may be limiting their employment options. When a department in a particular subject is closed, arrangements need to be made to ensure that students can continue to study that subject in its pure form.

18. Although the debate about departmental closures has tended to focus on individual cases, the main concern is for the outlook for overall provision of STEM subjects at a national and regional level. Thus Dr Campbell of RSC told us that “the worry that we have at the moment is that the closures we are seeing are cost driven and random. There is no sense of a national strategy and there is no sense of regional needs”.³³ One method that has been used to mitigate against the loss of capacity in individual STEM departments is for departmental closures to be regulated at a regional level. Whilst the closure of the

29 Ev 186

30 Q 424

31 Q 425

32 Ev 170

33 Q 318

chemistry department at Exeter has attracted an extremely adverse press coverage, the regional mechanism appears to have worked well in its case. Nick Buckland, Vice Chair of the South West of England Regional Development Agency, told us that, despite the closure, “we work with the universities in the region, so, as I said earlier, we have the same level of provision of chemistry within the region and they have pushed into their strengths, and are at roughly the same level of capacity”.³⁴ The Vice Chancellor of Exeter University agreed, telling us that the steps taken within the region “actually increase[d] the number of funded places for chemistry in the south-west”.³⁵ The regional dimension to the debate surrounding departmental closures is explored in detail in chapter 7 of this Report.

19. Further closures of university STEM departments would be a source of serious concern to us. However, the closure of an individual department need not entail a permanent loss of capacity in that subject, providing that suitable alternative arrangements for current students and long term planning for potential future increases in student demand is in place at a regional and national level. Chapter 6 sets out a blueprint for the form that this strategic planning should take.

20. The headline-grabbing individual instances of departmental closures are only a symptom of a much broader and more intractable problem. Student demand for STEM subjects, both at school and at university, has been in steady decline for the past ten years. If not addressed, this lack of demand, compounded by problems with university funding mechanisms, will continue to call into question the viability of university STEM departments (student demand and university funding will be discussed in detail in chapters 4 and 5 of this Report). Universities UK told us that “if progress is not made based on robust and relevant experience that helps identify the true nature of the problems and informs longer term sustainable solutions we could ultimately end up with short term micro management of the research base in a response to current ‘hot spots’ which, aside from its own unintended consequences, would distort institutional strategies and priorities”.³⁶ **There is little point in patching up the system in the short term if measures are not taken to address the underlying reasons for the difficulties faced by university STEM departments. It is essential that any measures taken to prevent further loss of capacity in the system are underpinned by a strategic approach.**

34 Q 304

35 Q 403

36 Ev 261

3 Skills

Is there a skills shortage?

21. STEM graduates make an invaluable contribution to the economic health and growth of the country, as is outlined in paragraphs 9 to 10 of this Report. As increasing numbers of university STEM departments come under threat, there is some concern that English universities will no longer be able to produce a sufficient number of STEM graduates to meet economic needs, both now and in the future. Indeed, evidence of the impact of the closure of university departments on employers is already available. The Chemical Industries Association (CIA) told us that “the decline in students is impacting directly on university chemistry courses leading to a shortage of graduates. The CIA believes that UK industries that rely on their ability to do chemistry will not be sustainable without them”.³⁷ The impact on the economy as a whole could be even greater. CIA states that, in a global business environment, “companies make strategic decisions every day on where to place their business globally. A key element to this decision-making is the local availability of skills [...] The closure of chemistry departments, potentially leading to a reduction in the overall UK skills base, may therefore have a direct effect on UK PLC’s bottom line with jobs and revenue moving abroad. We believe that this has already begun to happen”.³⁸ **Making sure that the UK can meet the demands of employers for skilled personnel is key to ensuring that it can maintain its competitive edge in a global market.**

22. We received extensive evidence of skills shortages in specific areas. Astra Zeneca told us that “in particular we are experiencing a deficit in the number of individuals who are willing to work with animals, an acute lack of graduate and PhD *in vivo* pharmacologists, a paucity of scientists in areas of integrative science such as drug metabolism and pharmacokinetics and diminishing numbers of suitably qualified chemists, toxicologists, post-graduate pharmacists and pathologists”.³⁹ Shortages of *in vivo* pharmacologists have also been highlighted by the Association of the British Pharmaceutical Industry (ABPI) as a problem for industry in the UK.⁴⁰ Most of the learned and professional societies that submitted evidence to us were able to pinpoint specific skills shortages within their fields. For example, both Professor Tom Blundell of the Biosciences Federation and the Society for General Microbiology expressed concern about the national shortage of skilled microbiologists.⁴¹ Across all the disciplines there was widespread concern about the general shortage of graduates with advanced numerical skills.

23. The specific instances of skills shortages cited in evidence to this inquiry are consistent with a general trend identified in comprehensive studies of the market for STEM graduates. A 1999 study carried out by the then Department for Education and Employment found that 57% of recent recruiters of technical electronics graduates had experienced “some difficulty” in meeting their recruitment targets. This compared to 43%

37 Ev 230

38 Ev 230

39 Ev 121

40 Ev 168

41 Q 328, Ev 144

of recent recruiters in R&D, 41% in machinery, 37% in computer services and 33% in pharmaceuticals.⁴² In their 2002 market survey, the Sector Skills Council for Science, Engineering and Manufacturing Technologies (SEMTEA) found that, across their sector, 25% of establishments had found it difficult to fill some vacancies in the previous 12 months. This was actually an improvement on previous years: in 1999, 36% of establishments had found it difficult to fill some of their vacancies, and in 1998 the proportion stood at 49%. According to the SEMTEA survey, particular recruitment difficulties were experienced in leading areas of technological development; areas requiring a hybrid of technological skills with “softer” generic business skills; and in production.⁴³ Overall, the proportion of STEM employers that are experiencing some difficulty in filling vacancies is high relative to other sectors. In some specific areas recruitment difficulties have become acute, most notably for organisations seeking to employ graduates with a chemical sciences background.

24. The problems experienced by employers are reflected in the relative ease with which STEM graduates currently find employment. The Director General of the Research Councils (DGRC), Professor Sir Keith O’Nions, told us that, “of all the PhDs who graduated in physical science and engineering in 2003, 79 per cent of them were in jobs in 2004, which is very good news, and 42 per cent were in jobs where they were in research roles and of those about half were in the educational system”.⁴⁴ Professor Boucher of the Royal Academy of Engineering gave us a similar statistic: “the fact is that currently, on graduation, 85 per cent of students graduating in engineering and indeed the sciences are in employment at the muster date, which is 31 December year of graduation”.⁴⁵ **Whilst it is “good news” for STEM graduates that so many of them find employment so quickly, it is not necessarily good news for employers in the sector. The relative ease with which STEM graduates find employment suggests that there may not be enough of them to fully meet employer demand.**

25. The higher education system needs to do more than simply meet *current* employer demand. We commented in our *Office of Science and Technology: Scrutiny Report 2004* on the ambitiousness of the Government’s target to increase the UK’s investment in R&D as a proportion of GDP to 2.5% by 2014.⁴⁶ If the Government is to increase the UK’s volume of R&D, it needs to increase the number of skilled people employed to carry out this work. The Royal Society has calculated that, if the UK is to meet its target, it would need approximately 50,000 additional research staff.⁴⁷ The same statistic was quoted to us by Ed Metcalfe of the South East England Development Agency: “we need about another 50,000 researchers if we are going to match a 2.5 per cent GDP target of expenditure in R&D over the next 10 years, so we need another 5,000 researchers per year on that measure. It is not

42 Geoff Mason, National Institute of Economic and Social Research, “The Labour Market for Engineering, Science and IT Graduates: Are there mismatches between supply and demand?”, Department for Education and Employment Research Brief No. 112

43 SEMTEA, Proposal for SEMTEA to be licensed as the Sector Skill Council for Science, Engineering and Manufacturing Technologies, Edition 2, January 2003, paras 2.1.26–2.1.28

44 Q 248

45 Q 327

46 Third Report from the Science and Technology Committee, Session 2004–05, *Office of Science and Technology: Scrutiny Report 2004* (HC 8), pp 13–15

47 Ev 174

just a question of standing still, it is a question of increasing the number of researchers”.⁴⁸ Compared to other developed countries, in 2002 a relatively small proportion of the UK’s total workforce was employed in science and engineering jobs: 26%. This compared to 32% in the US, 33% in Germany (in 2001), 29% in France and 38% in Sweden.⁴⁹ The extent to which the UK lags behind its competitor countries in this respect is, in itself, an indication of the potential for it to increase the proportion of its population employed in science and engineering jobs. **If the Government is to meet its ambitious target of increasing the UK’s investment in R&D as a proportion of GDP to 2.5% in 2014 it will need to take steps to significantly increase, not simply maintain, the total number of STEM graduates, as well as the proportion of those graduates that go on to pursue careers in science, engineering and technology. Evidence suggests that the UK may need to produce at least 5,000 additional researchers each year.**

26. The need to increase the number of academic researchers produced in the UK is made more urgent because, in common with most Western countries, the UK has an ageing workforce. This may have implications for the future supply of skilled personnel in STEM subjects. For example, the Royal Academy of Engineering found in its 2003 study, *The Future of Engineering Research*, that there was a “demographic time bomb” for engineering, “caused by growing numbers of academic staff reaching retirement age” and “exacerbated by the lack of UK engineering students wishing to follow academic careers”. According to the Academy, although “an increase in recruitment rates of between 22% and 36% over the next seven years [from 2003] is required just to maintain the current numbers of staff”, in reality “many institutions already have severe difficulty in recruiting and retaining staff in engineering-related subjects”. Furthermore, the percentage of staff under 30 almost halved between 1995 and 2000.⁵⁰ This study was supported in evidence to this inquiry by the Association of University Teachers, which told us that “the UK academic profession is generally getting older, with 23 per cent aged 50-plus in 1995–96, rising to 28 per cent in 2002–03. The ageing trend is seen particularly in the largest group of academics, who are engaged in both teaching and research. More than one-third of them are aged 50 and over”.⁵¹ These demographic trends serve to intensify the negative consequences of the declining popularity of STEM subjects and inevitably have an impact on the viability of university departments.

Matching supply with demand

27. It is not sufficient simply to increase the quantity of STEM graduates on the employment market. Quality is also a factor. Research carried out by the then Department for Education and Employment (DfEE) in 1999 showed that “the great majority of mismatches between supply and demand for technical graduates are attributable to quality problems rather than any overall shortfall in quantity”. It went on to observe that employer concerns about graduate quality related to a “lack of relevant work experience, followed by ‘lack of commercial understanding/awareness’ and ‘weak communication and presentation

48 Q 273

49 Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard*, 2003, pp 54–55

50 The Royal Academy of Engineering, *The Future of Engineering Research*, August 2003, p 20

51 Ev 285

skills'. Some concerns were also expressed about gaps in subject knowledge and understanding among weaker applicants".⁵² As with attempts to increase the number of students on STEM courses, discussed in chapter 4, the drive to increase the volume of STEM graduates must not neglect quality considerations.

28. The focus of a large proportion of English universities is on research (see paragraphs 115 to 118). We received evidence from employers that universities' emphasis on research excellence meant that they were often failing to meet the needs of non-academic employers of STEM graduates. Thus ABPI told us that "university science departments which have been rated 5 or 5* for the quality of their research do not always produce high numbers of graduates who wish to pursue a career in science. Industry is most likely to value the skills and knowledge developed during a four year MChem/MSci 'sandwich' course". According to ABPI the focus of many employers is not so much on "qualifications" as on "practical skills and depth of knowledge".⁵³ The necessity of providing a diversity of course options with varying degrees of focus on research, scholarship and applied skills, will be discussed in more detail in chapter 6.

29. Many employers of STEM graduates are looking for highly specific skill sets in their potential employees. For example, the pharmaceutical industry is able to identify a particular requirement for increased numbers of *in vivo* pharmacologists (see paragraph 22). Astra Zeneca suggested that there should be a shift in the focus of the market for higher education: "graduate courses curriculum should be based on national needs linked to a clear strategy and not on market forces driven by students as 'customers' rather than 'products' of higher education".⁵⁴ However, there are a number problems associated with any attempt to precisely match employer demand to higher education output:

- a) **Breadth versus depth.** Unless we resort to a wholly utilitarian (or "social engineering") model of education, and particularly in a climate where graduates can be expected to change jobs with relative frequency throughout their career, it can be assumed that a university course should do more than simply equip each graduate with the particular skills needed to do a particular job. Furthermore, as is illustrated in paragraph 52 of this Report, the majority of students do not choose their university course on the basis that it will equip them with the skills needed to do a specific job. There is no evidence to suggest that tailoring courses to the requirements of specific jobs would attract students to them. To a certain extent, employers will always bear some of the responsibility for job-specific training.
- b) **Multiple skills applications.** As the DGRC told us "there is not a one-to-one correlation between what people do in a degree and what sort of job they do".⁵⁵ There are many careers that would make use of the skills acquired by, for example, an astrophysicist, at university. Not all of these jobs would have "astrophysicist" in the job title. This mismatch complicates the task of planning for future skills requirements.

52 Geoff Mason, National Institute of Economic and Social Research, "The Labour Market for Engineering, Science and IT Graduates: Are there mismatches between supply and demand?", Department for Education and Employment Research Brief No. 112

53 Ev 170

54 Ev 122

55 Q 238

- c) **The evolving marketplace.** Organisations adapt in response to emerging technologies and changes in market conditions. A company that needs to employ six graduate chemists one year might need mainly mathematicians in the next. The goalposts are constantly shifting. Any attempt to micromanage the supply of skills to meet employer demand will thus inevitably fail to keep up.

30. We asked the DGRC whether he thought that the supply of skills in the UK graduate market matched employer demand. He told us that “even on physics and chemistry where you might have expected I had done a reasonable amount of homework in advance of this meeting, I come clean and say that we cannot go very much beyond the anecdotal evidence of whether supply is meeting demand and what the demand is. [...] Those numbers go up and down but I do not think we have good trend numbers”.⁵⁶ For the reasons enumerated above, we can understand why the DGRC would not have any figures detailing the specific numbers of graduates needed in each discipline in order to meet the particular requirements of employers. Nonetheless, the vagueness of his answer surprised us. The Government created Sector Skills Councils precisely in order to improve its management of the interplay between supply and demand in the employment market. Sector Skills Councils are independent, UK-wide organisations developed by groups of influential employers in business and industry sectors of economic significance. They are licensed by the Secretary of State for Education and Skills, in consultation with Ministers in Scotland, Wales and Northern Ireland, to tackle the skill needs of their sector. Their four key goals are:

- To reduce skills gaps and shortages;
- To improve productivity, business and public service performance;
- To increase opportunities to boost the skills and productivity of everyone in the sector’s workforce, including action on equal opportunities; and
- To improve learning supply, including apprenticeships, higher education and national occupational standards.⁵⁷

There are currently two Sector Skills Councils with a focus on science and engineering: SEMTA and e-skills UK, which focuses on the IT industry, IT users and IT professionals.

31. Each Sector Skills Council will develop Sector Skills Agreements, which will “provide the framework for [Sector Skills Councils] to work with employers in their sectors, with key agencies like HEFCE and with Government to address priority skills issues”. In preparing their agreements, the Councils have already done a significant amount of work in assessing the main gaps and weaknesses in the development of the workforce of their sectors and have identified priorities for skills development. DfES told us that it is currently working with the Sector Skills Councils and HEFCE to “agree how industry can engage more fully in the design of courses, for example via HEFCE’s HE Academy”.⁵⁸ Given the frequent mismatch between the skills possessed by graduates and the requirements of the jobs that they are employed to fill, some input by employers into the design of courses is

56 Q 235

57 www.ssda.org.uk (the website for the Sector Skills Development Agency)

58 Ev 306

essential. Armed with a better understanding of what employers need, universities can ensure that they equip their students both with a good all-round education and with the specific skills that they will need when they enter the workforce. In response to further questions, the Regional Development Agencies suggested a number of ways in which the Sector Skills Councils could influence higher education courses:

- Stronger advisory input to Funding Councils;
- Kite-marking of employer-led courses;
- Encouraging employer engagement and coordinating business input to course delivery through lectures/presentations, tutorials, projects and work-based placements; and
- Increasing demand for these courses through improved careers advice and guidance in schools (see paragraphs 67 to 71).⁵⁹

The Sector Skills Councils should help the Government and universities to improve their management of the interplay between the supply of, and demand for, graduate skills. In particular, we recommend that they develop a system of “kite marks” for employer-led higher education courses. This would send out much clearer signals to students about the likely value to their future career of the course that they choose. It would also help to avoid the problems associated with the over-provision of courses such as those in forensic science relative to the number of jobs available.

32. Given the information that is currently available, it is extremely difficult to gain a clear view of the interaction between supply and demand in the UK employment market. Whilst there is an abundance of statistics from different sectors and perspectives, these do not amount to a coherent picture. This is not a sound evidence base from which to establish a policy. **We recommend that the Government undertakes a comprehensive survey of existing research into the supply of, and demand for, STEM skills, including lessons learned from other countries. This will enable it both to take stock of the current situation, and to form a strategy that will meet the UK’s future skills needs.**

School science teachers

33. One of the sectors for which the Government does have clear data on the extent of the skills gap in science, engineering and technology is teaching. In particular, there is a problem with the supply of school science teachers with undergraduate qualifications in a STEM subject: science is being taught in many schools by teachers without these qualifications. In its *Investment Framework*, the Government notes that “in January 2004, there were still 240 unfilled science teaching posts in England, more than for any other subject except mathematics”.⁶⁰ ABPI told us that, “for chemistry, the number of teachers who have a degree in the subject has also decreased, from 6,490 in 1984 to 3,744 in 2002. On the assumption that there should be a balance of expertise in science teaching at GCSE (Key Stage 4), it was calculated that, in 2002, approximately 8,350 chemistry teachers were

59 Ev 307

60 HM Treasury, Department of Trade and Industry and Department for Education and Skills, *Science and Innovation Investment Framework 2004–2014*, p 88

required to cover teaching at GCSE and A level, whereas only 4,680 teachers in maintained schools had a degree, PGCE or BEd in chemistry”.⁶¹ One reason for the shortfall in physics teachers was suggested by Professor Peter Main of the Institute of Physics: “you just cannot get physics graduates to become school teachers and the reason for that is quite simply that they can do other things with higher salaries and less hassle”.⁶² Difficulties with teacher recruitment and retention are not simply a result of salary levels. As has been reported recently in the press, many teachers are demoralised by a range of factors, including classroom conditions and unruly behaviour.⁶³

34. In its *Science and Innovation Investment Framework 2004–2014*, the Government announced a number of measures to increase the number of STEM graduates going on to become teachers. These are:

- To increase the value of the teacher training bursary for science graduates from £6,000 to £7,000 from September 2005;
- To raise the “Golden Hello” for new science teachers from £4,000 to £5,000 for trainees who enter PGCE or equivalent courses from September 2005 onwards; and
- To eliminate as far as is possible the undershooting of the national Initial Teacher Training Targets for science by 2007–08.

These measures expand upon an earlier package of incentives that the Government believes “has brought about real change in recruitment into science teaching”.⁶⁴ Whilst any measures designed to increase the number of science teachers are welcome, it is not clear that the decisions to increase the teacher training bursary and the “Golden Hello” for science teachers by £1,000 each is based on any research about the level of incentive that would be required to stimulate new demand. **Instead of arbitrarily increasing by a round number the amount of money given to trainee and new teachers as a financial incentive, the Government should gather evidence on the level of incentive that is required to achieve the necessary increase in school science teachers.**

35. We questioned witnesses about the effectiveness of financial incentives at increasing the number of teachers in shortage subjects. The Minister of State for Lifelong Learning, Further and Higher Education told us that “in the year 2000 there were 2,220 PGCE science recruits; this year there are 2,690. It is not a massive increase but I do not think we would expect one”.⁶⁵ However, a Report published by the Education and Skills Committee in 2004 noted that, despite the introduction of financial incentives, “there were still shortfalls in recruitment in the shortage subjects of mathematics, physical sciences, modern foreign languages and religious education”.⁶⁶ Furthermore, a Higher Education

61 Ev 172

62 Q 322

63 For example, see Matthew Taylor, “Survey shows extent of classroom abuse”, *The Guardian*, Monday 21 March 2005

64 HM Treasury, Department of Trade and Industry and Department for Education and Skills, *Science and Innovation Investment Framework 2004–2014*, July 2004, p 88

65 Q 510

66 Fifth Report from the Education and Skills Committee, Session 2003–04, *Secondary Education: Teacher Retention and Recruitment* (HC 1057-I), p 14

Policy Institute paper states that, since the introduction of the scheme, despite increases in the number of PGCE students, “there has been a significant decline in undergraduate [Initial Teacher Training]”.⁶⁷ In other words, some of the increase in uptake of postgraduate teacher training is offset by decreases in the number of students undergoing teacher training at undergraduate level. Schools are also currently experiencing problems with the retention of their newly qualified teachers. The Education and Skills Committee reported that “we heard in evidence that fewer than 50% of those who begin teacher training are teaching after five years”.⁶⁸ **The Government is to be commended for taking action to increase the number of school science teachers. There are signs that its incentives are having some positive effect on overall teacher recruitment levels, despite continuing problems in some subjects. However, difficulties in retaining newly-qualified teachers suggest that financial incentives are not a long term solution to teacher shortages.** The effectiveness of financial incentives is discussed further in paragraphs 72 to 75.

