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Advancing Astronomy and Geophysics

Science and Technology Committee enquiry into strategic science provision in English Universities – response by the Royal Astronomical Society

Executive summary

1. **There is a national problem in both teaching and research in science, engineering and technology (SET). This is not simply special pleading by academics, as Sir Gareth Roberts' (2002) Review and others make clear.**
2. **Physics education at degree level must be regarded as of strategic national importance. Astronomy and geophysics provide a stimulating context in which to teach physics. They also have important roles in the public understanding of science. In particular, astronomy has a key role in attracting young people into science.**
3. **The impact of changing funding formulae are marginal to the national (though clearly not individual) provision - Universities are underfunded, leading Vice Chancellors to rationalise provision by reference to the costs of supplying lower demand subjects. This poses a threat to SET in many Universities.**
4. **The long term solution is a) better resourced/managed Universities and b) attracting more undergraduate students to SET through better school teaching and careers advice. The latter should trigger a feedback loop of attracting more scientists to teaching and more pupils to sciences.**
5. **Short-term intervention is almost certainly necessary to protect SET provision. This could be targeted towards 'key departments' (using criteria such as regional distribution, RAE rankings, QA reports), but the most important aspect is that it needs to be 'new' money, for example, from the Chancellor's promised extra cash for SET. However, we know and understand the Government's reluctance to interfere in the running of Universities, which are autonomous bodies, and we are acutely aware of the negative impact on academics of further paperwork, performance targets, and league tables.**

The Royal Astronomical Society is the learned Society representing astronomers (both professional and amateur) in the UK. It also represents a significant number of professional geophysicists, particularly those interested in the solid earth (and comparative planetology) – those with primarily interests in the shallow sub-surface are more likely to belong to the Geological Society of London. A significant number of the Society's members are employed in physics, astronomy and earth sciences departments of UK Universities. The Society is very concerned about the state in which science departments in UK Universities find themselves. We have recently commissioned two studies of UK undergraduate education, in astronomy and geophysics, to try to understand some of the causes of the decline, particularly in the

numbers of undergraduate students studying these subjects, and to make recommendations to stem it. The outcome of these studies will be reported later this year, and we are happy to share the results with the Science and Technology Committee. In conjunction with EPSRC, PPARC and the Institute of Physics, we have commissioned a follow-up (to compare with the first in 2000) International Review of UK Physics in the UK; the panel will visit the UK in November this year and report early next. Again, the results will be publicly available should the Committee wish to study them.

We suggest that a sensible starting point for the Committee's enquiry is to revisit the 2002 Sir Gareth Roberts' Review. In his covering letter, Sir Gareth states:

'The Review has identified a number of serious problems in the supply of people with the requisite high quality skills. They are not equally spread across science and engineering; indeed, the aggregate numbers of students with broadly scientific and technical degrees has risen in the last decade. However, there have been significant falls in the numbers taking physics, mathematics, chemistry and engineering qualifications. These downward trends, combined with deficiencies in transferable skills among graduates, could undermine the Government's attempts to improve the UK's productivity and competitiveness. Furthermore, these discipline related problems will have negative implications for research in key areas such as the biological and medical sciences, which are increasingly reliant on people who are highly numerate and who have a background in physical sciences.'

The trends identified in that report have continued, and there is therefore a continued, increasingly serious, threat to the nation's productivity and competitiveness. Thus the issue is not simply science teaching and research across Universities. The Roberts review made a number of recommendations, from schools level (since schools provide the 'raw material' for higher education) through to employment via the Universities. Implementation of these recommendations would have a significant positive impact on the situation, both in terms of the scope of the enquiry, but also more broadly in terms of the 'health' and wealth of the nation.

The Government's own 10 year Science and Technology Framework has a number of key guiding principles:

'The strategy will provide a framework for a successful and competitive science and innovation system in the UK, based on:

* a financially robust network of universities and public research laboratories across the UK;
* world class research;
* a continuing step-change in the responsiveness of the research base to the needs of the economy;
* raising business investment in R&D and innovation and encouraging stronger business engagement with the ideas and talent of the UK research base;
* making the supply of science and technology skills more responsive to demand;
* greater flexibility within schools and universities to attract the skills they need; and
* greater public understanding of, engagement with and confidence in UK scientific research and its innovative applications'

We will refer back to some of these principles below. They are not all covered by the points raised in the invitation to give evidence, so we comment further at the end of this document. We now address the specific issues on which we were invited to give evidence; some of our remarks cover more than one issue within a specific response,

since they are to some extent linked. For the same reason, we do not address them in the order in which they were posed.

