

PHYSICS PARTICIPATION AND POLICIES: LESSONS FROM ABROAD

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Executive Summary

Physics participation at A-level has fallen sharply in recent years. This is the sixth in a series of reports, funded by the Gatsby Charitable Foundation, which has investigated the decline. The first described the situation in schools, the second analysed national statistics, the third looked at schools that were bucking the trend, the fourth considered teacher supply in detail, and the most recent assessed the impact of the specialist schools. This final report draws together evidence from around the world to pose the question: is England typical?

A-Levels in UK

Between 1982 and 2006 A-level physics entries halved from 55,728 to 27,466. The number of 18-year-olds fell and there were more A-levels to choose from, but the decline seems to have been mainly an unintended consequence of the switch from the separate sciences to combined science at GCSE. Combined science has tended to be taught by biologists and it seems to have been a much better platform for biology than physics and chemistry at A-level. It is now government policy to revert to the separate sciences for the most able. Since 2006 there has been some modest recovery in A-level physics entries, with an increase of 7.3 per cent to 29,436.

A-Level Stage in Other Countries

Extensive searches yielded six countries in which physics participation at the A-level stage was both identifiable (it is often taken as part of a larger science grouping) and recorded over a run of years. In five - Australia, Eire, Finland, New Zealand and Scotland - take-up has been falling. Only in the United States have numbers been increasing. The A-level physics entry is much lower than for equivalent courses in other countries. In 2007 it was only 3.6 per cent of the age cohort compared to an average of 11 per cent elsewhere. Taken together with the halving of entries, this suggests there is considerable scope for raising participation.

Degrees and Doctorates in the UK

In contrast to the sharp falls at A-level, university physics entries in the UK have remained at much the same level for several decades. This is possible because only about one in ten of those passing A-level physics are needed to fill the university places, even in the lean years. While graduate output overall has burgeoned, especially following the elevation of the former polytechnics, physics has flat-lined. In the period 1995 to 2008 it was one of only three subjects - chemistry and engineering were the others - to fall back rather than to share in the rapid growth. Unemployment and salaries can be taken as indicators of the demand for graduates. Surprisingly physics comes toward the upper end of the unemployment range six months after graduating. The salaries of physics graduates, both first degree and doctoral, after three years were well below average, probably reflecting the high proportion going into research and the low salaries paid to university staff. The widespread belief that there is a severe shortage of physics graduates seems to stem from the undoubted difficulty of recruiting sufficient high quality teachers.

Degrees and Doctorates in Other Countries

At the first-degree and doctoral levels, physics graduate output in most countries has tended to stay about the same or to fall somewhat, in contrast to the physical sciences as a whole where there have been rises. In neither case, however, has any increase kept pace with the growth in graduates or doctorates overall, so shown as relative share they appear to decline.

In fact, in the United States and the UK, two countries with long runs of data, the output of first-degree physics graduates has remained much the same over many years. If there is shortage of physics specialists, it is curious that the market has not corrected for it.

The Science Dilemma

Statistics for the European Union show that, on average, 13.4 per thousand of 20-29 year-olds in 2007 had degrees in science, maths and technology, with a range from 20.5 in France to 6.4 in Hungary. In organising school science education, countries face a dilemma: do they gear it mainly to the science professionals of the future or to science for citizens so that all can participate in a society's decision-making about scientific issues? Often there are not enough high quality physics teachers to go round, so should the specialist teachers and scientifically talented pupils be brought together in some way? Some countries have selection in lower secondary education, including Germany, the Netherlands, Austria and Hungary, and others in upper secondary education as in Finland.

Specialist Science Schools

A number of countries, the United States, Korea, Japan, Singapore, the Philippines and Turkey among them, have specialist science schools for the especially able. Scientific ability and interest is identified not only through selection tests, but also from prior attainment, interviews, and assessment activities. Most are high schools but in Singapore entry is either at age 12 or 14, and in the Philippines it is 12. Japan created science schools through a bidding process among its high schools. Singapore encouraged its National University to take the lead. Entry can be very competitive. In New York about 29,000 take the admissions test for the 6,000 places at the eight specialised schools. Research in the United States found that science schools are "highly effective at producing graduates not only with high levels of aptitude in STEM, but who go on to further study and careers in STEM." The Bronx High has six Nobel laureates among its former pupils. It has been the inspiration for science schools in the Philippines and Turkey. In contrast to specialist science schools in other countries, science schools in England are explicitly non-selective.

National Strategies and Initiatives

The Netherlands has a comprehensive National Action Plan from primary school through to business-education links, which aims to raise participation in maths, science and technology by 15 per cent over the ten years from 2000. Some of its 'grammar' schools are funded as science schools to act as catalysts and there is also a university-based consortium at Utrecht University providing for the most gifted science pupils in partner schools. Japan has a Science Literacy Enhancement Initiative with the twin aims of raising interest and, through Super Science High Schools particularly, developing talented children's individuality and capabilities. Attracting sufficient physics teachers is a problem experienced by many countries and a number of initiatives target teachers, seeking to recruit more with science specialisms and improving training and support in employment. In Italy, the United States and Norway less than ten per cent of 14-year-old pupils are taught by a teacher whose main area in science is physics. England is second only to Tunisia in the proportion of science teaching in the hands of biologists. The United States seems to have increased physics take-up by making more science credits a requirement for high school graduation. There are voluntary out-of-school initiatives such as Les Petits Débrouillards, originally in Quebec but now in 15 countries, which aims to make science interesting and fun for younger children. Some initiatives are less about fun or achievement than increasing diversity through attracting more females or ethnic minorities.

Recommendations

The UK government has a broad raft of policies for improving physics participation and performance in England at both school and university. It has an ambitious target of raising A-level physics entries by nearly a fifth to 35,000 by 2014. There are signs that the drive on science has begun to turn around the continual decline, but the government is not satisfied and as this report is being written a Science and Learning Expert group is consulting on ways of promoting ‘stretch and challenge’. We suggest that there are important lessons to be learned from other countries and make eight recommendations.

Stretch and Challenge

- 1) The role of the specialist science schools should be re-thought with a view to harnessing them to provide stretch and challenge for the most able and increasing the numbers of young people taking physics and other science A-levels.
- 2) The development of a network of specialist science schools with provision for the scientifically talented from age 13-14 should be explored.
- 3) Universities with leading physics departments should be invited to bid for funds to enable them to pilot partnerships with schools to provide high-level courses in the sciences.

Curriculum, Examinations and Qualifications

- 4) The role of the universities in setting and regulating A-level examinations should be increased by requiring awarding bodies, the QCDA and Ofqual to have strong representation from them.
- 5) Universities should explore the feasibility of establishing a new examination board that would offer A-levels, or an alternative qualification, that fully met their entry requirements in terms of standards and distinguishing between applicants, and obviate the need for individual entrance tests.

Teachers

- 6) Accepting that good physics teachers are in short supply at present and are likely to remain so in the immediate future, models for ensuring that all secondary pupils have access to high quality specialist teachers should be trialled. These might include schools sharing teachers among themselves and working in partnership with the further education sector and universities.

University Numbers

- 7) It is widely held that there is a shortage of physics graduates, but the evidence for this is not unequivocal. An investigation should be undertaken to better understand the demand for physics graduates and the factors affecting supply.

Evaluation

- 8) All initiatives and strategies for improving physics participation and performance should set out the criteria by which they can be judged, and they should be carefully monitored and evaluated.