Graduate choices

36. Equipping graduates with STEM skills does not necessarily mean that they will go on to pursue careers in science, engineering and technology. To a certain extent this is desirable: as is explained in paragraph 9, one of the functions of university STEM courses is to raise the level of general scientific literacy in the public, not simply to send graduates into scientific careers. This is what Professor David Walton of Coventry University argued when he told us that “the ex-student need not still be working in the field of science to be a net earner for the country, and so represent a good ‘value-added’ return on the costs of education”.⁶⁹ However, the evidence we received suggested that too many STEM graduates from English universities are choosing not to pursue careers in science, contributing to existing skills shortages in specific areas. Professor David Eastwood, Vice Chancellor of the University of East Anglia, told us that “if we are looking at market effects here, universities are producing more than enough chemists to over stock schools with chemistry teachers but they are making different career choices”.⁷⁰

37. The evidence that we collected did not present a clear picture of why not enough STEM graduates go on to pursue related careers. One of the explanations offered was a lack of “pull” from business. A research paper produced by the Higher Education Policy Institute states that “a demand-pull from UK businesses is needed alongside an increase in supply of highly skilled individuals”.⁷¹ The Russell Group of universities told us that “many graduates in science, and not least in chemistry, presently choose to go straight into well-remunerated careers outwith science, and career salaries within science show little sign of the upward movement that would reflect any general skill shortage”.⁷² The lack of “pull”

67 Libby Aston, Higher Education Policy Institute, *Higher education supply and demand to 2010*, June 2003, p 26

68 Fifth Report from the Education and Skills Committee, Session 2003–04, *Secondary Education: Teacher Retention and Recruitment* (HC 1057-I), p 4

69 Ev 78

70 Q 459

71 Libby Aston and Bahram Bekhradnia, Higher Education Policy Institute, *Demand for Graduates: A review of the economic evidence*, September 2003, p 42

72 Ev 86

identified by the Russell Group relates to salaries: many witnesses argued that science careers do not attract graduates because they do not tend to pay well. (This does not necessarily contradict the Royal Society of Chemistry and the Institute of Physics, which have found that, over the course of their careers, chemistry and physics graduates earn a salary premium of 15% above non-graduates, as compared to a salary-premium of 12% for the “average” degree holder. The research does not track whether the graduates surveyed pursued careers in science or in other sectors.⁷³) Good salaries are undoubtedly one of the levers that employers can use to attract potential recruits. However, evidence from other sectors suggests that there are other, perhaps more important, levers. In the public sector and the media, for example, many graduates compete fiercely for jobs that pay relatively little.

38. The factors that influence graduates when they choose a career are likely to be as complex as those that influence school leavers when they choose a university course (see chapter 4). Many of these factors will be less tangible and harder to address than salary considerations. **In order to formulate a credible policy on attracting graduates into careers in science, engineering and technology, the Government needs to develop a sophisticated understanding of the motivating factors in graduates’ choices of careers. Given that they are in the best position to act upon any findings, we recommend that the Government commissions the relevant Sector Skills Councils to carry out further research into these factors.**

Research careers in STEM subjects

39. The Committee identified a fundamental reason why many STEM graduates decided not to pursue research careers in a 2002 Report entitled *Short-term Contracts in Science and Engineering*.⁷⁴ We found that postdoctoral researchers were frequently employed on a series of short term contracts with minimal job security and poor pay and conditions, and concluded that this was a serious disincentive to anyone considering a research career in the long term. We have tracked the Government’s progress in tackling this issue as part of our ongoing scrutiny of the Research Councils and of the Office of Science and Technology. In our *Office of Science and Technology: Scrutiny Report 2004* we concluded that “the Government needs to have a number of policy ideas at its fingertips should [it] identify a continuing problem with short-term research contracts in science and engineering. We are very concerned that an over-reliance on the perceived benefits to be realised from the introduction of the EU Fixed Work Term Directive will hold back any new Government initiatives to address this problem”.⁷⁵ During the course of this inquiry, many witnesses raised the same issues that we identified in our 2002 Report. For example, Ian Hutton, one of the panel of students we saw on 7 February, told us that “I have considered the career prospects and the job prospects after having done, say, a PhD and then several post-docs, a lot of them seem to bounce around from contract to contract with no real security, and if I had worked that hard to get that qualified and have a PhD then I

73 Royal Society of Chemistry and Institute of Physics, *The economic benefits of higher education qualifications: A report produced for the Royal Society of Chemistry and the Institute of Physics by PricewaterhouseCoopers LLP*, January 2005, p 3

74 Eighth Report from the Science and Technology Committee, Session 2001–02, *Short-Term Research Contracts in Science and Engineering* (HC 1046)

75 HC [2004–05] 8, pp 24–25

would want to find myself in a more stable environment than that”.⁷⁶ Very little time has elapsed since our last comment on research careers and we cannot reasonably expect the situation to have changed much since that time. However, this is an issue that the Government will need to continue to work on, particularly if it is serious about attracting more students onto STEM courses and into research careers. Ian Hutton’s comment also reveals that **it will be important for the Government to address negative perceptions about research careers. Without specific action in this area, it could take a long time for any improvements in research career paths to filter through to schoolchildren and students making choices about their future careers.**

4 Student demand

Demand for undergraduate STEM courses

40. In January 2003, the Government published its higher education White Paper, *The Future of Higher Education*. In it, the then Secretary of State for Education and Skills, Charles Clarke, restated the Government's target of increasing participation in higher education to 50% of those aged between 18 and 30, mainly through two-year work-focused foundation degrees.⁷⁷ The target is, by nature, aspirational. As a paper produced by the Higher Education Policy Institute explains, "history tells us that Government HE [higher education] policy targets have had a limited impact on demand for HE in terms of both the total number of students and the type of HE demanded. [...] For the most part, Government action at the HE level has affected the supply of places. Quite different, and much less controllable, factors affect student demand".⁷⁸ In order for the Government to achieve the participation rates that it has set for the higher education sector, it will have to find a way of motivating a sufficient proportion of school leavers to go to university, a much more complicated task than simply providing extra places.

41. The question of how to stimulate extra student demand is particularly acute for STEM subjects, which are taken at A-level and above by a relatively small proportion of each year group (see figure 1, below). Furthermore, statistics show a steady decline in student demand for undergraduate STEM courses, both in real terms and, more markedly, as a proportion of overall student demand levels. Sir Howard Newby, Chief Executive of HEFCE told us that "it has indeed been one of the ironies of the expansion during the late eighties and nineties, which coincided with the granting of full university status to the former polytechnics; the new universities expanded far more in the social sciences and humanities than in the science and engineering side".⁷⁹ The 1994 Group of universities stated that "the demand for teaching in science has shown considerable adverse change over a number of years, with a marked reduction in the proportion of students wishing to pursue undergraduate courses in science".⁸⁰ An Organisation for Economic Co-Operation and Development report shows that only 26% of total new degrees in the UK were awarded in science and engineering subjects. This compares to a figure of 32% in Germany, 29% in France and 38% in Korea.⁸¹ Given the importance of STEM graduates to the economy, at just over a quarter, the proportion of total new degrees being awarded in science and engineering subjects in the UK shows considerable room for expansion.

77 Department for Education and Skills, *The Future of Higher Education*, Cm5735, January 2003, p 57

78 Libby Aston, Higher Education Policy Institute, *Higher education supply and demand to 2010*, June 2003, pp 8-9

79 Q 185

80 Ev 136

81 Organisation for Economic Co-Operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard*, 2003, p 51. The percentages given have been rounded to the nearest whole percentage point.

Figure 1: Percentage of “year group” taking STEM qualifications, 2000

Subject	A-level (%)	First degree (%)	PhD (%)
Mathematics	7.8	0.6	0.05
Physics	4.1	0.3	0.07
Chemistry	5.1	0.5	0.13
Biology	6.6	2.5	0.25
Engineering and technology	2.2	2.8	0.24
Computer science	2.8	1.5	0.04
Business studies	4.7	4.4	0.05

Source: HM Treasury, *SET for Success: The supply of people with science, technology, engineering and mathematics skills: The report of Sir Gareth Roberts' Review*, April 2003, p 23

42. The extent of the decline in demand differs for different STEM subjects at different levels. For physics the relative decline in demand, when increases in overall levels of demand for higher education are taken into account, is pronounced, at 40% over the past decade.⁸² In the UK, demand for undergraduate engineering courses has fallen from 11.4% of all degree entrants in 1988 to 5.4% in 2003. In addition, in 1999, 20.8% of all students on engineering undergraduate courses in the UK were non-UK citizens.⁸³ Figure 2, below, shows the changes in UK student demand for five different disciplines for the period from 1997–98 to 2002–03.

Figure 2: Number of full time undergraduate students in UK higher education by (selected) subject.

Subject	1997–98	1998–99	1999–2000	2000–01	2001–02	2002–03	% change
Biological sciences	44,755	45,666	46,180	46,175	44,975	56,545	+ 26%
Chemistry	13,714	13,728	13,110	12,030	11,645	11,625	- 15%
Physics	9,731	9,706	9,480	9,025	8,605	9,045	- 7%
Social sciences	78,119	79,502	80,160	80,200	81,115	94,310	+ 20%
Psychology	20,667	20,333	20,720	21,285	22,690	35,795	+ 73%
All higher education	1,022,606	1,032,897	1,027,400	1,037,880	1,069,210	1,111,310	+ 9%

Source: Royal Society of Chemistry and Institute of Physics, *The economic benefits of higher education qualifications, A report produced for the Royal Society of Chemistry and the Institute of Physics by Pricewaterhouse Coopers LLP, January 2005, p 7*

82 Ev 133

83 The Engineering Council (UK) and the Engineering and Technology Board (etb), *Digest of Engineering Statistics 2003–04*, July 2004, p 28

Case study: levels of demand for chemistry

43. The Royal Society of Chemistry (RSC) denies that student demand for chemistry courses is in decline: “the current numbers applying to study chemical science courses in universities are around the long-term average of 3,000/year and reflect the continuing popularity of the subject”.⁸⁴ This statement is belied by statistics from a wide range of sources. For example, the 2002 report of Sir Gareth Roberts’s review, *SET for Success*, showed that, between 1994–95 and 1999–2000, there was a 23% decrease in the number of students gaining first degrees in chemistry; and a 19% decline in the number of PhDs.⁸⁵ The Association of the British Pharmaceutical Industry states that “applications from UK students to study chemistry have been declining steadily over the last 10 years. In 1993 4,110 applications were made to study chemistry as a single subject, this had fallen to 2,434 by 2003. Indications are that there was a slight increase in applications for 2004, but numbers are not yet available. As a percentage of students applying for HE courses, the percentage has fallen from 1.7% in 1994 to 0.68% in 2003”.⁸⁶ The RSC’s own study, *The economic benefits of higher education qualifications*, shows that from 1997–98 to 2002–03, there has been a decline of 15% in the number of full time undergraduate chemistry students in higher education. This is set against an increase of 9% in the higher education sector as a whole (see figure 2, above).

44. Many of the submissions we received focused on the actions that the Government could take to increase the *supply* of chemistry places in English universities, and on the need for it to preserve chemistry departments that would otherwise be forced to close. However, Professor Steve Smith, Vice Chancellor of Exeter University told us that, when his university proposed to close its chemistry department, “six institutions approached us about taking the chemistry students that we have at Exeter and each of them offered to take more students than we had. That means that there was clear capacity in those institutions”.⁸⁷ Later he told us that “there is an excess of places over the number of students that wish to study the subject”.⁸⁸ This indicates that there are sufficient university chemistry places to accommodate student demand within the system as a whole. **There are currently more places on undergraduate chemistry courses at a national level than there are students to fill them. Whilst it might be desirable to increase the number of places available in the long term, in the immediate term such a measure will not necessarily increase the number of chemistry undergraduates. In order to achieve the latter aim it is essential to stimulate student demand for chemistry courses.**

45. Statistics on the number of university chemistry places at a national level do not give any indication of either variability in the standard of chemistry provision or student choice. A chemistry degree at Exeter is not the same as a chemistry degree at Bristol or Bath. This was made clear to us by Danielle Miles, a student in the chemistry department at Exeter University that is now to close. She told us that “they are pressurising us to go to Bristol or

84 Ev 180

85 HM Treasury, Department of Trade and Industry and Department for Education and Skills, *SET for Success: The supply of people with science, technology, engineering and mathematics skills: The report of Sir Gareth Roberts’s Review*, p 24

86 Ev 173

87 Q 419

88 Q 458

Bath [...] I do not really want to go. I did not go to Exeter because of where it was, it was because of the university, and I am looking at going to Leeds”.⁸⁹ Students do not simply choose a course on the basis of its subject: other motivating factors may include university reputation or location, course reputation or quality, and career or social considerations. **Degrees in the same subject from different institutions are not necessarily interchangeable. Along with overall levels of subject provision, diversity of provision needs to be taken into account in national and regional planning in order to cater sufficiently for student choice and differing levels of attainment.**

Student demand and departmental closures

46. Declining student demand for undergraduate courses in core STEM subjects has played a pivotal role in the demise of many university STEM departments. The effects of the reduction in demand have been exacerbated by the funding mechanisms used to support universities. The teaching funding allocated to university departments is based on a number of factors, including student numbers. In determining an institution’s teaching grant for the coming year, HEFCE considers the number of students recruited in the previous year. Institutions can also bid for additional student places according to criteria set by HEFCE each year (for example, in a recent funding round, bidding exercises were restricted to foundation degrees and social work courses). These additional places are added to the number of students recruited in the previous year. The resulting total determines the level of funding awarded. There are premiums for certain types of student (for example, part-time students and students on long courses), and funding is also differently weighted for different subjects.⁹⁰ The method for calculating teaching funding means that departments which are successful at attracting high numbers of students generally receive a higher level of funding, although we note that departments that significantly exceed their recruitment quotas are also penalised. In addition, STEM departments are typically expensive to run and maintain. The unit cost for the department therefore increases significantly for STEM departments with fewer students. This and other issues relating to the teaching funding formula will be discussed in more detail in paragraphs 104 to 112 of this Report.

47. Several witnesses told us that student demand levels have not played a role in the closure of STEM departments. The RSC, for example, told us that “overall application figures for chemistry in 2004 show an increase of 6.5% in the numbers of students applying to study at the undergraduate level. Student demand for chemistry was buoyant at King’s College London, Queen Mary College, University of London, and Exeter University—at all of which recent closures have been announced—and yet the decisions to close their departments was made despite this buoyancy”.⁹¹ The same cases were also cited in written evidence by Professor Cadogan.⁹² We do not have statistics for most of the departments cited, but we did hear from Professor Smith of Exeter University that his chemistry department had reduced its student quota by 21% in five years. The fact that the

89 Q 60

90 Higher Education Funding Council for England, *Funding higher education in England: How HEFCE allocates its funds*, May 2004, pp 7–11

91 Ev 183

92 Ev 127

department filled its quota is therefore somewhat misleading. Furthermore, applications to study chemistry almost halved in the period between 1993 and 2003, against which an increase of 6.5% in 2004 is of little significance.⁹³ It is in this broader context of consistently declining numbers that claims about the buoyancy of demand for chemistry have to be interpreted.

48. The majority of witnesses told us that STEM departments were under threat as a result of a decline in student demand, compounded by university funding arrangements. Professor Steve Smith said that “I think the problem in science and engineering is a demand problem. It is not about the supply of places, it is about the demand for those places”.⁹⁴ The Institute of Physics states that “physics departments are closing principally as a result of an inability to attract sufficient students to make ends meet, exacerbated by cuts in research funding in some cases”.⁹⁵ Leeds University stated that “the underlying reason that sciences and engineering teaching is in difficulty is that the pool of students wishing to take these subjects has been decreasing for a long time, at least since the 1970s”.⁹⁶ In oral evidence Professor Peter Main amplified this point, adding that the recruitment problems of some departments were creating the illusion of overall buoyancy of demand in others: “I am absolutely certain that the bigger departments, having seen the fall of the unit of resource just referred to, in order to keep their finances stable, have taken more and more students. I can point to some universities that have almost doubled their student quota as a result of that, including my own”.⁹⁷ These statements are all borne out by the statistics given in figure 2, above.

49. The link in the system between funding and student numbers gives the student market a commanding role to play in the fortunes of university departments. A paper produced by the Higher Education Policy Institute notes that “the reliance on the block grant and the market has led to subjects where demand is in decline—perhaps only temporarily so—coming under threat as universities realise that their funding is at risk as they fail to recruit in those subjects. Although there are inevitable internal pressures to the contrary, there are strong incentives to downsize out of those subjects, or to switch into other subjects that are more in demand”.⁹⁸ **Student demand is a powerful player in the higher education sector under the current funding regime. If the Government is to secure good provision of STEM subjects for future cohorts of students it must ensure that demand is further stimulated.**

Quality versus quantity

50. Not only is it essential that the Government implements measures to increase the level of student demand for STEM courses, it is also vital to the continuing health of those disciplines that the students enrolling on such courses are of a high calibre. The quality of

93 Ev 173

94 Q 457

95 Ev 134

96 Ev 146

97 Q 352

98 Bahram Bekhradnia, Higher Education Policy Institute, *Government, Funding Council and Universities: How Should They Relate?*, February 2004, pp 11–12

student demand was perceived by many to be a problem. EEF, the manufacturers' organisation, told us that "the individuals applying for courses in these subjects are not suitable for high-level study, because they have not achieved the necessary levels of learning in prerequisite subjects such as mathematics and physics".⁹⁹ Professor Steve Smith told us that, at Exeter University, the lack of sufficiently-well qualified student applicants reduced still further the number of students that the university could accept on to its chemistry course: "our quota was an adjustment between the number of students with the right grade that we could get and the places available. Our quota in chemistry had gone down 21 per cent in five years because the quality students were not there".¹⁰⁰ Save British Science conducted a survey of UK Deans of Science in 2003 which found that on 70% of undergraduate physical science courses, less than 50% of students were considered to possess the required level of mathematics skills.¹⁰¹

51. In oral evidence Professor Peter Main from the Institute of Physics implied that some students without the requisite levels of learning were nonetheless accepted onto some STEM courses: "I think it is probably fair to say that we are now at a position where the number of people who want to do physics is approximately equal to the number of people who do do physics. There are essentially no students who are turned away".¹⁰² A paper produced by Mike Hill, a careers consultant on the choices made by school leavers, states that "in reality there is a strong argument to say that a student with C or D grades in the physical sciences like chemistry, physics and mathematics will have a greater choice of courses and careers than a student gaining B or even A grades in the subjects which have recently gained in popularity".¹⁰³ **If the standard for entry on to university STEM courses is lowered as a result of decreased demand, there is a danger that the currency of the resulting degrees will be devalued. This would not be in the interests of either the students taking those courses or their potential employers. It is important that, in the drive to increase student demand for university courses in STEM subjects, the quality of the student intake is not sacrificed for the sake of increasing student numbers.**

Student perceptions of science

52. The Dearing Report 2, published in 1997, identified four distinct categories of reasons why students choose a university course:

- i. "Intellectual—related primarily to their intrinsic interest in the course, the subjects covered, and the academic standing of the course and institution;
- ii. Pragmatic—related principally to practical issues such as the part-time structure of the course, proximity to home, etc;
- iii. Instrumental—associated with the outcomes of the course and especially, students' longer term job and career prospects;

99 Ev 99

100 Q 419

101 www.savebritishscience.org.uk

102 Q 327

103 Mike Hill, *Responding To The Challenges Of The Global Market: Ensuring Careers Education And Guidance Is Relevant To The Demands Of The Twenty First Century*

iv. Fatalistic—related to negative reasons such as being the only place offered”.¹⁰⁴

The majority of full-time students studied fell into the first category in selecting their course. This suggests that one of the reasons why a declining number of students choose to take STEM subjects at university is that these subjects have not attracted their intellectual interest. This is an issue that can be addressed at school level, as is discussed in paragraphs 62 to 66 below.

Cultural factors

53. A number of cultural factors are at work in the decisions made by schoolchildren. For example, the trend against women taking degrees in and pursuing careers relating to the physical sciences is visible from as early as at GCSE level: in England in 2001 there were 16,000 entries from girls for chemistry compared to 22,800 boys; and 15,400 entries from girls for physics compared to 23,000 boys.¹⁰⁵ Similar differentials are evident in the choices of male and female university students: only 1 in 5 undergraduate students studying either physics or computer science are female. Only 14% of applicants and acceptances through UCAS for engineering courses are female.¹⁰⁶

54. The Government has stated its intention to increase the participation of women in STEM subjects and careers.¹⁰⁷ The 2002 SET Fair study by Baroness Susan Greenfield, which was commissioned by the Government in order to inform its policy in this area, identified various factors that need to be addressed to engage girls in STEM subjects and careers. These included:

- “Stereotyping by teachers, parents and friends and stereotypical careers advice;
- Lack of visibility of women scientists/engineers and low contact with role models reinforced by low media presence of women;
- Peer pressure and the lack of linkage between science, engineering and technical jobs seen as being of benefit to society (girls rank this highly when considering careers);
- Antipathy towards science and technology in general”.¹⁰⁸

55. Other studies have also concluded that the image of, and stereotypes associated with, STEM careers are likely to be important in determining girls’ attitudes towards those careers and the university courses that support them. For example, a 2001 survey of secondary school-age pupils conducted by SEMTA and MORI found that only 1% of the girls surveyed wanted to be an engineer, and that this seemed to be allied to the girls’ perceptions that engineering “was a boring occupation, and one which required work in a

104 Dearing Report 2, *Students’ motives, aspirations and choices*, 1997. See Ev 307

105 <http://www.set4women.gov.uk/set4women/statistics/>

106 as above

107 For example, see Department of Trade and Industry, *A strategy for women in science, engineering and technology*, April 2003

108 Baroness Greenfield, Dr Jan Peters, Dr Nancy Lane, Professor Teresa Rees and Dr Gill Samuels, Department of Trade and Industry, *SET Fair: a Report on Women in Science, Engineering and Technology*, November 2002, p 40

dirty environment”. Another survey (2004) carried out by Careers Scotland and partners based in or near to Edinburgh found that the career preferences of 7–8 year olds tended to be related to their father’s occupational classification, but not to their mother’s.¹⁰⁹ In order to increase student demand—particularly amongst women—for STEM subjects, the Government needs to address these negative perceptions.