* The impact of HEFCE's research funding formulae, as applied to Research Assessment Exercise ratings, on the financial viability of university science departments

The main reason that University science and engineering departments are closing is the fall in numbers of students wishing to study these subjects, whether measured as a proportion of the total higher education student population (which is increasing) or even in terms of actual numbers. 'Tinkering' through formulae associated with RAE grades, weightings given to different science and engineering subjects in the teaching funding formula, and other manipulations of income merely help determine which departments in which institutions close, i.e. those judged by management to be weakest. A far more significant impact is expected through the change to full economic costing on research grants (i.e. the destruction of the dual-funding formula), which is likely to stimulate many more closures. This is not to say that the RAE formulae and teaching subject weighting changes do/will not have any effect on viability of individual departments in individual institutions – of course they do/would. Management of Universities look at how their 'cost centres' (often departments) function within the funding model used by that institution. Those that are consistently in deficit tend to be (depending on whether those staff the institution wishes to keep can be re-deployed elsewhere within it, redundancy costs, whether it hosts a high-profile externally-funded facility, and the like) the ones closed down to keep the institution viable, regardless of arguments related to strategic need, uniqueness, quality of the staff, amount of recent investment etc. It sets departments against departments, and colleague against colleague. Since funding comes into the institution formulaically, it is hard to argue that the money should not be spent formulaically – members of a more successful department would not be happy providing a long-term subsidy to a 'failing' department, when they see plenty of uses for the money within their own. Appeals higher up the line for changes in the formulae used are met with the response that, although money is earnt formulaically, there is no need for the institution to disburse it through the same formula. Of course, each institution has its own cost model, so a 'failing' department in one might be successful in another, through something as simple as the way space was costed, for example. Thus we have a scenario of closures simply due to Universities responding to short-term market forces. There is no real budget policy beyond this: fiddling with formulae is a marginal activity. Does the Government wish to ensure a long-term supply of qualified scientists and engineers for the UK beyond that which the present market will supply? If so, it needs to put a policy in place and reflect that in the way budgets are set - budgets need to be the tools of policy, not a substitute for policy. Ideally, this policy would surely include stimulating supply and demand, but in the short term, it is almost inevitable that a significant element of pure subsidy will be required even to maintain the status quo. We make some suggests below concerning stimulating growth.

* The implications for university science teaching of changes in the weightings given to science subjects in the teaching funding formula

With high costs associated with both teaching and research, and falling student numbers, science and engineering departments are the most vulnerable. The current teaching weightings are insufficient to compensate for the additional costs of educating a science or engineering student, but the money Universities receive for educating undergraduates is insufficient anyway – it's just that the gap is larger in these subjects. (Witness the recent statement by Oxford University that they are to

reduce their numbers of ‘home’ students in favour of full fee paying students to cut the amount by which they subsidise teaching.) Re-adjusting the weightings within the science and engineering subjects is no solution. The earlier proposals were seen by those in science and engineering departments that would have lost out as compensating subjects that had done a poor job of undergraduate recruitment - their costs are higher per student simply because the overall cost of, for example, maintaining a piece of laboratory equipment is divided by the smaller number of students it was servicing. A further effect of the shrinking science and engineering population is that each department teaches its students more ‘in house’. There are two reasons for this. The first is to retain a higher proportion of student FTE income – for example, whereas physics students would have been taught mathematics by colleagues from the mathematics department, they are now far more likely to be taught mathematics by physicists. The second is that they have no choice if the ‘partner’ department has closed down. Neither enhances the educational experience of students.

* The importance of maintaining a regional capacity in university science teaching and research

Astronomy and geophysics are subjects taught and researched in only a small number of institutions and it is unrealistic to expect regional capacity in these subjects. Few undergraduates specialise in them – Society members who are UK University academics tend to spend most of their undergraduate teaching time with physics or geology students. However, we have a hard time understanding how a University can claim to teach physical science if it doesn’t have the fundamental building blocks of physics, chemistry and mathematics departments. Since, as the Roberts review, the DTI ‘SET Fair’ (Greenfield) report, and numerous other studies, have noted, the UK needs more physical scientists, it makes sense to provide/maintain regional capacity in these subjects, if only because increasing numbers of students are studying from home, or in places where living costs are lower, to reduce the debt they (or their parents) build up during their undergraduate studies. What we are seeing instead is an increasing concentration of both teaching and research in the physical sciences in fewer institutions. Universities are becoming unbalanced – they might have a big physics department, but no chemistry department. This is detrimental to teaching, and also makes the departments that survive more vulnerable – a small tweak in funding formulae (teaching or research), a couple of failed large grants applications, or a need to replace a major facility, and they can be struggling.