56. The panel of students we saw on 7 February told us that STEM subjects had a negative image amongst students. Danielle Miles, a chemistry student from Exeter, said that “there is a whole image of [science] as not being very cool, as you say, looking like ‘geeks’”.¹¹⁰ Ian Hutton, a biological sciences student from the University of East Anglia, told us that “often you are stigmatised if you do a science course”.¹¹¹ A study on “The Labour Market for Engineering, Science and IT Graduates: Are there Mismatches between Supply and Demand?”, conducted in 1999 by the then Department for Education and Employment, found that one key reason for the low take up of STEM subjects by sixth form students is their poor “image”, with opinions of STEM occupations conforming to negative stereotypes.¹¹² The University of Leeds suggested that the similar decline in demand for science subjects being experienced across Europe indicated deep-rooted cultural elements at work.¹¹³ Cultural factors are relatively difficult to address because they are deeply embedded.

Difficulty

57. We heard that STEM subjects didn’t appeal to some students because of their perceived difficulty. Ian Hutton said that “it is almost as though there are these two cultures that go with university; there are the people who go to study and the people who go to university because they feel that they should, and they get on an easy course and they spend a lot of time lazing around and relaxing”.¹¹⁴ He classified science students in the former group. Similarly, the Committee of Heads of University Geoscience Departments told us that some students choose not to take STEM subjects because they “feel they don’t have the necessary skills (‘I’m not clever enough to do a science degree’)”.¹¹⁵ The panel of Vice Chancellors we saw on 9 March strongly rejected the notion that science courses were more difficult than other subjects. Professor David Eastwood, Vice Chancellor at the University of East Anglia, said that “if you look at the data on so called ‘easier’ subjects you get a very mixed message. If you look at A-level outcomes and indeed if you look at post degree outcomes, the subjects that the media often deride as ‘soft’ subjects are harder to get As in and harder to get Firsts in. In my own institution the highest proportion of First Class degrees in the main is in the science disciplines”.¹¹⁶ Dr Kim Howells MP, Minister of

109 The Engineering Council (UK) and the Engineering and Technology Board (etb), *Digest of Engineering Statistics 2003–04*, July 2004, p 8

110 Q 36

111 as above

112 Geoff Mason, National Institute of Economic and Social Research, “The Labour Market for Engineering, Science and IT Graduates: Are there mismatches between supply and demand?”, Department for Education and Employment Research Brief No. 112

113 Ev 146

114 Q 36

115 Ev 156

116 Q 436

State for Lifelong Learning, Further and Higher Education in the Department for Education and Skills (DfES), told us that “there are plenty of young people around who are perfectly capable of doing so-called difficult subjects, and I dispute that term as well, but they are choosing not to do them”.¹¹⁷ The debate about relative levels of difficulty is a red herring in this context: it is the widespread perception of the difficulty of STEM subjects, however inaccurate, that is important.

58. There is some evidence that STEM subjects have declined in popularity as the choice of university courses has increased. With a proliferation of new subjects and joint-honours courses now available at undergraduate level, student choice is extremely wide. As we explored in our recent Report on Forensic Science, *Forensic Science on Trial*, this has meant that some students choose new subjects over the old “core” disciplines—in this case forensic science over chemistry. When giving evidence as part of our inquiry into forensic science, Dr Angela Gallop, Chief Executive of Forensic Alliance, told us that “there seems to be a difficulty here because the Government on the one hand is exhorting the universities to fill seats, to get more and more people through their doors, and the only way they can do that is by putting on courses that are attractive to them. Forensic science at the moment is a very attractive option because of all the television programmes”.¹¹⁸ Professor Stephen Haswell from the University of Hull told us that “students applying for the forensic science courses are twice that for chemistry and chemistry with other subjects”.¹¹⁹ The inquiry heard widespread concerns about the quality of forensic science courses. Clive Wolfendale, Deputy Chief Constable in the North Wales Police, told us that such courses were “a savage waste of young people’s time and parent’s money”.¹²⁰ Dr Gallop also told us that “the huge danger is that so much time is spent on teaching pseudo forensic science that all the basic, pure science that you need to operate as a really good forensic scientist is missing”.¹²¹ This becomes problematic if students undertaking courses in forensic science are misled about the likely career prospects of their degree.

59. Many witnesses were dismayed by the popularity of non-core STEM degrees and told us that such courses were of little value. However, Scientists for Labour stated that “joint degree courses, such as physical sciences and sports science, should not be undervalued (nor risk closure). Whilst such courses may not attract the aspiring Nobel Prize winner, they provide an excellent source of schoolteachers”.¹²² As part of the Government’s drive to increase participating in higher education, universities are being encouraged to provide courses that are attractive to students. They should not be criticised for achieving this goal. **There is a strong case for continuing to provide a diversity of STEM degree courses to cater for the varying abilities of the students opting to take science subjects. Joint-honours courses and many of the new “softer” STEM subjects attract many students into science who may otherwise have studied something else altogether, or not studied at all. Chemistry, physics, mathematics and engineering will not suddenly become**

117 Q 476

118 Seventh Report from the Science and Technology Committee, Session 2004–05, *Forensic Science on Trial* (HC 96-II), Q 245

119 HC [2004–05] HC 96-II, Q 362

120 HC [2004–05] HC 96-II, Q 305

121 HC [2004–05] HC 96-II, Q 246

122 Ev 311

more popular if students are prevented from studying other subjects. Nonetheless, there is great variability in the quality, scientific content and entrance requirements of some non-core STEM subjects, some of which are only nominally “science” courses. Some of these courses will be of limited value to graduates seeking a scientific career and will not help to increase the supply of skilled scientific personnel. Students enrolling on these courses need to be clearly informed at the outset about whether or not they will be qualified upon completion to pursue a scientific career.

What can be done to increase levels of undergraduate demand?

60. As is set out above, the choices made by students upon leaving school have a profound impact on the viability of university departments. Currently, students are voting against core STEM subjects with their feet. Whilst the market approach to course provision has had adverse consequences for some of the less popular disciplines, it is difficult to see how else universities could be expected to operate. They cannot force students to take particular courses, even by closing off other options. As Professor Peter Main of the Institute of Physics told us, “ultimately, you cannot create demand if it is not there. It is all very well saying that we can reduce the number of media studies people, but those people probably will not want to choose to do physics and chemistry. So, it is really about increasing the demand for the subjects that we want”.¹²³

61. Stimulating student demand is no easy task, particularly if little is understood about why demand is so low in the first place. We asked the Minister what was and could be done to increase levels of demand. He told us that an official from DfES “has been doing a survey of the huge number of initiatives that are out there to try to get young people interested in science and mathematics and engineering and technology, and so far she has filled three volumes with these initiatives. I suspect we are spending as a nation, not just as a department, many millions of pounds on initiatives for which we have very little evidence that they are working. They do not seem to be working”.¹²⁴ It is, of course, extremely difficult to judge the success of initiatives to increase student demand, largely because such initiatives often require cultural change and thus have long lead times. Nonetheless we were very surprised to learn that the Government knew so little about the success of its attempts to enthuse young people about science. **Given the importance of the degree choices made by students to the health of the economy, it is essential that the Government takes a keen interest in the impact of its initiatives designed to attract students into science, and applies itself wholeheartedly to finding solutions to the problem of declining demand for STEM subjects.**

123 Q 335

124 Q 476

Science education in schools

Figure 3: A level examination entrants: 16–18 year old students in all schools and colleges in England analysed by selected subject

Subject	1997–98	1998–99	1999–2000	2000–01	2001–02	2002–03	2003–04	% change
Biological sciences	42,826	47,156	46,176	44,619	47,236	45,773	44,345	+ 4%
Chemistry	32,269	35,813	35,276	33,650	33,427	32,319	32,193	0%
Physics	26,440	29,481	28,105	27,809	28,549	27,128	24,671	- 7%
Other science	5,840	6,742	6,722	6,679	8,008	4,184	3,777	- 35%
Mathematics	54,980	61,185	58,618	58,277	50,326	51,438	51,218	- 7%
Psychology	-	-	-	-	-	39,907	42,865	n/a
Total (all subjects)	605,320	679,812	672,192	686,360	666,073	686,472	676,679	+ 12%

Source: Royal Society of Chemistry and Institute of Physics, *The economic benefits of higher education qualifications, A report produced for the Royal Society of Chemistry and the Institute of Physics by Pricewaterhouse Coopers LLP, January 2005, p 7*

62. The decline in the number of students wanting to take undergraduate courses in STEM subjects is mirrored by the decline in the number of school pupils opting to take science A-levels. Professor Amanda Chetwynd, Vice President of the London Mathematical Society, told us that “in terms of mathematics, we know that there has been a 25 per cent fall in the number of students doing A level over the last 20 years”.¹²⁵ Bahram Bekhradnia of the Higher Education Policy Institute said that there had been a “13 per cent reduction in A Levels in physics, 13 per cent in mathematics and seven per cent in chemistry. A reduction at the time when the number of A Level entries has increased by ten per cent overall. That is bound to be reflected, if it has not already been reflected—and I suspect it must have been—in demand at university level”.¹²⁶ Figure 3, above, illustrates the change in demand for science A-levels between 1997–98 and 2003–04. We learnt that the problem was worse in the state maintained sector. Professor Bob Boucher of the Royal Academy of Engineering stated that “the 15 per cent of the students educated in the independent sector were producing 50 per cent of the students with two science A levels. So, the state school sector has seen a tremendous fall in the qualified output to study science and engineering at universities, a deeply fundamental problem in my view”.¹²⁷

63. We were not at all surprised to hear about the poor take-up rates for A-level science courses. Our Report on *Science Education from 14 to 19* found that science teaching in secondary schools was uninspiring, and in some cases positively off putting, from a very early stage. In that Report we observed that:

125 Q 328

126 Q 128

127 Q 322

“Current GCSE courses are overloaded with factual content, contain little contemporary science and have stultifying assessment arrangements. Coursework is boring and pointless. Teachers and students are frustrated by the lack of flexibility. Students lose any enthusiasm that they once had for science. Those who choose to continue with science post-16 often do so in spite of their experiences of GCSE rather than because of them. Primary responsibility should lie with the awarding bodies; the approach to assessment at GCSE discourages good science from being taught in schools.”¹²⁸

The Centre for Bioscience, part of the Higher Education Academy, told us that “physics and some chemistry in schools are taught in a way which students find difficult to relate to their everyday experiences, often by biology graduates with little chemical background, or by physics and chemistry graduates of low ability”.¹²⁹ This phenomenon has also been experienced elsewhere. A European Union-wide survey, conducted in December 2001, found that 59.5% of the 16,029 people surveyed thought that science lessons at school were “not appealing enough”.¹³⁰ If schoolchildren are put off science subjects by their experiences of them at school, it is hardly surprising that many of them show little inclination to continue studying those subjects at university. **The poor quality of science education in secondary schools plays a significant role in the lack of student demand for university STEM courses.**

64. The vast majority of the evidence we took concurred that the only way to address the issue of declining student demand for STEM subjects in the long term was to improve science teaching in schools. The Russell Group of universities, for example, stated that “the dynamics are such that student demand in these areas is ultimately an issue of national significance which will have to be addressed at the Secondary Education level, and any significant improvements will necessarily have long lead times”.¹³¹ NATFHE, the union for university and college lecturers, told us that “student demand for science and engineering at higher education will not improve unless science teaching and the science curriculum at primary and secondary level is sufficiently exciting and effective”.¹³² Ed Metcalfe, from the South East England Development Agency, told us that “it is not just asking the universities to take on more science undergraduates; the problem is much earlier and is about getting 11-year olds engaged in being interested in science, and 16-year olds beginning to make the right career choices, and all the way through to graduates. There are a number of choices that they will make”.¹³³ Professor Ian Diamond of Research Councils UK used the example of mathematics: “at the beginning we need to make sure there are students in schools and so mathematics has to be taught properly and taught in an exciting way that people want to

128 HC [2001–02] 508, p 5

129 Ev 126

130 “Why do our youth stay out of scientific careers? New EU-wide data”, Press Release from the Press and Communications Directorate General, European Commission, December 2003

131 Ev 86

132 Ev 82

133 Q 274

do it at an undergraduate level”.¹³⁴ The Government itself stated that “there are no instant solutions, and [...] demand for these subjects has to be kindled in schools”.¹³⁵

65. In its Response to our Report on *Science Education from 14 to 19*, the Government broadly welcomed the Committee’s recommendations and outlined a number of steps that it was already taking to address them.¹³⁶ Change cannot be expected overnight. It will inevitably take some time to reverse previous underinvestment in school science facilities, to see the results of the Government’s initiatives to attract more science teachers (see paragraphs 33 to 35), and to adapt the curriculum to make it more interesting and relevant to schoolchildren. Nonetheless, we believe that the Government has already missed a significant opportunity to improve the school science curriculum. In its *Science and Innovation Investment Framework 2004–2014* it states that “the Working Group on 14–19 Curriculum and Qualifications Reform, chaired by Mike Tomlinson, is developing a diploma framework which will include: the generic skills needed by everybody for any further learning, employment and adult life; and the specific subjects and areas of learning in which young people want to progress”.¹³⁷ This undertaking is broadly in line with recommendations made in our Report on *Science Education from 14 to 19*. Given that the output of this Working Group is heralded in the *Investment Framework* as one of the Government’s main actions to improve school science, it is surprising that, when the Tomlinson Report was published in October 2004, the Government rejected out of hand its proposals for a new diploma to replace existing school qualifications. **It is a pity that the Government has missed its first major opportunity, offered by the Tomlinson Report, to reinvigorate the school science curriculum.**

66. **The only way of securing high levels of future student demand for STEM subjects is by enthusing them about those subjects from an early age. Until school science teaching improves, the Government must expect that school leavers will continue to view mainstream STEM subjects as too difficult, irrelevant or simply too boring. The Government needs to apply itself to resolving these issues. It should not be deterred by the possibility that its efforts in this area will not bear fruit for several years. If it does not invest in school science education for the long term, the difficulties experienced by university STEM departments in recruiting students, and thus staying open, can only continue to get worse.**

Careers information

67. STEM graduates have excellent career prospects. There is some evidence that this is already a factor in students’ decisions to take STEM subjects at university. Stephen Rowley, one of a panel of students that we saw on 7 February, told us why he chose to take a degree in civil engineering: “I was aware I wanted to do something that got me out and about; I did not want to be stuck behind a desk and things like that. They made me aware that there

134 Q 254

135 Ev 237

136 Sixth Special Report from the Science and Technology Committee, Session 2001–02, *Science Education From 14-19: Government Response to the Committee's Third Report* (HC 1204), p 6

137 HM Treasury, Department of Trade and Industry and Department for Education and Skills, *Science and Innovation Investment Framework 2004–2014*, July 2004, p 90

was going to be a shortage of good engineers, so it might be a good way to go”.¹³⁸ Nonetheless, the evidence we received suggests that other prospective students have a less clear idea about, or interest in, the career prospects stemming from their choice of degree. This is borne out by the Dearing Report, which showed that the majority of full-time students picked their courses for “intellectual” rather than “instrumental” reasons (see paragraph 52 above). Our Report on *Science Education from 14 to 19* found that “students need better information about the value of science to their future careers”.¹³⁹ Student choices appear to be informed in an unstructured way by a variety of sources outside school. Mike Hill, who has studied the choices made by school leavers, notes that “the role of television in influencing career choice should not be underestimated. An Office Angels survey in 2005 revealed that 82 % of 1,500 young people between the ages of 16 to 25 said dramas like *Spooks*, *CSI*, *Ready Steady Cook* had a major influence on their choices. The five most popular choices were forensic science, journalism, government security agencies, becoming a chef and property development. This is irrespective of the realities of the job market and potential vacancies in some of these fields of work”.¹⁴⁰ Furthermore, the Institute of Physics observes that careers advice given to schoolchildren tends to be “reactive”, effectively closing off the possibility of avenues that the children themselves have not thought of.¹⁴¹

68. The public image of scientists and engineers has an impact on the appeal of STEM-related careers to schoolchildren, particularly girls (see paragraphs 53 to 56). Further evidence for this is provided by the drastic increase in popularity of forensic science and allied subjects (for both male and female students) in conjunction with the prominent and favourable image of this profession projected by the media in recent years (see paragraphs 58 to 59). The Government should learn from this example the power of the media as a tool for promoting interest in scientific careers. **The Government should consider measures to promote scientific careers to people of all ages, for example, by using advertising campaigns such as those used to improve the image of teachers, policemen and recruits for the armed services.**

69. A recent study commissioned by the Institute of Physics (IoP) and the RSC stated that, “the individual rate of return to the average degree holder is about 12% per annum. This compares with an individual rate of return for graduates in chemistry and physics of approximately 15% per annum. Undertaking a chemistry and physics degree provides an above average investment to the individual”.¹⁴² Yet, evidence suggests that awareness of the salary potential of certain careers, and the university courses that lead into them, is low amongst school leavers. The Lambert Review stated that “more information should be provided to students on the economic consequences of their course choices”.¹⁴³ As students become increasingly mindful of debt, the prospects of a high-earning career at the end of

138 Q 75

139 HC [2001–02] 508, p 5

140 Mike Hill, *Responding To The Challenges Of The Global Market: Ensuring Careers Education And Guidance Is Relevant To The Demands Of The Twenty First Century*

141 Ev 132

142 Royal Society of Chemistry and Institute of Physics, *The economic benefits of higher education qualifications: A report produced for the Royal Society of Chemistry and the Institute of Physics by PricewaterhouseCoopers LLP*, January 2005, p 3

143 HM Treasury, *Lambert Review of Business-University Collaboration*, December 2003, p 108

their degree are likely to become more attractive to them. Good financial prospects have the potential to act as a powerful lever to encourage students to take up STEM subjects at university. In addition, the skills shortages identified by some employers of scientists (see chapter 3) mean a greater likelihood of securing employment for those who have acquired the requisite skills. By contrast, the increase in the number of students taking degrees in such subjects as psychology, forensic science and media studies has led to an over-supply of graduates for the jobs available. This was described by Scientists for Labour as a “market breakdown [...] school students are failing to appreciate the advantages of science subjects that confer excellent transferable skills and career options, while other subjects have become fashionable out of all proportion to job opportunities”.¹⁴⁴

70. In its *Science and Innovation Investment Framework 2004–2014*, the Government sets out its plans to increase the access by young people to careers advice by means of the Connexions service. It states that “the Connexions service [...] offers a conduit for good quality careers information from employer organisations or sector bodies”.¹⁴⁵ Whilst it is a positive sign that the Government has acknowledged the importance of providing schoolchildren with good quality, impartial careers advice, we are not convinced that such advice is best located outside school. Unless careers advice is delivered directly to schoolchildren, as an integral part of their school experience, there is a chance that they will not take the opportunity to benefit from advice offered to them by the Government.

71. Degrees in STEM subjects generally have good career prospects, particularly given current skills shortages in many areas. The Government should ensure that all schools are in a position to offer impartial careers advice to schoolchildren well before the time that they choose their A-level, and subsequently degree, subjects. The advice should be proactive rather than reactive, and should seek to make children aware of the full range of exciting possibilities offered by scientific careers. A realistic indication of job and salary prospects should also be given.

Financial incentives

72. In our *Office of Science and Technology: Scrutiny Report 2003*, we recommended that, in order to maintain sufficient demand for particular subjects, “the Government should consider establishing bursaries for undergraduates to study shortage subjects, such as physical sciences and engineering”.¹⁴⁶ In its Response, the Government rejected our suggestion.¹⁴⁷ In the US, a Bill is currently being drafted that would remove interest on college loans for students graduating with science-related majors and subsequently working for at least three years in the field, until the point when their salaries exceeded four times the median US income (\$32,000).¹⁴⁸ In the UK, the IoP has already introduced a bursary scheme for physics students worth £1,000 a year. In oral evidence, Professor

144 Ev 311

145 HM Treasury, Department of Trade and Industry and Department for Education and Skills, *Science and Innovation Investment Framework 2004–2014*, July 2004, p 91

146 Fourth Report from the Science and Technology Committee, Session 2003–04, *Office of Science and Technology: Scrutiny Report 2003* (HC 316), p 28

147 Fourth Special Report from the Science and Technology Committee, Session 2003–04, *Government Response to the Committee's Fourth Report, Session 2003–04, Office of Science and Technology: Scrutiny Report 2003* (HC 588), p 8

148 “Forgiving Science Majors”, *Science*, 18 March 2005, vol 307, p 1707

Michael Sterling, Chairman of the Russell Group, told us that the scheme was “already attracting increased student interest. Positive intervention can influence the market for strategic purposes”.¹⁴⁹ He told us that national bursaries “need not be very many [...] and they need not cost very much money”, and emphasised that “it is more the message that is given to prospective applicants rather than the actual sum of money that they would get that is important”.¹⁵⁰ Indeed, all three of the other members of the panel of Vice Chancellors that we saw on 9 March were strongly in favour of the introduction of such a scheme.

73. Evidence on the effectiveness of financial incentives at stimulating student demand for STEM subjects is largely speculative because, apart from the still-embryonic IoP scheme and sponsorship deals run by employers, no such national bursary for STEM subjects currently exists. However, a similar venture has been used by the Government to try to increase the number of PGCE students. As is shown in paragraphs 34 to 35 of this Report, financial incentives for teachers have increased the recruitment of teachers, but have not improved retention rates. This experience suggests that, whilst financial incentives may be sufficient to attract initial student interest, recipients do not necessarily sustain their interest once funds dry up. This is potentially a serious limitation of a science bursary scheme, given that part of the intention of attracting more students into STEM courses at university is to increase the number of graduates pursuing long term careers in science.

74. In order to better understand the factors that motivate students, we asked a panel of students whether they thought that a bursary scheme would increase demand for STEM subjects. Danielle Miles told us that “I think it would appeal to people but I think you would get the wrong people on the courses [...] you might end up not having as many researchers and people going into the fields that they have studied in, and more people just going into IT with good degrees and things like that”.¹⁵¹ Ian Hutton agreed, saying that “I think you would have to be very careful about what incentives you offered because it is not just taking the places as a blank spot and trying to put people in them, you need the right kind of people to fill those places and careful consideration would need to be given as to why those places are not being filled by the people you want them to be filled by”.¹⁵² Attracting students who are more interested in the money than the subject, or its potential applications, is an inevitable risk of introducing a bursary scheme.

75. We recommend that the Government introduces a national bursary scheme, based on the scheme currently being run by the Institute of Physics, for outstanding university applicants in shortage STEM subjects. Such a scheme would give a much needed boost to levels of student demand in the short term. However, bursaries are not a cure-all, and the Government will need to introduce further measures to sustain increases in demand in the long term.

149 Q 411

150 Q 412

151 Q 45

152 Q 51

5 The higher education funding system

Overview of the funding system

76. English universities are funded by Government at arms' length through two main sources. Under the Dual Support System, core funding (the "block grant") is awarded to universities by the Higher Education Funding Council for England (HEFCE), which allocates both quality-related (QR) funding for research on the basis of institutions' performance in the Research Assessment Exercise (RAE); and teaching funding. The second funding stream in the Dual Support System is channelled through the Office of Science and Technology, and is awarded by the Research Councils for specific research projects, again on the basis of merit. In 2004–05, HEFCE awarded a total of £5,993 million in funding to universities. Figure 4, below, shows how this was broken down. In response to the *Lambert Review of Business-University Collaboration*, the Government has confirmed its support for "third leg" university funding through the Higher Education Innovation Fund (HEIF). HEIF is a "permanent third stream of funding for universities in England to further build capacity in the university sector for knowledge transfer". The value of HEIF will be increased in value to £110 million per year by 2007–08.¹⁵³ Universities also secure funding from other sources: research project support from charities, the private sector and the European Union; donations from alumni and other benefactors; and fees from students.

Figure 4: Breakdown of HEFCE funding in 2004–05: total £5,993 million

Component	Amount of funding (£ million)
Teaching	3,826
Research	1,081
Special funding	486
Earmarked capital funding	584
Provision for transfers and flexibility	16

Source: HEFCE, *Funding in higher education in England: How HEFCE allocates its funds, May 2004*, p 5

77. The degree of control that the Government can exercise over HEFCE is formally very limited. Dr Kim Howells MP, Minister of State for Lifelong Learning, Further and Higher Education, told us that "we are prevented by law from instructing HEFCE to do anything. The Secretary of State once a year writes a letter which sets out what it is that the Government thinks is required from the Higher Education Funding Council for England and of course it is a means of protecting the academic independence of the university sector and of individual universities".¹⁵⁴ The independence of the university sector is a principle endorsed by both Government and HEFCE. We have found in the past, however, that, because Government has ultimate control of the purse strings, HEFCE cannot in

153 HM Treasury, Department of Trade and Industry and Department for Education and Skills, *Science and Innovation Investment Framework 2004–2014*, July 2004, p 74

154 Q 472

practice act entirely on its own initiative. We believe that this informal control exercised by Government has on occasion constrained HEFCE and its associate Non-Departmental Public Bodies from forming an independent view.¹⁵⁵

University autonomy

78. Universities are autonomous institutions and, as such, have the power to decide how they will spend the funds that they receive from HEFCE. They are under no obligation to distribute internally the funds that they receive according to the formulae used by HEFCE as the basis for making the award. Indeed, the principle of “collegiality”, or the cross-subsidisation of one department using funds nominally awarded to another, is widespread in the university sector. Under current arrangements, each university is required by HEFCE to develop an institutional mission and a corporate plan. Whilst HEFCE requires to be shown these plans, it does not have the power to sanction or approve them.

79. University autonomy was enshrined in the funding system in order to ensure that the Government could not “use the power of the purse to interfere in academic judgements, but it has the additional advantage of ensuring that detailed decisions on higher education funding are not taken with an eye to short-term political considerations”.¹⁵⁶ A Higher Education Policy Institute paper notes that “the arrangements we have here have endured for good reasons, and have contributed to the dynamism, vibrancy and quality of our higher education system. By and large, universities that are well-managed are in a better position to make their own decisions based on their strengths and weaknesses and their perception of market conditions than a central bureaucracy, however much expertise is injected into it”.¹⁵⁷ University autonomy is widely supported and the general principle was not questioned in the evidence we received. The Government itself stated in written evidence that “it is not desirable to revert to a state-controlled curriculum, where government decides what courses universities can run. That route would destroy university autonomy, and leave subjects fossilised according to last century’s needs”.¹⁵⁸ The universities themselves unanimously defended their autonomy in evidence to this inquiry, although, as will be seen below, in common with other witnesses some of them are in favour of limited Government intervention in university affairs where particular disciplines are under threat.

80. It has been argued that, since universities are autonomous, HEFCE has no direct responsibility for the financial difficulties experienced by any one particular university department. HEFCE itself stated that “the great majority of HEFCE funding is allocated to HEIs as a single block grant, and it is entirely for the HEIs to decide how to allocate this and the other resources available to them between disciplines and between activities within disciplines. We do not therefore see a direct linkage between our grant allocations and the financial viability of academic departments”.¹⁵⁹ Whilst this may be true in theory, in

155 See Fourteenth Report from the Science and Technology Committee, Session 2003–04, *Responses to the Committee’s Tenth Report, Session 2003–04, Scientific Publications: Free for all?* (HC 1200), *passim*.

156 Bahram Bekhradnia, Higher Education Policy Institute, *Government, Funding Council and Universities: How Should They Relate?*, February 2004, p 3

157 Bahram Bekhradnia, Higher Education Policy Institute, *Government, Funding Council and Universities: How Should They Relate?*, February 2004, p 9

158 Ev 237

159 Ev 89

practice university autonomy is constrained by universities' need to play the system in order to win funding. As we have commented in our two Reports on the RAE, such games-playing limits the number of options that universities have for the internal distribution of their block grant.¹⁶⁰ The informal control that Government exercises over university affairs was acknowledged by the Minister for Lifelong Learning, Further and Higher Education, who told us that “the biggest finger in the pie we have got is we are the ones who have got our hands around the pound notes that we hand over to the VCs, via HEFCE of course, and, believe me, that is quite a handful”.¹⁶¹

81. The other brake on university autonomy is the market-driven approach advocated by the Government. As a consequence of this approach, universities have become demand-led, providing the courses that attract high student numbers and closing those for which there is very low demand. Whilst one student we saw was unhappy about the closure of her own chemistry department, she advocated the principle of a market driven by student demand, saying that universities “have to look at the fact that the people paying for it are taxpayers and the like, and also we are all customers of the university; we pay to be there and we pay quite a lot to be there and they should respect what we want”.¹⁶² With the introduction of variable tuition fees, and the consequent treatment of the student as consumer, the market principle in higher education can only become further established. In combination, the twin imperatives of securing Government funding and responding to student demand have the effect of limiting quite severely the number of choices that theoretically autonomous universities can make. Professor Steve Smith, Vice-Chancellor at Exeter University told us that “universities do not want to go around shutting expensive facilities. You do not get pleasure from displacing students. You really try not to do this. I think the combination of a situation in which there are fewer well qualified students in many of the sciences than one would need to fill all the places that are available nationally and the double whammy of the research funding model means that institutions have to make choices”.¹⁶³

82. It is entirely proper that universities should be able to react to the student market and changes in the levels of funding that they receive by taking decisions on the basis of their own financial interests. Indeed, any changes to this arrangement would be inconsistent with the performance-based principles under which the higher education system operates. However, as the Government itself stated, “it is possible that independent universities, acting separately, may take decisions which, taken collectively, are not in the best interests of individual regions (or of the country as a whole)”.¹⁶⁴ It is precisely because the sum of individual interests does not always equate to the interests of the higher education system as a whole that HEFCE is considering two mechanisms by which it can intervene to secure the provision of threatened subjects that are of strategic importance. The Government's *Investment Framework* states that:

160 Second Report from the Science and Technology Committee, Session 2001–02, *The Research Assessment Exercise* (HC 507), and Eleventh Report of the Science and Technology Committee, Session 2003–04, *Research Assessment Exercise: A re-assessment* (HC 586)

161 Q 519

162 Q 50 [Danielle Miles]

163 Q 432

164 Ev 237

- “The Government expects HEFCE to explore with HEIs [higher education institutions] and bodies representing HEIs’ interests the possibility of making a notice period of 12 months before the closure of any department a condition of grant”; and
- “HEFCE will now consider providing additional funding to particular departments if there is a powerful case that weakening provision in a particular region would hinder student access to disciplines that are important to national and regional economic development”.¹⁶⁵

These measures do not sit easily with the principle of university autonomy, however beneficial they may be. Nonetheless, the principle of university autonomy could be substantially protected, providing that HEFCE intervened only if it could be proved that the national or regional economic interest would be compromised if no action was taken; and only if its intervention was positive (to secure provision of a struggling subject) rather than negative (to reduce or curtail provision of a subject that did not meet the Government’s policy objectives).

83. We endorse the principle of university autonomy. We also acknowledge that, in practice, the decisions taken by universities are in large measure dictated by the need to win funding and respond to changes in student demand. Where market conditions and the university funding system make it financially difficult for universities to continue providing subjects of national or regional strategic importance, HEFCE may need to intervene to prevent their decline at a national or regional level. We support HEFCE’s proposals to require universities to give a period of notice before closing a department and to consider offering financial support to individual departments where it is in the national or regional interest to do so. Without the introduction of these mechanisms, many STEM departments will struggle to survive in the short term. In the longer term, STEM subjects are best protected by measures to influence student demand. These are discussed in chapter 4.

84. There is a risk that, if HEFCE provides financial support to protect struggling university STEM departments, universities will knowingly allocate insufficient funds to such departments in the knowledge that further targeted funding will be forthcoming. **It is essential that any additional HEFCE funding for strategic subject provision is used only as measure of last resort. In order to qualify for such funding, universities should have to prove to HEFCE that no alternative financial arrangements can be made. HEFCE should also have to satisfy itself that, without the allocation of such funds, capacity in the subject in question would be severely damaged at either a regional or a national level.**

Funding for minority subjects

85. HEFCE has acknowledged that “there is some HE [higher education] provision which is in the national interest but which it would not be reasonable to require institutions to make within their formula-based allocations for teaching and research”. Since 1991 it has

¹⁶⁵ HM Treasury, Department of Trade and Industry and Department for Education and Skills, *Science and Innovation Investment Framework 2004–2014*, July 2004, p 95

set aside funding in addition to existing research and teaching funds in order to support subjects that it designates as “minority subjects”. This academic year (2004–05), it has allocated £2.8 million in their support. In order to qualify for this additional support, subjects have to be deemed to be in the national interest. For these purposes, HEFCE has defined the national interest as follows:

- a) **“The needs of diplomacy:** this covers the full range of UK interests, influence and commitments overseas and requires a supply of independent expertise to be available to respond to the patterns of UK interests as they vary over time;
- b) **The needs of industry and commerce:** international trade and the development of overseas markets demand knowledge of local language and culture. Again, as international trading patterns change, so do the countries and regions about which knowledge is required; and
- c) **Maintenance of academic diversity:** minority subjects contribute to the diversity of provision by HEIs [higher education institutions] and their continuation is important to maintaining the balance and breadth of discipline expertise in the UK. Minority subjects by their nature are dependent upon a very small group of experts and would quickly become in danger of disappearing if the number of new first degree entrants were allowed to decline too far. Once gone, the reintroduction of a subject would be unlikely”.¹⁶⁶

In order to qualify as a minority subject, HEFCE stipulates that a subject must have enrolled no more than 100 students throughout the UK.

86. HEFCE’s arrangements for minority subjects establish the principle of limited Government intervention in the higher education market where intervention is deemed to be in the national interest. In practice, however, these arrangements help to preserve only a very narrow range of subjects. As a paper published by the Higher Education Policy Institute notes, “the definition of minority subjects—which requires that fewer than 100 students study them nationwide—means that they tend to be rather esoteric”.¹⁶⁷ In oral evidence, the Chief Executive of HEFCE, Sir Howard Newby, told us that “the vast majority of these subjects are what we call exotic languages, although they do include some science and technology subjects—paper-making technology for example, and shoe and leather technology have been two in particular”.¹⁶⁸ The degree of specialisation of such subjects; the existence of a direct and specific application for graduates in these areas; and the very small scale involved all make the question of Government intervention relatively straightforward, and limit the financial burden of any action taken. It is clear that the issue of minority provision is less straightforward when applied to mainstream STEM subjects. The demand for skills acquired through the study of these subjects is far less easily quantified: as is seen in chapter 3 above, there is often no single direct application for a core STEM degree, and the benefits of taking one may be cultural rather than practical. Furthermore, the numbers involved are far greater. If only 100 students per year took

166 Ev 301

167 Bahram Bekhradnia, Higher Education Policy Institute, *Government, Funding Council and Universities: How Should They Relate?*, February 2004, p 13

168 Q 179

physics degrees, numbers would already have fallen far lower than was necessary to meet the demands of the economy, however indirect the relationship between the volume of graduates and the demand for their skills. In order to sustain the provision of STEM subjects at an acceptable level, a greater number of students, and thus more money, would be required than is currently the case for HEFCE's designated "minority subjects".

87. We commend HEFCE for its support for minority subjects deemed to be in the national interest. It is clear, however, that the arrangements that have been made to secure the provision of such subjects would not be applicable to mainstream STEM subjects.

Research funding

A system based on performance

88. Both pillars of the Dual Support System fund research on the basis of excellence. Research Councils award research grants on the basis of research proposals, which are peer reviewed. Some Research Council grants are awarded within managed strategic programmes, which are established—usually at RCUK level—in response to emerging national priorities. It is the intention that such projects meet the same criteria of excellence as projects funded in responsive mode. Similarly, QR funding is awarded by HEFCE on the basis of departmental performance in the RAE. There is no mechanism to ensure that both funding streams are channelled to the same recipients, but, as RCUK observes, "in practice, statistics collected by the Research Councils demonstrate a strong correlation between RAE rating and success in winning funding from the Research Councils for research, training or access to facilities".¹⁶⁹ Whilst this correlation suggests that the assessment processes for both funding streams are working well (their decisions are mutually confirmed), one of its consequences is the concentration of research funding in a relatively small number of departments (see paragraphs 96 to 103).

The Research Assessment Exercise (RAE)

89. The problems caused by past RAEs are well documented, particularly in two Committee Reports published during this Parliament, *The Research Assessment Exercise* and *Research Assessment Exercise: a re-assessment*.¹⁷⁰ Ironically, these problems are associated with a widespread improvement in the quality of research being carried out in an ever increasing number of departments. For example, 144 departments that were rated 3a (on a scale of 1–5*) or below in the 1996 RAE were rated 5 or, in ten cases, 5* in 2001. Of the total 439 departments that were rated 3a in 1996, 306 were rated 4 or higher in 2001.¹⁷¹ Thus only 30% of departments rated 3a in 1996 did not improve their rating five years later. In 2001, the proportion of research active staff in departments rated 5 or 5* was, at 55%, very high. Although the total amount of funding available to support research through QR funds increased between 1996 and 2001, it did not increase in step with the

169 Ev 196

170 HC [2001–02] 507, and HC [2003–04] 586

171 Fifth Report from the Education and Skills Committee, Session 2002–03, *The Future of Higher Education* (HC 425-I), p 17

dramatic improvement in RAE scores. This meant that HEFCE had to make a strategic decision about the distribution of funding. Sir Howard Newby explained to us that “our first priority is to sustain truly world-class science research in this country; then, as I often say, we work our way down until the money runs out. At the moment, it runs out at about two-thirds of the way through the grade-4 departments. I wish we could fully fund the grade 4s, but we do not have the resources to do so”.¹⁷²

90. After RAE 2001, all but those departments scoring in the top two categories saw a reduction in funding, regardless of whether or not they had shown an improvement in rating between 1996 and 2001. For departments rated 3a or lower, the allocations following RAE 2001 brought no funding at all. Departments rated 4 saw their combined funding drop from a total of £139 million in 2002–03 to £118 million in 2003–04. Figure 5 shows how RAE 2001 affected departments in different subjects with different ratings at London Metropolitan University. Box 3 illustrates the consequences that the new arrangements following 2001 had on three STEM departments at Exeter University. At Exeter, despite an increase in rating from 3a to 4, the biology department saw a decrease in QR funding of 18% between RAE 1996 and RAE 2001. However, unlike chemistry, the biology department at Exeter was kept open and targeted for growth. Also unlike chemistry, demand for courses in the biological sciences was high at Exeter (see box 2 in chapter 2). This case study tends to reinforce the argument that student demand plays a vital role in the ability of a department to thrive (see chapter 4).

Figure 5: London Metropolitan University: Percentage changes in the value of the QR funding unit between 2001–02 and 2003–04

Subject	4-rated	5-rated	5*-rated
Biological sciences	-50%	-7%	-11%
Chemistry	-46%	+1%	+1%
Physics	-42%	+7%	+7%
Earth science	-49%	-5%	-5%
Environmental science	-38%	+17%	+16%
Pure mathematics	-39%	+15%	+14%
Applied mathematics	-44%	+3%	+3%
Statistics	-49%	-5%	-4%
Computer science	-38%	-16%	+16%

Source: Ev 125

Box 3: Consequences of RAE 2001 for Exeter UniversityPhysics

Rated 4 in RAE 1996.

Rated 5 in RAE 2001.

Rating change: improvement.

In the last year of the old RAE distribution (2001–02), it received a sum of £24.8k per staff member. By 2004–05, this had risen to £46.2l per staff member.

Change in funding: +86%

Chemistry

Rated 4 in RAE 1996.

Rated 4 in RAE 2001.

Rating change: no change.

In the last year of the old RAE distribution (2001–02), it received a sum of £28.2k per staff member. By 2004–05, this had fallen to £16k per staff member.

Change in funding: -43%

Biology

Rated 3a in 1996 RAE.

Rated 4 in 2001 RAE.

Rating change: improvement.

In the last year of the old RAE distribution (2001–02), it received £18.3k per staff member. By 2004–05, this had fallen to £15k per staff member.

Change in funding: -18%

The funding cliff

91. As a result of the funding decisions taken by HEFCE following RAE 2001, the funding differential between departments rated 5 and 5*, departments rated 4, and departments rated 3a or less has become extremely steep. Many witnesses felt that this was responsible for the financial difficulties—and, in some cases, closures—being experienced by many STEM departments rated 4 or lower (see figure 6, below). The UK Deans of Science, for example, told us that “since the 1996 RAE there have been at least 80 cases of closure of single subject science degrees in lower (RAE) graded departments”.¹⁷³ Loughborough University stated that “there is no doubt that the funding ratios of roughly 1: 2.8: 3.3 have been damaging for grade 4 departments [...] reasonable assumptions and private data suggest that ratios of roughly 1: 2: 3 would be the highest one could justify on the basis of RAE criteria of excellence”.¹⁷⁴ In oral evidence, Dr Simon Campbell, President of the Royal Society of Chemistry, told us that “the cliff is very steep between five-star, five and fours and that is the problem, but we need more money”.¹⁷⁵ Professor Amanda Chetwynd, Vice President of the London Mathematical Society, stated that “I would make the cliff less steep and I would put more money in altogether”.¹⁷⁶ In our 2004 Report, *Research Assessment Exercise: a re-assessment* we noted that, as a result of the steep cliff in funding,

173 Ev 83

174 Ev 232

175 Q 340

176 Q 339

“comparatively fine judgements at the grade boundaries could have a disproportionate impact upon funding and reputation”.¹⁷⁷

Figure 6: University chemistry department closures by RAE scores

University	Subject	RAE rating in 2001	% of returned staff in units below 5/5*
Exeter	Chemistry	4	43
King's College London	Chemistry	4	39
Queen Mary, London	Chemistry	3a	53
Swansea	Chemistry	4	81
Newcastle	Physics	4	40
Keele	Physics	3a	59

Source: Informal meeting with Professor Steve Smith, Vice Chancellor of Exeter University, on 14 December 2004

92. Although many witnesses told us that research funding was a problem mainly in conjunction with declining student demand, very few witnesses thought that the RAE played no role at all in the financial viability of university departments. The University of York told us that it was possible to maintain STEM departments regardless of their RAE score, stating that it had “made a strategic decision to maintain and build all its Departments, irrespective of RAE 2001 performance, and has successfully implemented this strategy in this challenging financial environment”.¹⁷⁸ We asked a panel of Vice Chancellors why other universities had not pursued a similar policy. Professor Steve Smith of Exeter University told us that the information provided by the University of York needed to be seen in context: “the key figure about York is to look at the percentage of staff it has in a four ranking and below. Just off the top of my head, I think 85 per cent of their staff are in five or five star. If you look at all of the closures in the last two years in the physical sciences, in every single case there are institutions that have around 40 per cent or more of their staff in fours and below”.¹⁷⁹ In other words, the viability of 4-rated departments in institutions that have a majority of departments rated 5 or higher can be secured through cross-subsidy. This becomes more difficult in institutions where less than half of the departments are rated 5 or above.