* The desirability of increasing the concentration of research in a small number of university departments, and the consequences of such a trend

We have argued that the concentration of both teaching and research is happening *de facto* through closures, which themselves are governed by ‘market forces’ affecting where and what students choose to study, and how research monies are distributed (both as a result of the RAE formula and through research grant and commissioned research income). There is no policy or strategy associated with it. There is no attempt to assess how the losses affect the responsiveness of the research base to the needs of the economy, business investment in R&D and innovation, business engagement with the ideas and talent of the UK research base, and the ability to respond to demand in the supply of science and technology skills. Even if the assessment were made, there is no mechanism for using it to intervene to protect a department, since Universities are autonomous bodies. Thus the pattern of closures and concentration of research is haphazard. This cannot be healthy.

* The optimal balance between teaching and research provision in universities, giving

particular consideration to the desirability and financial viability of teaching-only science departments

Teaching is best done in Universities with a substantial research effort in the relevant subjects, both main and subsidiary, relevant to the course a student is taking. Having, say, a physicist teaching chemistry because the chemistry department has closed, or having chemistry taught by a chemist in an essentially teaching-only department (or by the 'tame' chemist kept on in the physics department to satisfy the teaching need after the chemistry department closed) is a poor second. Many of us can provide examples of our research informing our teaching, and the 'extra' this brings to teaching is frequently favourably commented upon by external reviewers during quality assurance assessment. There is an unfortunate assumption in some quarters that departments with strong research records do this at the expense of their teaching. In most cases, the contrary is the case – teaching is better in departments where the majority of staff are involved in high quality research. However, for many academics, most of their research is undertaken in their 'spare' time, with greater than 60 hour working weeks being the norm. For most, it is not the balance between what we see as our 'core' activities of teaching and research that is the issue, but the increase in time spent on (largely pointless and irrelevant) administration and paperwork. Increasing student-staff ratios have an impact, too, as does the extra time most of us find we have to spend on 'welfare' and pastoral care aspects of having students e.g. worried about debt, and undertaking more paid work to the detriment of their studies and health.

Further comments

The S&T 10 year Framework's guiding principles mention the need for 'greater flexibility within schools and universities to attract the skills they need'. Unless or until the UK reverses the decline in numbers of students studying science and engineering at undergraduate level, the situation can only deteriorate, and more and more departments will close. We have already argued that Government must intervene – the UK's continuing prosperity depends on having a numerate, scientifically trained workforce to sustain high technology industries and the like. However, Universities are just one area where change is urgently needed. At the same time, Government needs to improve the teaching of science and mathematics in schools. Most of us working in science departments in Universities see the poor quality of school science and mathematics education, and the lack of good careers guidance, as the main reason why students do not wish to study them at University. There are too few teachers who are trained in relevant subjects (e.g. physics is often taught by a teacher without any post-school physics education), and school science laboratories are not well funded/equipped. Other problems exacerbate the situation, such as the perception of science as non-trendy, and not leading to a high earning career, and of scientists as old, grey haired men with beards in white coats. How are we going to persuade young people to study science if they believe that the salaries associated with likely career paths are such that they will never be able to afford to buy a house? Perception thus applies to the subject itself, and its career prospects. We are privileged, being involved in astronomy, space science and geophysics, in studying subjects that attract enormous public interest and are stimulating contexts in which to convey and teach basic mathematics and science, especially physics (geophysics interest sadly boosted significantly by the Sumatran earthquake and tsunami). The Society takes its 'promotion' role seriously, putting considerable resources and effort into media activities (e.g. press releases, speaking and appearing on radio and television, lending our support to other bodies involved in public understanding of science) and education. Ours and other relevant learned Societies, other interested groups, and individuals, all put significant effort into supporting school science teachers, through training courses, providing teaching materials, and

speaking in schools. However, this tends to consist of a plethora of uncoordinated activity, which therefore is somewhat piecemeal and does not have the impact it might. We also have difficulty in finding working teachers willing and able to belong to and participate in our Education Committee, due to conflicts with their teaching commitments. The situation would be alleviated if such activity were viewed as part of their CPD and commitment to the strategic development of education.