93. The funding allocations made as a result of RAE 2001 have severely compromised the financial viability of departments rated 4 or lower, particularly in those institutions that do not have an overall majority of research staff in departments rated 5 or higher. In order to prevent the continued decline of many 4-rated departments, there needs to be a reduction in the steepness of the “cliff edges” between the funding allocated to departments falling within different funding bands.

94. Our 2004 Report, *Research Assessment Exercise: a re-assessment*, welcomed the acceptance by the Funding Councils of Sir Gareth Roberts’s proposal for a “quality profile”

177 HC [2003–04] 586, p 20

178 Ev 166

179 Q 421

to be used in RAE 2008. Under the current system, a department's performance rating is recorded as an average of its total activity—this means that pockets of excellence within departments with a varying standard of performance tend to go unrewarded. The new system will instead give a full picture of all the research activity taking place within a particular department, its research “footprint”. This will provide a means of rewarding pockets of excellence within departments performing less well overall. By giving a more rounded picture, the new assessment method is intended to help eliminate the cliff edge between ratings on the scale used in previous RAEs. As we noted in our Report, the proposals have received widespread support. We concluded that “the introduction of a quality profile is a significant step forward and, if associated with an equitable funding formula, could eliminate many of the iniquities of the previous grading system”.¹⁸⁰ **We hope that the new “quality profiles” to be used in RAE 2008 will help to reduce the steepness of the funding scale for the allocation QR funds. In the meantime, however, many departments are still feeling the adverse effects of the funding arrangements made as a result of RAE 2001. The Government may have to recognise that short term measures, such as those proposed by HEFCE, are required to support departments currently rated 4 or lower until the new arrangements have had time to take effect. Intervention by HEFCE is discussed in paragraphs 82 to 84.**

Impact of full economic cost policy

95. In May 2003 the Government published *The Sustainability of University Research: A consultation on reforming parts of the Dual Support System*.¹⁸¹ In it the Government proposed to increase the proportion of the full economic cost of research paid by the Research Councils by means of research project grants. In January 2005, a letter from Lord Sainsbury announced that the proportion of the full economic cost of research paid by the Research Councils would be 80%.¹⁸² In our *Office of Science and Technology: Scrutiny Report 2004*, we cautiously welcomed this development, although we commented that the opacity of the data provided to us meant that we were unable to judge the extent to which the changes would improve the overall sustainability of research funding.¹⁸³ Some witnesses to our current inquiry welcomed the changes more wholeheartedly. Nottingham Trent University, for example, stated that “forthcoming changes to Research Council funded projects, which are moving towards full economic costing, should reinforce our ability to maintain a small core of highest quality research within the physical sciences irrespective of RAE funding”.¹⁸⁴ **The move towards Research Councils meeting the full economic cost of the research projects that they fund should improve the financial viability and thus the sustainability of STEM departments carrying out a significant volume of research. In turn, this may mitigate against some of the more negative consequences of the RAE. We hope that our successor Committee will have the opportunity to assess the impact of this new policy once it has had time to take effect.**

180 HC [2003–04] 586, p 21

181 Department of Trade and Industry, *The Sustainability of University Research: a consultation on reforming parts of the Dual Support system*, May 2003

182 “Higher Education Research”, Letter from Lord Sainsbury of Turville to Vice Chancellors, 6 January 2005

183 HC [2004–05] 8, p 23

184 Ev 118

Research concentration

96. The Government has no explicit policy aim to increase the concentration of research funding. It told us in written evidence that “it is not Government’s policy to concentrate funding or research in this way, and we are not convinced that there is such a concentration”. Nonetheless, research is funded through both streams of the Dual Support System on the basis of excellence: “our research policy is to support excellence wherever it is found, and we make no apologies for providing a higher level of public funding to the best departments”.¹⁸⁵ It is widely acknowledged, not least by Government, that an inevitable consequence of the policy of rewarding excellence—particularly in view of the fact that the two funding streams tend to converge—is research concentration. We were told by the Director General of the Research Councils that “something like 46 per cent of Research Council expenditure is within ten universities and just over 80 per cent of it is within 25 universities. The numbers for HEFCE are broadly comparable to that”.¹⁸⁶ The University of York told us that “research funding is already concentrated with 40% of HEFCE [research] funds going into the Oxford/Cambridge/London triangle, and the top four institutions attracting 30% of entire QR funding available”.¹⁸⁷ Professor O’Nions told us that he thought that research concentration is “an inevitable situation in terms of the resources we have available”.¹⁸⁸ **The concentration of research funds is an inevitable consequence of a system that funds research on the basis of excellence from limited funds. The Government is responsible for this system. It is therefore disingenuous of the Government to deny that it has a policy to concentrate research.**

97. Many submissions argued strongly against the further concentration of research. The Royal Academy of Engineering told us that “a concentration policy, too crudely applied, could damage the ability of young researchers in less favoured institutions to win funding and affect the flow of talent”.¹⁸⁹ The Institute of Electrical Engineers argued that “concentrating research into fewer departments would create deserts of research in many areas of the country, and would adversely impact on local innovation and wealth creation initiatives, and regional development plans”.¹⁹⁰ The London Mathematical Society told us that research concentration could damage vital interdisciplinary links, saying that it would “damage the symbiotic relationship between mathematical scientists and other disciplines in research. The vitality of application-driven research in mathematics depends crucially on research-active mathematicians being available”.¹⁹¹ Parents Against Cuts at Exeter stated that “universities as a whole benefit from being comprised of a rounded comprehensive range of disciplines and the consequences of the trend towards concentrating research in a small number of universities will be an increasing number of specialist universities, reduced provision of a healthy range and mix of disciplines overall, and regional deserts in particular subject areas”.¹⁹² In a 2002 Report, *The Future of Higher*

185 Ev 235

186 Q 209

187 Ev 166

188 Q 209

189 Ev 151

190 Ev 96

191 Ev 240

192 Ev 190

Education, the Education and Skills Committee remained unconvinced that research concentration would benefit the UK's research base.¹⁹³ A 2003 review, commissioned by OST and conducted by the Science and Technology Policy Research Unit (SPRU) at Sussex University, concluded that “there seems to be little if any convincing evidence to justify a Government policy explicitly aimed at further concentration of research resources on large departments or large universities in the UK on the grounds of superior economic efficiency”.¹⁹⁴ In its Response to our Office of Science and Technology: Scrutiny Report 2003, the Government dismissed the SPRU study, saying that it “criticised a caricature of Government policy”.¹⁹⁵

98. There are two main arguments that are often used in favour of a degree of research concentration: international competitiveness and critical mass. The 1994 Group of universities told us that “success in the face of [...] international competition requires [...] a proper depth of research expertise and capability, particularly in science subjects. For the UK, these considerations require a continued concentration of research resources”.¹⁹⁶ Oxford University made the same argument on the basis that funds for research were limited: “to protect Science research, it is essential that research selectivity applied by HEFCE in respect of its QR funding is maintained. This is especially so if the UK is to maintain international competitiveness. If funds are limited, they must be concentrated in the most successful and competitive departments”.¹⁹⁷ The Lambert Review made the same argument: “if [the scope of the Dual Support System] were broadened radically, public resources would be spread too thinly across the university system, putting the research-intensive universities at a disadvantage in the competition for global research excellence”.¹⁹⁸ A Report commissioned by the Department of Trade and Industry from consultants Evidence Ltd, and published in October 2004, states that “the UK relative international research performance is second behind the USA in terms of overall research recognition”.¹⁹⁹ Universities UK told us that “the current basic research profile of UK universities shows research of international standards”.²⁰⁰ It would be unwise to jeopardise the UK's international standing in research by taking away resources from those universities that contribute the most to it.

99. The panel of Vice Chancellors we saw on 9 March agreed that some degree of research concentration is necessary. Professor David Eastwood of the University of East Anglia said that “if we are to be, and to remain, internationally competitive size matters, critical mass matters and therefore the policy, which is in effect a settled policy of the concentration of research resources, is the right one”. He also noted the consequences of following such a policy: “once you commit to that kind of policy in an expensive research led discipline then

193 Fifth Report from the Education and Skills Committee, Session 2001–02, *The Future of Higher Education* (HC 425-I), pp 16–17

194 N. von Tunzelmann, M. Ranga, B. Martin and A. Guena, *The Effects of Size on Research Performance: A SPRU Review*, June 2003, p iv

195 HC [2003–04] 588, p 7

196 Ev 85

197 Ev 97

198 HM Treasury, *The Lambert Review of Business-University Collaboration*, December 2003, p 86

199 Department of Trade and Industry, *PSA target metrics for the UK Research Base*, October 2003, p 12

200 Ev 258

it will have consequences for the provision of undergraduate teaching”.²⁰¹ Professor Michael Sterling pointed out that subject provision at the institutions into which research funds are concentrated is enhanced by the process: “some Vice Chancellors decide that strategically chemistry is not important and therefore close it. Those applicants that would have gone to that university are now dispersed across the rest and as that process continues applications at the remaining universities go up and so the viability of their department gets better and that is tending to happen now”.²⁰² This suggests that research concentration is a self-constrained process: it will end automatically when the quality of all remaining provision is uniformly high. The model endorsed by Professor Sterling favours depth of provision, at the possible expense of breadth.

100. The obvious way to resolve the issue of research concentration to the satisfaction of all parties would be to increase overall levels of funding for research, thus enabling the system to provide both depth and breadth. This is the preference of many of the learned societies, as is shown in paragraph 91. However, as we set out in the introduction to this Report, we think it unlikely that the overall pot of money for research will increase significantly in the immediate future. Thus we have assumed that any attempt to address the issue of breadth versus depth would have to operate within current financial limits—the system would continue to be a “zero sum” game, with funding gains in one area offset by funding losses in another.²⁰³ The two scenarios we have considered are as follows:

- a) Taking funds away from departments rated 5 or 5* in RAE 2001 and redistributing them amongst departments rated 4 or lower. This was described by Malcolm Keight of the Association of University Teachers as “robbing Peter to pay Paul”.²⁰⁴ Whilst much of the evidence we received expressed support for the principle of extra funding for departments rated 4 or lower, very few submissions countenanced taking funding away from the best performing departments in order to achieve this.
- b) Redistributing the funding that is currently automatically allocated to 4-rated departments (until it runs out: see paragraph 89). This was the solution, initially proposed in the Sir Gareth Roberts’s Review, that we recommended as part of our “three track” approach in *Research Assessment Exercise: a re-assessment*.²⁰⁵ Under this system:
 - i. departments currently achieving the highest scores (5 and 5*) would be exempt from the RAE process and would be proportionally funded on the basis of their research grant income;
 - ii. other departments could continue to take part in the RAE process. The funding that they received from the Funding Councils would be based on a formula relating to the volume and quality of their research. Departments not reaching a minimum standard of quality would not be funded;

201 Q 411

202 Q 441

203 Ev 147

204 Q 395

205 *Review of research assessment: Report by Sir Gareth Roberts to the UK funding bodies*, May 2003

- iii. departments could also bid for funds to develop their research. They would be assessed by subject panels based upon the RAE units of assessment and would be required to enter subsequent RAEs to provide a benchmark for improvement. Applications would be based on a business plan which indicating how the department in question intended to achieve a higher research quality rating.²⁰⁶

In its Response to our Report, *Research Assessment Exercise: a re-assessment*, the Government rejected our recommendation of the three-track approach on the basis that “the Funding Bodies’ consultation with the sector on the desirability of the ‘three track’ assessment process had a mixed response. There was a substantial majority opposed to the idea, which runs counter to the desire for criterion referencing”.²⁰⁷

101. There is a serious risk with the implementation of the first option listed above (paragraph 100a) that the removal of funding from 5 and 5* rated departments would compromise their ability to continue performing at the same high level. The University of York told us that “to penalise Grade 5 and 5* departments in order to support those with lower research grades would put the international standing of UK science at risk”.²⁰⁸ This was the position adopted by the Director General of the Research Councils: “to move away from the international excellence that that has achieved to distribute the things more widely is a policy which would be curious to follow after all the benefits in terms of international competitiveness and career structures that the selective funding and ‘concentration’ have achieved”.²⁰⁹ In addition, the Institute of Electrical Engineers told us that “spreading funding too thinly tends only to create mediocrity amongst many whilst we should be aiming for excellence”.²¹⁰ Furthermore, even some 5- and 5*-rated STEM departments are struggling financially. For example, the chemistry department at Oxford University, rated 5* in the RAE, announced in November 2004 that it was running at an annual £1 million deficit.²¹¹ Removing some of the funds of such departments could only increase the number of chemistry departments that were struggling to survive. **Instead of resolving the financial difficulties experienced by some STEM departments, the wholesale redistribution of research funds would diffuse those problems more widely. Such a policy would threaten the ability of 5 and 5* rated departments to continue performing at a high level. It would also risk their international standing, a move that could have adverse consequences for the UK’s international competitiveness and for individual careers. In the absence of increased overall funding, “robbing Peter to pay Paul” is not a viable solution to the financial difficulties of some STEM departments.**

102. By contrast, the introduction of a three-tier assessment process would allow the Government to continue to support excellence in research and would not penalise departments rated 5 and 5* for their previous success. It would also allow departments currently rated 4 or lower to compete for funds on the basis of merit, with funding available for the developmental stage of research on the basis of bids made by individual

206 HC [2003–04] 586, pp 10–11

207 First Special Report from the Science and Technology Committee, Session 2004–05, *Research Assessment Exercise: a re-assessment: Government Response to the Committee’s Eleventh Report of Session 2003-04* (HC 34), p 2

208 Ev 167

209 Q 224

210 Ev 96

211 Donald MacLeod, “Cash crisis at Oxford’s chemistry department”, *The Guardian*, Monday 29 November, 2004

institutions. **We urge the Government to reconsider its rejection of proposals for a three-tier research assessment process. Such a process would allow departments to bid for funding on the basis of merit instead of imposing an arbitrary cut off point for departments upholding the same standard of research activity. Although this would not increase overall levels of funding for research, it would distribute existing funds more fairly amongst lower performing departments.** See paragraph 94 for a discussion of changes to the RAE for 2008.

103. Many of the objections to research concentration centre on the assumption that, by differentiating between the performance of different departments, the funding system questions the ultimate value of those that perform less well. This need not be the case. In chapter 6 we make the case for a diversity of higher education provision. Research is not the only function of a university: such institutions also teach undergraduates, engage in scholarship and forge links with businesses. Greater differentiation of function might enable all departments to thrive on the basis of their own particular strengths, instead of forcing all departments to compete—and inevitably many will lose—on the basis of the strengths of a few. **Research concentration is not an evil *per se*: it only becomes a problem when it occurs in a uniform system, where universities that do not carry out world class research but are nonetheless strong in other areas of their work, are disregarded.**

Teaching funding

104. Teaching funds form the largest of the two main funding elements given to universities and colleges by HEFCE in the form of the block grant. In 2004–05, HEFCE allocated a total of £3,826 million in funds for teaching, comprising 64% of its total allocations (see figure 4, above). This amount is supplemented by tuition fees, paid by individual students, the Government, the Research Councils or other research funding bodies and industry. Box 4, below, sets out the method used by HEFCE to calculate the level of teaching grant given to each university or college. As is shown, the calculation is based on an institution's expenditure rather than on the cost of their activities.

Box 4: HEFCE's method for calculating the teaching grant for universities and colleges*Stage 1*

HEFCE calculates the **standard resource** for each institution. This is a notional calculation of what the institution would get if the grant was calculated afresh each year. It is based on each institution's profile of students, and takes into account:

- the number of students
- subject-related factors
- student-related factors
- institution-related factors

Stage 2

HEFCE calculates the **assumed resource** for each institution. This is based on the teaching grant paid to the institution got the previous year, adjusted for various factors such as inflation and HEFCE's assumption of student tuition fee income.

Stage 3

The **standard resource** is compared with the **assumed resource**, and HEFCE works out the percentage difference between them.

Stage 4

If the difference between the **standard resource** and the **assumed resource** is no more than 5% either way, the HEFCE grant will be carried forward from one year to the next. For institutions outside the 5% **tolerance band**, their grant and/or student numbers need to be adjusted so that they move within the **tolerance band**.

Source: HEFCE, *Funding higher education in England: How HEFCE allocates its funds, May 2004*, p 8

105. As Box 4 sets out, there are a number of variables that are taken into account when HEFCE calculates the level of teaching grant allocated to each institution. Paragraph 46 sets out the impact that student numbers have on the grant. Much of the evidence to this inquiry was concerned with the subject weightings used by HEFCE. Different subjects need different levels of resource. For example, subjects that are broadly classroom based are much less expensive to teach than subjects that require the use of laboratories and workshops. Consequently, STEM subjects, because of the need for laboratories and expensive equipment, tend to be more expensive to teach than arts and humanities subjects. HEFCE has created four broad groups of subjects, each with a different cost weighting. These four categories, set out in Figure 7, below, were changed for 2004–05 on the basis of responses to a HEFCE consultation conducted in August 2003, *Developing the funding method for teaching from 2004–05*.²¹² The subject weightings are designed to ensure that institutions have sufficient funding to cover the full range of their teaching activities. Institutions are not obliged, however, to distribute the grant internally according to the same ratios used by HEFCE in the calculation: “we do not expect institutions to allocate their teaching grant internally using the same approach that we have adopted for the sector as whole”.²¹³

212 HEFCE, *Developing the funding method for teaching from 2004–05*, August 2003

213 Ev 90

Figure 7: Changes to the subject weightings used to calculate HEFCE's teaching grant: 2003–04 to 2004–05

Funding band	Description	Cost weight 03–04	Cost weight 04–05
A	The clinical stages of medicine and dentistry courses and veterinary science	4.5	4.0
B	Laboratory-based subjects (science, pre-clinical stages of medicine and dentistry, engineering and technology)	2.0	1.7
C	Subjects with a studio, laboratory or fieldwork element	1.5	2.3
D	All other subjects	1.0	1.0

Source: HEFCE, *Funding higher education in England: How HEFCE allocates its funds, May 2004*, p 11, and informal meeting with Professor Steve Smith, Vice Chancellor of Exeter University on 14 December 2004

106. The majority of STEM subjects fall into category B, which saw its weighting reduced from 2.0 to 1.7 in 2004–05. We have received extensive evidence suggesting that the new weighting for category B subjects is insufficient to meet their teaching costs. Richard Sear, a lecturer in the School of Electronics and Physical Sciences in the University of Surrey, told us that the teaching grant “is inadequate to pay for teaching physics degrees in the way they have been traditionally taught in the UK, i.e. with substantial time in experimental and computing labs, and a relatively high staff to student ratio”.²¹⁴ The Royal Academy of Engineering said that STEM subjects “receive less than 50 per cent of the funding for medicine despite being equally, if not more, expensive in terms of resources for equipment and laboratory staff and the cost of industrial projects and design”.²¹⁵ The University of Central England stated that “reduction in the weightings means that students will have less practical work and more PC-based stimulation. A reduction of laboratory-based sciences takes them further away from the practical needs of industry”.²¹⁶ Senior scientists from the pharmaceutical industry told us that “for undergraduate chemistry teaching, the single most important problem is that the funding weighting given to the subject is totally inadequate and in no way reflects the cost of providing good education and training in the subject *and* complying with modern standards of safety”.²¹⁷ The UK Deans of Science told us that they had received estimates of the effect of the changed weightings on three universities: “these led to the removal for the 2004–05 session of approximately £750,000 for one Science Faculty and around £1,000,000 each from two others, despite their increasing costs”.²¹⁸ Both the UK Deans of Science and the Council of Professors and Heads of Computing told us that HEFCE’s decision to move computer science from band B to band C has caused “reductions in staff at a time when [...] employers are increasingly demanding higher level skills in this area”.²¹⁹

214 Ev 290

215 Ev 151

216 Ev 214

217 Ev 114

218 Ev 84

219 Ev 105

107. Not all the subjects contained in funding band B cost the same amount of money to teach. The Royal Society of Chemistry, for example, told us that “the money universities spend on chemistry is 37% per student more than pharmacy, 19% more than the biosciences, 17% more than earth and environmental sciences and 12% more than with engineering, to take four examples, yet all are in the same band and therefore funded equally through the HEFCE funding formula”.²²⁰ This difference in costs means that the more expensive STEM subjects in band B benefit less from the current subject weightings, although this imbalance may be compensated for by the recipient university when it distributes teaching funding internally. Paragraph 112 shows that when HEFCE consulted on changes to the subject weightings, it proposed splitting funding band B to reflect the differences in costs between subjects in that band, but that the proposal was rejected.

108. One of the signs that HEFCE’s teaching grant is insufficient to cover the costs of teaching STEM subjects is found in widespread reports that STEM departments are subsidising their teaching activity from research and other funds. Astra Zeneca told us that “nearly all Chemistry Departments conduct undergraduate teaching at a loss, and recoup the shortfall through HEFCE research funding”.²²¹ Dr Tina Overton from the Department of Chemistry at the University of Hull told us that “the teaching funding formula does not support science teaching and departments rely on cross subsidy from research streams to maintain staff and equipment levels”.²²² Professor Tom Blundell, President of the Biosciences Federation, told us that “I have done an analysis on our school in Cambridge and I think the teaching looks as if it is about one third under funded and that is actually funded through research activity”.²²³ By contrast, HEFCE told us that “it is possible for departments to remain viable where the majority of income comes through teaching resource. For example, in 2003–04 there were some 42 departments of chemistry with significant student numbers. Sixteen of these do not receive HEFCE research funding, although they do earn research income from other sources”.²²⁴ Professor David Eastwood, Vice Chancellor of the University of East Anglia supported this position, telling us that early indications from the application of the TRAC methodology suggested that research had a greater deficit than teaching.²²⁵ **It would be unacceptable if universities had to use research funds to subsidise teaching activity. In order to ensure that both teaching and research are supported at a sustainable level, the Government needs to have a clear understanding of the costs of each type of activity. We recommend that it uses the TRAC methodology to produce a comprehensive analysis of the costs of research and teaching relative to the level of funding that each activity receives.**

109. We received evidence that the calculation of the new subject weightings was flawed because it looked at expenditure rather than cost. Professor Michael Sterling, Vice Chancellor of Birmingham University and Chairman of the Russell Group of universities, explained that:

220 Ev 185

221 Ev 120

222 Ev 229

223 Q 349

224 Ev 91

225 Q 449

“In chemistry it was held that expenditure was going up. Why was it going up? It was going up because the student number was going down and it was difficult for chemistry staff to find alternative jobs outside the academic world. So essentially you had a high cost base remaining in staffing costs and a declining number of students and therefore your unit cost was going up. If you contrast that with engineering, engineering numbers were going down but staff numbers were also going down because engineering could make the transition into the commercial industrial world much more easily, so your cost base was going down. What appeared to happen is that the unitary resource, the spend, was going down for engineering and HEFCE then drew the conclusion that you do not need to spend as much money on engineering because the unitary resource is lower but you need to support the science one.”²²⁶

There would be very little to be gained by discussing at length here the relative costs of chemistry and engineering provision. What Professor Sterling’s example demonstrates is that a number of factors influence a department’s expenditure: many of them will be unrelated to the costs of teaching the subject in question. HEFCE told us that “currently our funding method uses expenditure as a proxy for cost in each subject area. This is the best information available, but we are piloting a means of looking more closely at costs based on the TRAC methodology, and may use this information in making future allocations”.²²⁷ It has since asked consultants to examine cost-based approaches to funding to inform its ongoing review of the teaching funding method. The consultants are due to report on their findings by the end of June 2005.²²⁸ **Departmental expenditure is a flawed basis from which calculate the level of teaching funding allocated to STEM departments. This seems to have been accepted by HEFCE: we understand that it has commissioned research on possible cost-based approaches to funding, including an approach based on the TRAC methodology.**

110. Throughout the course of this inquiry, HEFCE has insisted that STEM subjects have not been disadvantaged by the change in teaching weightings. In written evidence, and subsequently repeated by Sir Howard Newby in oral evidence, HEFCE stated that:

“The change in weighting affects the relativities between subject allocations. Changing the relativities naturally has an effect on the base unit of funding used to calculate grant allocations. When the weighting for SET subjects was changed from 2 to 1.7, this led to only a slight shift in resource for these subjects of -3.4%. Moreover, the allocations made to HEIs [higher education institutions] included additional funding for teaching, meaning that the overall grant for 2004–05 was allocated against a higher base. Taking this into account, the resource for SET subjects actually increased by 5.5%.”²²⁹

We have not received any statistics that contradict this statement. However, the proportion by which the resource for category B subjects has increased or decreased is meaningful only in context. This is a point made by Universities UK in written evidence. It states that, whilst

226 Q 442

227 Ev 91

228 Ev 301–302

229 Ev 90

the impact of changes to the subject weights will vary between institutions “depending on the particular circumstances of that institution and the way in which resources are allocated internally [...] there are two additional and more fundamental issues that need to be considered—the inadequate funding base for university teaching and learning and the historic basis upon which the funding is allocated”.²³⁰ Professor Boucher, a fellow of the Royal Academy of Engineering told us that “yes, there has been a modest increase but it is an increase that is still in a situation where there is chronic under funding”.²³¹ Set against this “chronic under funding”, which is attested to by a majority of those who submitted evidence to this inquiry, even an increase in teaching funds of 5.5% is likely to be insufficient to meet the actual costs of running STEM departments.

111. STEM subjects might have seen a slight increase in their levels of teaching resource, even after the change in subject weightings for their category was reduced from 2.0 to 1.7. However, any such increases need to be set against a history of chronic under funding for teaching. We recommend that the Government uses its research into the costs of teaching, facilitated by the TRAC methodology, to reach a settlement for STEM subjects that accurately reflects their cost.

112. When HEFCE consulted on its adjustment of the teaching funding weightings, it initially proposed to split price band B into two separate categories: B1 (containing physics, chemistry, chemical engineering and mineral, metallurgy and materials engineering) and B2 (containing other laboratory sciences and engineering). The proposal, made on the basis of expenditure data, was intended to increase the ratio of funding for the four subject areas that had seen the most significant decline in student demand, leading to increased unit costs. In its publication on the outcomes of its consultation, HEFCE framed the proposal as “a policy question: to what extent should HEFCE provide higher rates of recurrent funding to support subject areas of national importance that are in decline?” HEFCE abandoned the proposal on the basis that “a significant majority of institutions did not favour splitting price group B. It was also not generally supported by the broad science and engineering subject bodies, who perceived that science and engineering as a whole would lose out, even if the B1 subjects gained”.²³² We are not convinced that this opposition was well founded. Throughout the course of our inquiry we observed the special pleading used by many of the learned and professional societies to advance the cause of their particular area of specialism. However, the benefits of such tactics for one subject have to be weighed against the negative consequences for all the others. **It would be a matter of regret if, when HEFCE changed the subject weighting for teaching funding, competition between the science and engineering bodies about the relative importance of their areas of specialism had prevented some subjects, such as chemistry and physics, from receiving the funding uplifts that they so badly needed. The scientific community needs to pull together to ensure that future discussions about funding are resolved in the interests of science as a whole, regardless of the interests of individual specialisms.**

230 Ev 259

231 Q 346

232 HEFCE, *Funding method for teaching from 2004-05: Outcomes of consultation*, June 2004, p 8

6 The hub and spokes model

Is the current situation sustainable?

113. We have already established that the funding streams for both research and teaching are insufficient to meet the costs incurred by most university STEM departments. One of the reasons for this is that England has a very high number of universities competing for relatively limited funds. Many of these universities seek to be amongst the best at both research and teaching, yet evidence and experience suggest that the total funding in the system is not enough to allow every institution to be funded to be excellent at both in every discipline. Thus RCUK told us that “not all HEIs [higher education institutions] can be research intensive and excellent at every discipline”.²³³ This situation was summarised by the Director General of the Research Councils, Professor Sir Keith O’Nions, in oral evidence: “I think when we moved to a system of 130 universities, which we have at the moment, very often it took some time for universities to figure out where they were going to go and whether the whole thing had to be academics spending 50 per cent of the time doing research and 50 per cent of the time teaching. It is absolutely clear that is not a situation which exists or, indeed, could be sustained into the future”.²³⁴

114. Whilst the most successful universities flourish in competition with others, and win high levels of funding for the full gamut of their activities, those universities that are less successful frequently find themselves in financial difficulties. A Higher Education Policy Institute paper notes that “a number of weaker institutions find it difficult to flourish in any system that funds performance, especially when the performance for which rewards are available—most notably research—is in areas where they are least likely to succeed. And yet they feel obliged to put effort into these areas, thus damaging other activities, for little or no gain. Even student recruitment can be difficult, and they are vulnerable to the loss of Funding Council grant which is held back if students are not enrolled in sufficient numbers”.²³⁵ The Lambert Review also identified a perceived bias within the university system towards research, meaning that “instead of concentrating on their own areas of comparative advantage—which may be of real value to their local and regional economy—[universities] strive to be measured against a world-class benchmark”.²³⁶ As a consequence of the bias towards research, research funding comes under intense pressure and universities miss the opportunity to focus on other areas of strength that may yield them greater financial benefit.

The separation of teaching and research

115. The inability of the current system to sustain every university to carry out both excellent research and excellent teaching gives rise to questions that have been the subject of considerable controversy. If there is insufficient funding for every university to be

233 Ev 197

234 Q 252

235 Bahram Bekhradnia, HEFCE, *Government, Funding Councils and Universities: How Should They Relate?*, February 2004, p 11

236 HM Treasury, *The Lambert Review of Business-University Collaboration*, December 2003, p 84

excellent in research and provide high quality undergraduate teaching, should the functions of research and teaching be separated out between institutions? As one of our terms of reference, we asked for views on “the optimal balance between teaching and research provision in universities, giving particular consideration to the desirability and financial viability of teaching-only science departments”.²³⁷ Many witnesses told us that the research function of universities should not, or in some cases could not, be separated from the teaching function. Thus the Russell Group of universities said that there is “an essential and close link between the sustainability of high quality teaching and the successful prosecution of research activity”.²³⁸ The Society for General Microbiology stated that “a science degree [that] is taught in a university without relevant research activity would be valueless as far as potential employers and international comparisons are concerned. No student with a choice would choose to go to such a university. This is because of the limited opportunities that such a degree would afford students with respect to practical work and diminished quality of teaching staff that are not contributing to the development of their subject”.²³⁹ This view was borne out by one member of the student panel that gave evidence on 7 February, Ian Hutton, who told us that “one of the things that I wanted [was] to be taught by the people doing the research at the forefront of the subject”.²⁴⁰

116. The main reason cited for the need to maintain the link within institutions between their research and teaching functions was the need to equip students with practical laboratory and research skills. This is undoubtedly true for those who wish to pursue a career in academic research or industrial R&D. However, not every STEM graduate will go on to pursue such a career. Many will go into teaching, or careers completely unrelated to science. This is increasingly likely to be the case as participation rates in higher education increase without a corresponding increase in academic and industrial career opportunities. The Association of the British Pharmaceutical Industry told us that “as participation in higher education is widened towards the target of 50%, it is inevitable a large number of students will embark on higher education courses without having appropriate study skills and self motivation to complete the course”.²⁴¹ Similarly, CBI stated that “the government’s ambitions for 50% of school leavers to attend university will make it very unlikely that teaching can remain coupled with research in the long-term as the necessary growth in teaching resources is unlikely to be matched by growth in the level of support for research”.²⁴² Furthermore, as is shown in chapter 3, several employers of STEM graduates have told us that graduates from research-intensive universities often lack the more practical skills required by employers. The reverse is also true. Astra Zeneca stated that “although not strongly noted for its research capability, Salford has excellent chemistry teaching departments and has provided Astra Zeneca with many excellent students and graduates”.²⁴³ There is clearly a need for a diversity of STEM degrees: some students need to have extensive contact with academic research in order to pursue their chosen career;

237 Press notice 12 of Session 2004–05.

238 Ev 85

239 Ev 143

240 Q 23

241 Ev 172

242 Ev 245

243 Ev 119

others may benefit from a greater emphasis on practical and vocational skills and teaching-based learning.

117. As well as a bias towards research, the reluctance to separate out the teaching and research functions of some universities seems to be based, in the majority of cases, on the perception that departments that focus on teaching are unlikely to be abreast of current developments in research and are unlikely to challenge their students. The validity of this assumption is open to challenge. Professor Michael Sterling, Vice Chancellor of Birmingham University, told us that “I think there is a difference between staff that are working themselves at the cutting edge of research and clearly that is an advantage compared with staff that are not. The intermediate category is that those staff that are teaching are aware of where the leading edge of research is even if they are not doing it. That is what I would call scholarship”.²⁴⁴ The University of Central England also made the distinction between research- and scholarship-active teaching staff: “university-teaching is stimulated by the development of subject knowledge through research. Not all teachers need be research active and not all researchers need be RAE-active. All teachers need to be ‘scholarly active’”.²⁴⁵

118. Whilst links with research may be essential in training future generations of researchers, scholarship-based teaching may be sufficient to train students who wish to pursue other careers, such as teaching in schools. Professor Peter Main of the Institute of Physics told us, for example, that “it might be possible to have institutions teaching the subject to this sort of common basic level and then people could leave those teaching only institutions and possibly become school teachers—it might be another route to improve school teachers—whereas the ones who wanted to go off and do professional research and become professional scientists would move to the research institutions”.²⁴⁶ Furthermore, the Society of Chemical Industry (SCI) told us that “departments that concentrate on teaching could play a big part in encouraging young people into science”.²⁴⁷ **Many students benefit from exposure to research during their undergraduate degree, particularly if they want to go on to pursue a career in research. However, research-intensive departments are not essential to train all STEM students. It is an inevitable, if inadequately foreseen, consequence of the drive towards higher levels of participation in higher education that it is unsustainable for every student to be taught in a research active environment. This is unfortunate, but not necessarily damaging, provided that all STEM students are taught on the basis of scholarship, if not research. We recommend that the Government and universities recognise that teaching-focussed departments are not only accepted, but supported sufficiently well to ensure that they retain good quality staff and a commensurately high status.**

Collaboration

119. In the light of the distinction between scholarship, teaching and research, the term “teaching-only departments” is unhelpful, since it implies complete isolation from

244 Q 447

245 Ev 214

246 Q 350

247 Ev 115

contemporary research outputs. Not only is scholarship properly informed by research, but there is no imperative for departments that focus on teaching to cut themselves off from departments in other institutions that conduct research to a very high standard. Thus the Director General of the Research Councils stated that “with appropriate connectivity and so on I think high quality teaching can take place outside the research intensive universities”.²⁴⁸ Connectivity between universities is precisely what is lacking in the current system. The Education and Skills Committee heard from Professor Philip Tasker of De Montfort University that, “currently, higher education is characterised through competition. Most universities see their neighbours more as a threat than an opportunity for collaboration. This is encouraged by the funding mechanisms that are competitive”.²⁴⁹ The frequent lack of collaboration identified by Professor Tasker is one of the major obstacles to a system in which the responsibility for providing teaching and research for undergraduate students is shared between institutions where necessary. Collaboration can provide a solution to the problem of failing provision in some subjects. As was set out in paragraph 18, universities in the South West collaborated to ensure that, when Exeter University’s chemistry department closed, overall capacity in chemistry in the region was not reduced. **Universities are not islands. If the way to healthy provision of STEM subjects in English universities lies in collaboration between institutions, they will need to work together in the national and regional interest.**

120. If universities collaborated better, it would be possible to ensure that all students received both good teaching and exposure to research, in some cases by arranging visits or transfers to, or joint working with, other universities in the same region. Some examples of cooperation between institutions within a particular region already exist. Ed Metcalfe, Head of Science, Technology, Entrepreneurship and Management at the South East England Development Agency, told us that “Plymouth, with its foundation degrees out in local FE colleges and then feeding it to the centre, has worked extremely well. That is a very successful programme”.²⁵⁰ The White Rose Consortium in Yorkshire provides a good example of the successes to be yielded from collaborative research between universities. The collaborative model is commonplace in the United States. Several submissions made reference to this. Senior scientists from the pharmaceutical industry, for example, stated that, in the US, “universities derive enough income from teaching to fund undergraduate activities [...] Many of the smaller colleges are renowned for producing high quality graduates who often transfer to major research departments (e.g. Harvard, Columbia, Stanford, MIT etc.) to pursue postdoctoral-level work”.²⁵¹ The Director General of the Research Councils stated that “looking at some of the private and state funded universities in the US, they are very proud to attract an extremely good core bench across Massachusetts, New Hampshire, and so on. They have first class teaching, they attract good staff and they stop at the Masters level of teaching. They hold their heads high and are proud of what they do and in no sense do they feel they are second rate because they are not research intensive”. However, he also told us that “I do not think we are quite at that point yet in the UK, where, being a non-research intensive university which has a very high

248 Q 210

249 Fifth Report from the Education and Skills Committee, Session 2002–03, *The Future of Higher Education* (HC 425-II), Qq 236–7

250 Q 308

251 Ev 113

quality of teaching, all of those are simultaneously holding their heads high and confident in the way they are going forward. You may find many exceptions to that, but culturally I do not think we are quite at that point”.²⁵²

121. Collaboration between universities often takes place on an informal basis. The best way to ensure its effectiveness would be to formalise the arrangement through the wholesale adoption of the “hub and spokes” model of provision. The key characteristics of this model are:

- HEFCE ensures that there is *at least one* department in each core STEM subject within each region that is funded at the highest (currently 5*) level for its research. This department becomes the research “hub” of the region for its subject. The choice of hub would be decided in regional competition against national standards of excellence. The system would not preclude other departments within the region from competing for funds to become research hubs too. The only constraint, within the limits of the total funding available at a national level, would be the need to have at least one hub per region.
- Other departments in the region could choose to specialise in other areas of provision, such as teaching or knowledge transfer, according to their strengths. They would bid for teaching funds or funds from the Higher Education Innovation Fund accordingly. Departments choosing to specialise in teaching would receive a premium over and above the level of the basic teaching grant to reflect their teaching status. Of course, this aspect of the model relies upon the self-sufficiency of teaching funding (see paragraphs 104 to 111), and on the ability of departments choosing to focus on knowledge transfer to secure additional funding from industry.
- Undergraduate provision would be coordinated at a regional level by HEFCE and the Regional Development Agencies. Students from teaching-intensive departments would be able to gain research experience at one of the regional research hubs. This was a possibility alluded to by Professor Tom Blundell of the Biosciences Federation: “there will have to be some arrangement between institutions, perhaps on a regional basis, so that people can move to the research-led part perhaps in the third year to make it a proper degree”.²⁵³ Researchers from research hubs might be contracted to provide a certain number of lectures or seminars in other departments. Similarly, staff from teaching-intensive institutions might be contracted to help teach students from the research hubs.
- Departments not applying for research hub status could nonetheless bid for research funds, from the Research Councils and other research project funders, and from a ring-fenced pot of HEFCE money roughly equivalent to that currently distributed between departments graded 4 or lower. Research funds would be allocated on merit, through open competition, and would have some basis in the amount of Research Council income won by the department in question.

252 Q 253

253 Q 350

- Research hub status would be allocated at a departmental, not institutional level. It would be possible, therefore, for a single university to contain research hubs in some disciplines, but to have teaching-intensive status or a focus on knowledge transfer in others.

122. Support for a collaborative model of university STEM provision came from a wide variety of organisations and individuals. Dr Michael Bolton of Manchester University told us that “specialisation by individual Universities makes sense and can be based on both traditional strengths and geographic location”.²⁵⁴ The Regional Development Agencies told us that the hub and spokes model “could increase the visibility, accessibility and responsiveness of the research base to business needs and near market research. The possibilities for staff in the spokes to carry out research in the hubs transfer could have a beneficial effect in raising aspirations”.²⁵⁵ Professor Ian Diamond of RCUK emphasised that collaboration could even invigorate research taking place outside the main research hubs: “where there are pockets of excellence and where there are particularly junior pockets of excellence we do try to enable there to be, for example, something like hubs and spokes models which have the best junior able to be part of some of the critical masses of larger centres, particularly where there is expensive equipment that is required to be used to take forward research. There are huge possibilities so long as we make that happen”.²⁵⁶ The Director General of the Research Councils told us that, by focussing on areas other than research, knowledge transfer could potentially be greatly enhanced in some departments: “universities which are not research intensive, which are not getting a significant proportion of research council or Higher Education Funding Council money [could] have a role in terms of innovation and working with RDAs and other businesses and so on”.²⁵⁷

123. The hub and spokes model has the potential to resolve some of the difficulties currently being experienced by some university STEM departments. Where a region has two small departments teaching the same subject, both of which are experiencing low student numbers and financial difficulties, it may be better to merge their provision to ensure continuing capacity in that subject in the region, than to be forced to close both. Whilst it has not been proved that larger departments make efficiency savings (see paragraph 97), if they can prevent loss of capacity at a regional level they are to be welcomed. This opportunity was identified in evidence to this inquiry by Astra Zeneca, which told us that “there is merit in encouraging universities to collaborate in order to capitalise on their relative strengths. The concept of regional universities collaborating in chemistry or physics for example may offer a genuine solution, e.g. the East Midlands”.²⁵⁸ In some cases, the pooling of resources would make the difference between the long term viability or otherwise of threatened STEM departments.

124. It could be argued that the hub and spokes model would compromise the autonomy of universities. To a certain extent, it is inevitable that this autonomy will be compromised

254 Ev 73

255 Ev 218

256 Q 216

257 Q 212

258 Ev 119

if the Government makes any attempt at all to ensure that the interests of individual institutions do not compromise national or regional interests. We have argued that it is reasonable, and indeed necessary, to ask universities to take account of national or regional interests in the decisions that they take. Indeed, as we explain in paragraphs 78 to 84, the Government already limits the choices that can be made by universities through the funding mechanisms that it uses to support higher education. Nonetheless, we believe that there would be ample scope within the hub and spokes model for universities to exercise their independence from Government. By allowing them to play to their strengths, the model actually gives universities greater freedom from games-playing and enables them to realistically determine their own strategic direction.

125. The hub and spokes model of university provision would allow STEM departments to capitalise on their areas of strength, whether they are research, teaching or knowledge-transfer, whilst still ensuring that undergraduates received a rounded education in the discipline of their choice. By collaborating on their provision of STEM courses, departments would make more efficient use of resources, and thereby ease the financial difficulties currently being experienced by many STEM departments. We recommend that the Government encourages the acceptance and implementation of this model throughout the system via HEFCE, the RDAs and Universities UK, and by means of the funding regime for higher education.

Practicalities

126. The hub and spokes model will not work if it is implemented on an ad-hoc basis. It needs to be centrally coordinated, with input from the regions. To a certain extent, HEFCE already fulfils this function. Professor Steve Smith, Vice Chancellor of Exeter University, told us that “we have found HEFCE to be an enormously supportive broker. They have worked with us and other universities in the region to come up with a solution which actually increases the number of funded places for chemistry in the south west”.²⁵⁹ He added that “the outcome of what they have done in our case has been to strengthen science provision in the region by allowing us to spend the same amount of money on science but on fewer subjects and putting extra resource into Bristol and Bath which enables them to make their chemistry provision more sustainable”.²⁶⁰ In addition to HEFCE, the Research Base Funders’ Forum’s Functional Sustainability sub group has been carrying out work on the health of disciplines, which could be used in support of a hub and spokes model. In January 2005 the sub group, which includes representatives from the Research Councils, met with the Funding Councils to propose and discuss suitable metrics for evaluating and monitoring health of research disciplines. During the summer of 2005, the Funding Councils and the Research Councils will work together to identify strategies for taking the issue of the health of disciplines forward.²⁶¹

127. We recommend that a Regional Affairs Committee is established within HEFCE to coordinate the implementation of the hub and spokes model within the regions. The Committee should contain representatives from each of the Regional Development

259 Q 403

260 Q 404

261 www.ost.gov.uk/fundersforum

Agencies, who would each be responsible for ensuring the implementation of decisions taken by the Committee within their region. The Committee should draw upon the valuable work being carried out by the Research Base Funders' Forum on the health of disciplines, giving this work some practical effect. HEFCE's Regional Affairs Committee would also be responsible for monitoring the implementation and success of the hub and spokes model in the regions.

7 Regional issues

The need for a regional research presence in all core subjects

Universities and business: the regional dimension

128. Implementation of the hub and spokes model of university provision would mean placing a greater emphasis on the role played by the regions in the higher education system. Some research-intensive universities have been reluctant to endorse such a shift of emphasis because they see their focus as being international, rather than regional, in scope.²⁶² It is a common assumption that, by attaching greater weight to the role that a university should play within their region, their international standing will somehow be compromised. We believe that this is not the case: by collaborating with other institutions within a region, universities have the opportunity to widen and deepen their portfolio of activities, thereby enhancing their reputation.

129. The Lambert Review identified an important role for universities in supporting their regional economy, which in turn contributes to the health of the national economy. The review argued that these economic benefits can best be realised through links between universities and businesses, stating that “each region has a number of universities with different strengths that can attract talent, investment and professional services, raise the quality of education and skills, enrich intellectual life and serve as an entry point for the latest international thinking. Strengthening their links with industry should help raise the competitiveness of firms in each region”.²⁶³ In order to realise the vision outlined in the Lambert Review, we have argued in chapter 6 that collaboration between universities and university interactions with business need to be coordinated at a regional level in line with an overarching national strategy.

The Regional Development Agencies

130. In 1998 the Regional Development Agencies Act created eight new public sector bodies, the Regional Development Agencies (RDAs), the purpose of which was to increase regional output and reduce regional disparities. The following year a ninth RDA was created with the same purpose, the London Development Agency. Each RDA has a long term strategy based on the economic needs of their particular region. The Lambert Review commented that these bodies, which are chaired by senior industry executives, are “well placed to act as a bridge between business and universities”.²⁶⁴ In chapter 6 we recommend that the RDAs be given an important role in the coordination of university collaborations within their region by means of participation in a new Regional Affairs Committee within HEFCE. Concerns have been expressed in the past, however, about the ability of the RDAs to carry out such important work. In our Report on *Too little too late?: Government Support for Nanotechnology*, for example, we criticised the RDAs for their lack of scientific

262 See for example, Anna Fazackerley, “End ‘willy-nilly’ closures – MPs”, *Times Higher Education Supplement*, 25 March 2005

263 HM Treasury, *The Lambert Review of Business-University Collaboration*, December 2003, p 65

264 HM Treasury, *The Lambert Review of Business-University Collaboration*, December 2003, p 67

expertise.²⁶⁵ This echoed criticisms made by the House of Lords Science and Technology Committee in their Report on *Science & The RDAs: SETting the regional agenda*.²⁶⁶ The Lambert Review noted that “many businesses and universities are concerned that some agencies do not have the necessary level of skills and expertise for working on knowledge transfer. Raising the quality and breadth of their work in this area must be a priority”.²⁶⁷ Since these criticisms were made, all the RDAs have established Science and Industry Councils to provide high level advice from businesses and universities on regions’ science priorities. This is a significant step forwards, although we have noted that “it is too early to tell whether or not the establishment of Science and Industry Councils within RDAs will improve their performance on science, engineering and technology-related matters”.²⁶⁸

Knowledge transfer

131. With the creation of the RDAs came an increased recognition of the importance of “third stream funding” for universities’ knowledge transfer activities, an area of their work that is frequently overlooked in favour of academic research and teaching. The proportion of university research income that comes from industry is relatively small. In 1990–91, industry spent £114 million on research in UK universities (6% of total university research income). By 2000–01 this had increased to £259 million (7%).²⁶⁹ This still relatively modest sum shows that there is a potential for universities to further increase their interactions with, and thus income from, businesses. This aspect of their work is supported by the Higher Education Innovation Fund (HEIF), which supports universities in the exchange of knowledge and productive interactions with business, public sector organisations and the wider community. It is a consolidation of an earlier funding stream called the Higher Education Reach-out to Business and Community (HEROBC) fund.

132. HEIF is currently entering its third funding round, which will be announced in 2006. HEIF 3 will provide a total of £238 million to English universities, to be allocated between August 2006 and July 2008. Compared to the £3,826 million of HEFCE funding for teaching and £1,081 million for research, this funding stream still represents a relatively small proportion of total university income (see figure 4 in chapter 5). There are five key principles underpinning HEIF:

- “HEIF 3 is focused on promoting activities that result in both direct and indirect economic benefit to the UK;
- HEIF 3 will support a broad range of knowledge transfer activities that benefit the world outside but which would be unlikely to generate large amounts of net income for the universities themselves;
- HEIF 3 is a national scheme with a regional dimension;

265 Fifth Report from the Science and Technology Committee, Session 2003–04, *Too little too late?: Government Support for Nanotechnology* (HC 56), pp 33–34

266 Fifth Report from the House of Lords Science and Technology Committee, Session 2002–03, *Science & The RDAs: SETting the regional agenda* (HL 140-1)

267 HM Treasury, *The Lambert Review of Business-University Collaboration*, December 2003, p 68

268 HC [2004–05] 8, p 30

269 HM Treasury, *The Lambert Review of Business-University Collaboration*, December 2003, p 81

- A substantial proportion of third stream funding should be allocated on a more predictable basis to allow retention of highly skilled staff and greater continuity; and
- A small amount of funding should be allocated by competition. The competition is likely to focus on proposals with an innovative approach and support priorities which might include collaborative activities which capitalise on excellence and achieve economies of scale”.²⁷⁰

In oral evidence, Professor Sir Keith O’Nions discussed with us “the extent to which universities which are not research intensive, which are not getting a significant proportion of Research Council or Higher Education Funding Council money have a role in terms of innovation and working with RDAs and other businesses and so on. My personal view is that this is an extremely important and possibly under-developed role”.²⁷¹ **Under the hub and spokes model of university provision, a greater number of universities may choose to focus on their knowledge transfer activities. Third stream funding (HEIF) is still relatively modest in comparison with the funds available for teaching and research. The Government may need to consider developing HEIF further in order to encourage more universities to concentrate on knowledge transfer. A concomitant increase in research funding from industry will also need to be encouraged if universities are to have a real opportunity of diversifying.**

The importance of geography

133. We have taken evidence on the extent to which geography plays an important role in the interaction of universities with their partners in the higher education sector, business or the wider community. The “cluster” theory asserts that clusters of businesses tend to develop in close proximity to research-intensive universities. The Lambert Review strongly supported this hypothesis, noting that “more often than not, research active universities are to be found at the heart of successful business clusters. Oxford and Cambridge are the most spectacular examples, but there are many others across the country, and more are developing”.²⁷² The University of Durham, for example, told us that “the North East of England has a very strong presence in the chemical and pharmaceutical industries. Its RDA has placed the universities of the region at the heart of its regeneration strategy”.²⁷³ However, others have been more sceptical. HEFCE told us that “the proposition of a direct linkage between the location of centres of research strength and enhanced regional economic growth (sometimes referred to as ‘clusters’) remains unsupported by clear evidence and requires further investigation”.²⁷⁴ The Director General of the Research Councils told us that it was too early to make a judgement on this issue: “at some point, after sustained investment in these areas, we actually have to be very clear about what it is

270 www.hefce.ac.uk

271 Q 212

272 HM Treasury, *The Lambert Review of Business-University Collaboration*, December 2003, p 65

273 Ev 159

274 Ev 92

delivering. On this particular one we are still a few years away from a reasonable expectation of seeing measurable economic benefit”.²⁷⁵

134. The evidence submitted to this inquiry strongly suggests that the availability of local skills and research are important factors in decisions taken by companies about where to locate. The Society of Chemical Industry told us that this was particularly the case for smaller companies: “many SMEs have strong ties with one local university department, with sometimes the majority of their staff having been first attracted to the area by the university”.²⁷⁶ The RDAs supplied us with evidence on the extent to which proximity was a factor in university-business collaborations. This is given in figure 8, below. These statistics show that the majority of companies which have local markets (88%), and a substantial proportion of companies that have regional or national markets (47% and 37%), collaborate mainly with universities in their region. Companies with an international market tend to collaborate mostly with universities at a national level. Ed Metcalfe of the South East England Development Agency, told us that “the large companies in the [South East] region cite skills supply as one of the reasons that they are there. If you ask them for the top three reasons why they are there, supply of skills is usually in the top three”.²⁷⁷ **The proximity of a source of skills and research capacity is one of the main considerations when a business decides where to locate. This is particularly the case for smaller companies.**

Figure 8: UK university-business collaboration split by market size of company and university location

Type of firm's largest market	Local university	National university	International university
Local	88%	12%	0%
Regional	47%	53%	0%
National	37%	47%	16%
International	26%	48%	26%

Source: Ev 307 onwards

135. The argument that it is important to provide businesses with a good local supply of skills relies, to some extent, on the assumption that graduates will tend to be employed in the region in which they studied. The Royal Academy of Engineering told us that “many students who attend university in their region are likely, at least initially, to take up employment in that region”.²⁷⁸ Data supplied by the RDAs suggested that regional retention rates of graduates varied from region to region, as is shown in figure 9, below. Many witnesses observed that graduate retention was stronger in the South East, particularly in London, which also attracted a high proportion of graduates from other regions. The RDAs told us that the North East and North West also did well at retaining

275 Q 228

276 Ev 212

277 Q 300

278 Ev 152

graduates, whilst the East Midlands performed relatively badly in this respect.²⁷⁹ It is difficult to interpret these statistics because it is not clear whether graduate retention rates are influenced most by the availability of jobs in the region of study or by graduate choice, which, as is shown in chapters 3 and 4, can be influenced by a wide variety of—frequently intangible—factors. There is some suggestion that, in some regions, “the supply of graduates is massively outstripping the local demand for new graduate labour”, although we did not receive sufficient evidence on this subject to form a view.²⁸⁰

Figure 9: Retention of graduates within region of study

Region	Total number of graduates employed in region	% of first degree graduates employed in region of study	% of all graduates employed in region of study	% of first degree graduates employed in home region
North East	5,115	59	54	64
North West	11,865	62	61	69
Yorks and Humber	8,430	51	47	61
West Midlands	9,235	52	41	61
East Midlands	7,535	39	40	51
South West	9,340	52	49	50
East England	3,835	50	45	46
London	13,595	70	61	66
South East	23,125	53	51	52

Source: Ev 307 onwards

Should all the regions be equal?

136. The importance to businesses, especially SMEs, of the proximity of a good source of skills and research can be used to argue that a strong research presence is needed in every region. The Lambert Review states that “small companies do not usually have the time or money to build partnerships with university departments that are not located in their neighbourhood. So business across the UK would not be well served by a university system which concentrated all its research expertise in the south eastern corner of England”.²⁸¹ The Chemical Industries Association observed that the lack of university provision in some regions was already causing problems for business: “some CIA member companies are unable to find suitable universities in their local vicinity with whom they can undertake collaborative innovation or to whom they can send their staff for training. This increases

279 Ev 307 onwards

280 Ewart Keep and Ken Mayhew, “The Economic and Distributional Implications of Current Policies on Higher Education”, *Oxford Review of Economic Policy*, Vol 20, No.2, p 302

281 HM Treasury, *The Lambert Review of Business-University Collaboration*, December 2003, p 79

the cost and inconvenience of undertaking such activities, putting barriers in the way of workforce up-skilling and innovation”.²⁸² **If university departments suffer particularly heavy losses in one region, there is a possibility that businesses within the region would also suffer or, worse, migrate to a region where conditions were better. In this way, universities play a pivotal role in their regional economies.**

137. There was some hostility from the older universities for the idea that regional interests should be taken into account in national strategic planning for higher education. The Russell Group, for example, told us that “we see no merit whatsoever in seeking to preserve uncompetitive and lower quality provision merely to enable its continued availability at the sub-regional or indeed regional level”.²⁸³ We agree that, whatever model of provision is proposed, research quality should not suffer. However, we think it unlikely that any attempt to emphasise the role of universities in their regions would have a damaging effect on the quality of provision. In its evidence, the Government told us that “we do not believe there to be any immediate regional crisis in science: high quality research departments and associated funding are located throughout the UK in a wide spread of institutions”.²⁸⁴ This view was reinforced by the Director General of the Research Councils: “it turns out that most regions in the UK do have a presence of 5* and 5 departments”.²⁸⁵ Given existing research strengths in each region, there would be no need to maintain uncompetitive research in order to meet regional goals. Furthermore, as universities diversify, departments will no longer need to bid for funds in support of research of a low quality in order to remain viable as teaching departments.

138. Ensuring that each region has some research strength and supporting strong research departments to be internationally excellent need not be contradictory aims. Ed Metcalfe from the South East England Development Agency told us that “I think you have to do both; you have to invest to support science development in the north, and also you have to keep the triangle [Cambridge, Oxford and London] going”.²⁸⁶ This view was endorsed by the Lambert Review, which stated that

“the globalisation and growing costs of scientific research suggest that the arguments for greater selectivity in favour of world-class research departments will continue to strengthen. But this approach needs to be balanced by a broader view of the reasons for the public support of university research. Other forms of funding need to be developed to support alternative forms of excellence and emerging fields of research, as well as to ensure that all the regions and nations can share in the economic and intellectual benefits of R&D.”²⁸⁷

There are sound economic and social arguments for ensuring that there is a strong research presence in each of England’s regions. We do not agree that protecting this research presence would involve lowering standards. Quality can be preserved if every

282 Ev 230

283 Ev 86

284 Ev 237

285 Q 226

286 Q 314

287 HM Treasury, *The Lambert Review of Business-University Collaboration*, December 2003, p 85

university and every region play to their individual strengths instead of concentrating all their efforts on the same goal, and the same limited pot of research money.

Student demand for regional provision

Current regional provision

139. One of the main arguments for maintaining university provision in every region is based on the assertion that increasing numbers of students are choosing to study closer to home. Two universities provided evidence to support this assertion. Sheffield Hallam told us that “approximately 50% of the student population (undergraduate and postgraduate together) at Sheffield Hallam University comes from the Sheffield area and a similar percentage remain in the area after graduation”.²⁸⁸ Similarly, the Department of Physics and Astronomy at Nottingham University said that “we are aware that many pupils taking physics in the leading 6th form colleges in Nottingham do not wish to leave the city to attend university”.²⁸⁹ Nonetheless, as is shown in paragraph 45, Danielle Miles, one of the students that we saw on 7 February, told us that location had played no part in her choice of university.²⁹⁰ This difference in view could be attributable to cultural and social factors. Students from poorer backgrounds, precisely those whom the Government is trying to attract to university as part of its widening participation policy, are logically more likely to study close to home for financial reasons. Some students who are the first in their family to attend university may not be comfortable with a move away from home.²⁹¹ Many students choose their university on the basis of the course they want to do: location may be incidental to them. Furthermore, some students may be prepared to travel further to attend a university that was deemed to be world class, such as Durham or UCL, than they would be to attend an institution that was not.

140. The ability of students to study a STEM subject at a university in their home town, or home region, is threatened by the recent spate of departmental closures. Thus the Association of University Teachers (AUT) told us that “the market approach is failing to deliver adequate regional provision, for example, there are no 5 or 5* chemistry departments in Wales and in the eastern region of England, Cambridge is the only institution to provide physics. With an increasing number of students attending local institutions, this development has negative implications for the government’s widening participation agenda”.²⁹² A lack of regional provision of a subject could also be damaging to the economic health of a region, as is discussed in paragraphs 134 to 137. Professor Ian Diamond of RCUK told us that, as a result of departmental closures, “it is not absolutely clear at the moment that there will be large numbers of students who will be forced to travel who would not have been forced to travel in the first place”.²⁹³ Nonetheless, we believe that, **if STEM departments continue to close, there is a real danger that some**

288 Ev 112

289 Ev 189

290 Q 60

291 See, for example, evidence from the Department of Physics and Astronomy at the University of Nottingham, in paragraph 141.

292 Ev 284

293 Q 231

STEM students will be unable to study their chosen subject in their home region, should they choose to do so.

Variable tuition fees

141. There are two factors that are likely to cause an increase in the number of students opting to study closer to home. The first is the Government's aim to increase participation in higher education, particularly by those from lower socio-economic backgrounds. Several witnesses speculated that, amongst this group of new recruits to higher education, the proportion choosing to study in their home region would be high. Thus, the Department of Physics and Astronomy at the University of Nottingham told us that the trend towards remaining at home "will become more prevalent as fees increase, particularly amongst students from families who have not previously participated in higher education".²⁹⁴ The second influencing factor is the introduction of variable tuition fees. As the effect of tuition fees has yet to be seen, the evidence we received was speculative. The AUT, for example, stated that "as students increasingly study from home—a trend which will inevitably increase once top-up fees are being paid—how are we to ensure all students have access to all subject areas?"²⁹⁵

142. Whilst it is logical to assume that increasing debt may lead some students to economise by studying closer to home, the evidence on this subject is less clear cut. A Higher Education Policy Institute paper explains that, overall, "price elasticity of demand for higher education is low", but does not comment on the impact of fees on students' choice of university location.²⁹⁶ In answer to further questions, DfES provided a summary of a range of studies on the factors that influence student demand. Whilst one study found that "amongst potential entrants the costs of going to university led half to apply to universities nearer their homes and nearly two-fifths were taking a subject with better employment prospects", another found that the right course, rather than financial considerations, was the most important factor influencing students' choice of where to study.²⁹⁷ When we asked the Director General of the Research Councils about the impact that variable tuition fees would have on the finances of university STEM departments he told us that "in most things to do with education and science [...] when you change the rules a little bit it may be totally well-intentioned and so on but one often induces some behaviour which one might not have anticipated. All I can say is that we have to look at this and watch it very carefully".²⁹⁸ **It is too early to assess what impact the impending introduction of variable tuition fees will have on departmental closures as universities position themselves in preparation for the new system. We agree, however, with the reply given to the Committee by the Director General of the Research Councils, that the impact of variable tuition fees on STEM departments should be kept under constant review, and that emerging evidence should be published as part of the Government's ongoing reviews to make clear what the impact of the scheme has been. It is also logical to assume that, given increasing levels of student debt, an increasing proportion of the**

294 Ev 189

295 Ev 285

296 Libby Aston, Higher Education Policy Institute, *Higher education supply and demand to 2010*, June 2003, p 42

297 Ev 307

298 Q 232

student population will be unable to live away from home. It is therefore extremely important that provision for core STEM subjects is maintained in every region.

143. When Exeter University announced that its chemistry students would have the opportunity to transfer to one of two other chemistry departments in the region, either Bath or Bristol, it was quickly pointed out that the distance between Bath or Bristol and Exeter was over 100 miles. Parents Against Cuts at Exeter told us that “the closure of the chemistry department at Exeter University [...] deprives future science students of the possibility of attending their local university. The South-West will become a wasteland in terms of chemistry teaching and research”.²⁹⁹ Particularly in the largest regions, a distinction is frequently drawn between “local”, or sub-regional, and “regional” provision. **Whilst we believe that all prospective STEM students should have the opportunity to study within their region, it would be unreasonable, and a strain on resources, to expect provision of each and every subject to be maintained in every sub-region. Sub-regional provision can be addressed through regional collaboration between universities.**

8 Conclusion

144. Through its funding regime, the Government is passively pursuing a policy of research concentration that will call the financial viability of some university departments into question. Universities, although theoretically autonomous institutions, have little choice but to compete for funds from a limited pot of research money. Whilst some research-intensive universities have benefited from this system, those that have been less successful in winning funds are struggling to keep all their departments open, particularly those in science, technology, engineering and mathematics (STEM) subjects, which are amongst the most expensive to run. Their financial difficulties are greatly increased by a steady decline in the number of students wanting to study STEM subjects. In the absence of student demand, it becomes yet more difficult for a department to secure funding, since funding for teaching is calculated on the basis of student numbers. Departments with too few students are expensive to run and maintain, and are the logical target for universities needing to economise.

145. Universities are not just research institutions. They also play a vital role in the national economy by teaching undergraduate and postgraduate students. This aspect of their work will only gain in importance as the Government moves towards its target of 50% participation in higher education. The Government has also set universities the challenge of improving their collaboration with businesses to see their knowledge, skills and experience transferred out of academia into the public and private sectors. We believe that these two important roles are frequently overlooked in the competition for research funds. Yet if universities were to diversify, with each institution concentrating on its strengths—whether they be research, teaching or knowledge transfer—the strain on resources would be greatly reduced. Through collaboration on a regional basis, universities could ensure that all their staff and students had access to all three functions, whatever their own focus. With this in mind, we have recommended that a “hub and spokes” model of provision be employed, to be coordinated by a Regional Affairs Committee sitting within the Higher Education Funding Council for England, and with representation from all the Regional Development Agencies.

146. The only barrier to the realisation of the benefits to be conferred by the implementation of the hub and spokes model of provision is in the form of the universities themselves. Unless they collaborate with each other it will not work. Forcing them to do so would be a breach of their autonomy. However, we have argued that the Government can, and already does, influence the choices that universities make by means of the funding regime. By rewarding collaboration between institutions; by ensuring that teaching funding is self-sufficient; and by giving greater emphasis to third stream, knowledge transfer, funds, the Government can encourage universities to work together within their regions to ensure the sustainability of provision in STEM subjects.

147. There is a risk that, if many more STEM departments close, the university system will not be able to produce enough STEM graduates to meet the Government’s economic goals. This Report presents the Government with the opportunity to help resolve this problem in the long term, instead of relying on short term measures to patch up a system that is inherently unsustainable.

Conclusions and recommendations

1. Given the unlikelihood of increased overall funding, this Report focuses on ways in which existing funds can be used more effectively to ensure good provision of STEM subjects in English universities. (Paragraph 7)
2. STEM graduates help to maintain the healthy operation of society at all levels—by driving the economy; by generating knowledge and innovating; by raising the scientific literacy of the population as a whole; by informing Government policy; and by aiding participation in international research networks. (Paragraph 10)
3. Whilst it may be exaggerating to say that university STEM departments are in crisis, it is clear that their numbers are experiencing a sharp decline. Since the financial situation faced by these departments is unlikely to change in the short term, it is reasonable to assume that there will be further closures. If this process continues unchecked, there is a very real possibility that the system will no longer be able to provide sufficient numbers of STEM graduates to meet the needs of the UK economy. Unless the Government takes action now, it will have a crisis on its hands in the foreseeable future. (Paragraph 15)
4. Given the Government's goal of increasing the number of students taking STEM courses, it is essential that sufficient capacity is maintained in the system to meet a possible future growth in student demand. (Paragraph 16)
5. Further closures of university STEM departments would be a source of serious concern to us. However, the closure of an individual department need not entail a permanent loss of capacity in that subject, providing that suitable alternative arrangements for current students and long term planning for potential future increases in student demand is in place at a regional and national level. (Paragraph 19)
6. There is little point in patching up the system in the short term if measures are not taken to address the underlying reasons for the difficulties faced by university STEM departments. It is essential that any measures taken to prevent further loss of capacity in the system are underpinned by a strategic approach. (Paragraph 20)
7. Making sure that the UK can meet the demands of employers for skilled personnel is key to ensuring that it can maintain its competitive edge in a global market. (Paragraph 21)
8. Whilst it is “good news” for STEM graduates that so many of them find employment so quickly, it is not necessarily good news for employers in the sector. The relative ease with which STEM graduates find employment suggests that there may not be enough of them to fully meet employer demand. (Paragraph 24)
9. If the Government is to meet its ambitious target of increasing the UK's investment in R&D as a proportion of GDP to 2.5% in 2014 it will need to take steps to significantly increase, not simply maintain, the total number of STEM graduates, as well as the proportion of those graduates that go on to pursue careers in science,

engineering and technology. Evidence suggests that the UK may need to produce at least 5,000 additional researchers each year. (Paragraph 25)

10. The Sector Skills Councils should help the Government and universities to improve their management of the interplay between the supply of, and demand for, graduate skills. In particular, we recommend that they develop a system of “kite marks” for employer-led higher education courses. This would send out much clearer signals to students about the likely value to their future career of the course that they choose. It would also help to avoid the problems associated with the over-provision of courses such as those in forensic science relative to the number of jobs available. (Paragraph 31)
11. We recommend that the Government undertakes a comprehensive survey of existing research into the supply of, and demand for, STEM skills, including lessons learned from other countries. This will enable it both to take stock of the current situation, and to form a strategy that will meet the UK’s future skills needs. (Paragraph 32)
12. Instead of arbitrarily increasing by a round number the amount of money given to trainee and new teachers as a financial incentive, the Government should gather evidence on the level of incentive that is required to achieve the necessary increase in school science teachers. (Paragraph 34)
13. The Government is to be commended for taking action to increase the number of school science teachers. There are signs that its incentives are having some positive effect on overall teacher recruitment levels, despite continuing problems in some subjects. However, difficulties in retaining newly-qualified teachers suggest that financial incentives are not a long term solution to teacher shortages. (Paragraph 35)
14. In order to formulate a credible policy on attracting graduates into careers in science, engineering and technology, the Government needs to develop a sophisticated understanding of the motivating factors in graduates’ choices of careers. Given that they are in the best position to act upon any findings, we recommend that the Government commissions the relevant Sector Skills Councils to carry out further research into these factors. (Paragraph 38)
15. It will be important for the Government to address negative perceptions about research careers. Without specific action in this area, it could take a long time for any improvements in research career paths to filter through to schoolchildren and students making choices about their future careers. (Paragraph 39)
16. There are currently more places on undergraduate chemistry courses at a national level than there are students to fill them. Whilst it might be desirable to increase the number of places available in the long term, in the immediate term such a measure will not necessarily increase the number of chemistry undergraduates. In order to achieve the latter aim it is essential to stimulate student demand for chemistry courses. (Paragraph 44)
17. Degrees in the same subject from different institutions are not necessarily interchangeable. Along with overall levels of subject provision, diversity of provision

needs to be taken into account in national and regional planning in order to cater sufficiently for student choice and differing levels of attainment. (Paragraph 45)

18. Student demand is a powerful player in the higher education sector under the current funding regime. If the Government is to secure good provision of STEM subjects for future cohorts of students it must ensure that demand is further stimulated. (Paragraph 49)
19. If the standard for entry on to university STEM courses is lowered as a result of decreased demand, there is a danger that the currency of the resulting degrees will be devalued. This would not be in the interests of either the students taking those courses or their potential employers. It is important that, in the drive to increase student demand for university courses in STEM subjects, the quality of the student intake is not sacrificed for the sake of increasing student numbers. (Paragraph 51)
20. There is a strong case for continuing to provide a diversity of STEM degree courses to cater for the varying abilities of the students opting to take science subjects. Joint-honours courses and many of the new “softer” STEM subjects attract many students into science who may otherwise have studied something else altogether, or not studied at all. Chemistry, physics, mathematics and engineering will not suddenly become more popular if students are prevented from studying other subjects. Nonetheless, there is great variability in the quality, scientific content and entrance requirements of some non-core STEM subjects, some of which are only nominally “science” courses. Some of these courses will be of limited value to graduates seeking a scientific career and will not help to increase the supply of skilled scientific personnel. Students enrolling on these courses need to be clearly informed at the outset about whether or not they will be qualified upon completion to pursue a scientific career. (Paragraph 59)
21. Given the importance of the degree choices made by students to the health of the economy, it is essential that the Government takes a keen interest in the impact of its initiatives designed to attract students into science, and applies itself wholeheartedly to finding solutions to the problem of declining demand for STEM subjects. (Paragraph 61)
22. The poor quality of science education in secondary schools plays a significant role in the lack of student demand for university STEM courses. (Paragraph 63)
23. It is a pity that the Government has missed its first major opportunity, offered by the Tomlinson Report, to reinvigorate the school science curriculum. (Paragraph 65)
24. The only way of securing high levels of future student demand for STEM subjects is by enthusing them about those subjects from an early age. Until school science teaching improves, the Government must expect that school leavers will continue to view mainstream STEM subjects as too difficult, irrelevant or simply too boring. The Government needs to apply itself to resolving these issues. It should not be deterred by the possibility that its efforts in this area will not bear fruit for several years. If it does not invest in school science education for the long term, the difficulties experienced by university STEM departments in recruiting students, and thus staying open, can only continue to get worse. (Paragraph 66)

25. The Government should consider measures to promote scientific careers to people of all ages, for example, by using advertising campaigns such as those used to improve the image of teachers, policemen and recruits for the armed services. (Paragraph 68)
26. Degrees in STEM subjects generally have good career prospects, particularly given current skills shortages in many areas. The Government should ensure that all schools are in a position to offer impartial careers advice to schoolchildren well before the time that they choose their A-level, and subsequently degree, subjects. The advice should be proactive rather than reactive, and should seek to make children aware of the full range of exciting possibilities offered by scientific careers. A realistic indication of job and salary prospects should also be given. (Paragraph 71)
27. We recommend that the Government introduces a national bursary scheme, based on the scheme currently being run by the Institute of Physics, for outstanding university applicants in shortage STEM subjects. Such a scheme would give a much needed boost to levels of student demand in the short term. However, bursaries are not a cure-all, and the Government will need to introduce further measures to sustain increases in demand in the long term. (Paragraph 75)
28. We endorse the principle of university autonomy. We also acknowledge that, in practice, the decisions taken by universities are in large measure dictated by the need to win funding and respond to changes in student demand. Where market conditions and the university funding system make it financially difficult for universities to continue providing subjects of national or regional strategic importance, HEFCE may need to intervene to prevent their decline at a national or regional level. We support HEFCE's proposals to require universities to give a period of notice before closing a department and to consider offering financial support to individual departments where it is in the national or regional interest to do so. Without the introduction of these mechanisms, many STEM departments will struggle to survive in the short term. (Paragraph 83)
29. It is essential that any additional HEFCE funding for strategic subject provision is used only as measure of last resort. In order to qualify for such funding, universities should have to prove to HEFCE that no alternative financial arrangements can be made. HEFCE should also have to satisfy itself that, without the allocation of such funds, capacity in the subject in question would be severely damaged at either a regional or a national level. (Paragraph 84)
30. We commend HEFCE for its support for minority subjects deemed to be in the national interest. It is clear, however, that the arrangements that have been made to secure the provision of such subjects would not be applicable to mainstream STEM subjects. (Paragraph 87)
31. The funding allocations made as a result of RAE 2001 have severely compromised the financial viability of departments rated 4 or lower, particularly in those institutions that do not have an overall majority of research staff in departments rated 5 or higher. In order to prevent the continued decline of many 4-rated departments, there needs to be a reduction in the steepness of the "cliff edges"

between the funding allocated to departments falling within different funding bands. (Paragraph 93)

32. We hope that the new “quality profiles” to be used in RAE 2008 will help to reduce the steepness of the funding scale for the allocation QR funds. In the meantime, however, many departments are still feeling the adverse effects of the funding arrangements made as a result of RAE 2001. The Government may have to recognise that short term measures, such as those proposed by HEFCE, are required to support departments currently rated 4 or lower until the new arrangements have had time to take effect. (Paragraph 94)
33. The move towards Research Councils meeting the full economic cost of the research projects that they fund should improve the financial viability and thus the sustainability of STEM departments carrying out a significant volume of research. In turn, this may mitigate against some of the more negative consequences of the RAE. We hope that our successor Committee will have the opportunity to assess the impact of this new policy once it has had time to take effect. (Paragraph 95)
34. The concentration of research funds is an inevitable consequence of a system that funds research on the basis of excellence from limited funds. The Government is responsible for this system. It is therefore disingenuous of the Government to deny that it has a policy to concentrate research. (Paragraph 96)
35. Instead of resolving the financial difficulties experienced by some STEM departments, the wholesale redistribution of research funds would diffuse those problems more widely. Such a policy would threaten the ability of 5 and 5* rated departments to continue performing at a high level. It would also risk their international standing, a move that could have adverse consequences for the UK’s international competitiveness and for individual careers. In the absence of increased overall funding, “robbing Peter to pay Paul” is not a viable solution to the financial difficulties of some STEM departments. (Paragraph 101)
36. We urge the Government to reconsider its rejection of proposals for a three-tier research assessment process. Such a process would allow departments to bid for funding on the basis of merit instead of imposing an arbitrary cut off point for departments upholding the same standard of research activity. Although this would not increase overall levels of funding for research, it would distribute existing funds more fairly amongst lower performing departments. (Paragraph 102)
37. Research concentration is not an evil *per se*: it only becomes a problem when it occurs in a uniform system, where universities that do not carry out world class research but are nonetheless strong in other areas of their work, are disregarded. (Paragraph 103)
38. It would be unacceptable if universities had to use research funds to subsidise teaching activity. In order to ensure that both teaching and research are supported at a sustainable level, the Government needs to have a clear understanding of the costs of each type of activity. We recommend that it uses the TRAC methodology to produce a comprehensive analysis of the costs of research and teaching relative to the level of funding that each activity receives. (Paragraph 108)

39. Departmental expenditure is a flawed basis from which calculate the level of teaching funding allocated to STEM departments. This seems to have been accepted by HEFCE: we understand that it has commissioned research on possible cost-based approaches to funding, including an approach based on the TRAC methodology. (Paragraph 109)
40. STEM subjects might have seen a slight increase in their levels of teaching resource, even after the change in subject weightings for their category was reduced from 2.0 to 1.7. However, any such increases need to be set against a history of chronic under funding for teaching. We recommend that the Government uses its research into the costs of teaching, facilitated by the TRAC methodology, to reach a settlement for STEM subjects that accurately reflects their cost. (Paragraph 111)
41. It would be a matter of regret if, when HEFCE changed the subject weighting for teaching funding, competition between the science and engineering bodies about the relative importance of their areas of specialism had prevented some subjects, such as chemistry and physics, from receiving the funding uplifts that they so badly needed. The scientific community needs to pull together to ensure that future discussions about funding are resolved in the interests of science as a whole, regardless of the interests of individual specialisms. (Paragraph 112)
42. Many students benefit from exposure to research during their undergraduate degree, particularly if they want to go on to pursue a career in research. However, research-intensive departments are not essential to train all STEM students. It is an inevitable, if inadequately foreseen, consequence of the drive towards higher levels of participation in higher education that it is unsustainable for every student to be taught in a research active environment. This is unfortunate, but not necessarily damaging, provided that all STEM students are taught on the basis of scholarship, if not research. We recommend that the Government and universities recognise that teaching-focussed departments are not only accepted, but supported sufficiently well to ensure that they retain good quality staff and a commensurately high status. (Paragraph 118)
43. Universities are not islands. If the way to healthy provision of STEM subjects in English universities lies in collaboration between institutions, they will need to work together in the national and regional interest. (Paragraph 119)
44. The hub and spokes model of university provision would allow STEM departments to capitalise on their areas of strength, whether they are research, teaching or knowledge-transfer, whilst still ensuring that undergraduates received a rounded education in the discipline of their choice. By collaborating on their provision of STEM courses, departments would make more efficient use of resources, and thereby ease the financial difficulties currently being experienced by many STEM departments. We recommend that the Government encourages the acceptance and implementation of this model throughout the system via HEFCE, the RDAs and Universities UK, and by means of the funding regime for higher education. (Paragraph 125)

45. We recommend that a Regional Affairs Committee is established within HEFCE to coordinate the implementation of the hub and spokes model within the regions. The Committee should contain representatives from each of the Regional Development Agencies, who would each be responsible for ensuring the implementation of decisions taken by the Committee within their region. The Committee should draw upon the valuable work being carried out by the Research Base Funders' Forum on the health of disciplines, giving this work some practical effect. HEFCE's Regional Affairs Committee would also be responsible for monitoring the implementation and success of the hub and spokes model in the regions. (Paragraph 127)
46. Under the hub and spokes model of university provision, a greater number of universities may choose to focus on their knowledge transfer activities. Third stream funding (HEIF) is still relatively modest in comparison with the funds available for teaching and research. The Government may need to consider developing HEIF further in order to encourage more universities to concentrate on knowledge transfer. A concomitant increase in research funding from industry will also need to be encouraged if universities are to have a real opportunity of diversifying. (Paragraph 131)
47. The proximity of a source of skills and research capacity is one of the main considerations when a business decides where to locate. This is particularly the case for smaller companies. (Paragraph 134)
48. If university departments suffer particularly heavy losses in one region, there is a possibility that businesses within the region would also suffer or, worse, migrate to a region where conditions were better. In this way, universities play a pivotal role in their regional economies. (Paragraph 136)
49. There are sound economic and social arguments for ensuring that there is a strong research presence in each of England's regions. We do not agree that protecting this research presence would involve lowering standards. Quality can be preserved if every university and every region play to their individual strengths instead of concentrating all their efforts on the same goal, and the same limited pot of research money. (Paragraph 137)
50. If STEM departments continue to close, there is a real danger that some STEM students will be unable to study their chosen subject in their home region, should they choose to do so. (Paragraph 140)
51. It is too early to assess what impact the impending introduction of variable tuition fees will have on departmental closures as universities position themselves in preparation for the new system. We agree, however, with the reply given to the Committee by the Director General of the Research Councils, that the impact of variable tuition fees on STEM departments should be kept under constant review, and that emerging evidence should be published as part of the Government's ongoing reviews to make clear what the impact of the scheme has been. It is also logical to assume that, given increasing levels of student debt, an increasing proportion of the student population will be unable to live away from home. It is

therefore extremely important that provision for core STEM subjects is maintained in every region. (Paragraph 142)

52. Whilst we believe that all prospective STEM students should have the opportunity to study within their region, it would be unreasonable, and a strain on resources, to expect provision of each and every subject to be maintained in every sub-region. Sub-regional provision can be addressed through regional collaboration between universities. (Paragraph 143)

Formal Minutes

Monday 4 April 2005

Members present:
Dr Ian Gibson, in the Chair

Paul Farrelly
Dr Brian Iddon

Mr Robert Key

The Committee deliberated.

Draft Report (Strategic Science Provision in English Universities), proposed by the Chairman, brought up and read.

Ordered, That the Chairman's draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 147 read and agreed to.

Ordered, That the provisions of Standing Order No. 134 (Select Committee (reports)) be applied to the report.

Resolved, That the Report be the Eighth Report of the Committee to the House.

Ordered, That the Chairman do make the Report to the House.

[The Committee adjourned.]

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Professor Ian Diamond , Research Councils UK, and Professor Sir Keith O’Nions , Director General of the Research Councils	Ev 21
Dr Bob Bushaway , Vice Chair, Association for University Research and Industry Links, Mr Nick Buckland , Vice Chair, South West of England Regional Development Agency, and Dr Ed Metcalfe , Head of Science, Technology, Entrepreneurship and Management, South East England Development Agency	Ev 31
 Wednesday 2 March 2005	
Professor Bob Boucher , Fellow, Royal Academy of Engineering, Dr Simon Campbell , President, Royal Society of Chemistry, Professor Peter Main , Director, Education and Science, Institute of Physics, Professor Sir Tom Blundell , President, Biosciences Federation and Professor Amanda Chetwynd , Vice President, London Mathematical Society	Ev 38
Professor Richard Bruckdorfer , Department of Biochemistry and Molecular Biology, University College London, and President of University College London AUT branch, and Mr Malcolm Keight , AUT Deputy General Secretary	Ev 47
 Wednesday 9 March 2005	
Professor David Eastwood , Vice Chancellor, University of East Anglia, Professor Alasdair Smith , Vice Chancellor, University of Sussex, Chair, 1994 Group, Professor Steve Smith , Vice Chancellor, University of Exeter, and Professor Michael Sterling , Vice Chancellor, University of Birmingham, Chair, Russell Group	Ev 52
Dr Kim Howells , a Member of the House, Minister of State for Lifelong Learning, Further and Higher Education, Department for Education and Skills	Ev 63

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