The Supply of, and Demand for, Scientists and Engineers

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Introduction

1. It is a great pleasure to have this opportunity, on the opening day of the ASE Conference and under the auspices of Save British Science, of considering with you the supply of, and demand for, scientists and engineers.

2. My main arguments are that, on the supply side, difficulties have arisen from the piecemeal nature of educational reform. On the demand side, I am suggesting that, in relation to current levels of investment in research and development (which are low in comparison with other major industrial nations), there is no apparent shortage of scientists and engineers in Britain. The impression of shortage comes in part from the difficulty of filling the places now provided in the expanded university system, and in part from the problems of science-teacher recruitment.

3. From these perspectives the key issues become:

- whether, and at what stages, the emphasis in science education should be on science as part of the general culture or educating the professionals of the future;
- where are the science teachers to come from;
- how many and what kinds of science graduates should we be looking for;
- what are the appropriate levels of investment in people and the science-base?

Science in the National Curriculum

4. As background, let us look at the quantitative picture. First, a success story. It was not so long ago that many young girls and young boys wrote themselves off from the sciences at 13 or 14 years of age. Now with science as a core subject of the national curriculum and the development of the double-award GCSE in science, most continue till age 16 at least. The first chart shows that in 1980 only 31 per cent of boys and 11 per cent of girls

Chart 1: O-Level/GCSE Entries

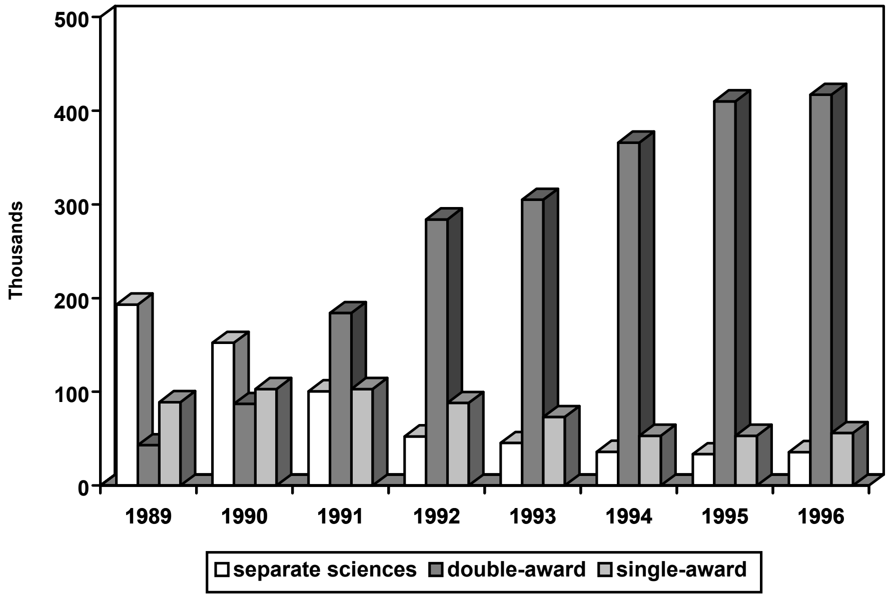
Subject	Entries (Thousands) m	Entries (Thousands) f	% Age Group m	% Age Group f	Ratio m:f
Physics					
1980	127	42	31.1	10.9	2.85
1996[1]	240	231	81.7	80.7	1.01
Chemistry					
1980	87	48	21.2	12.4	1.71
1996[1]	239	231	81.5	80.7	1.00
Biology					
1980	83	145	20.4	37.5	0.54
1996[1]	239	233	81.5	81.4	1.00

1. includes double-award science

Source: *Statistics of Education, School Leavers, CSE and GCE. London: DES; Statistics of Education, Public Examinations GCSE and GCE in England* (1996). London: HMSO.

entered for O-level physics,whereas in 1995 over 80 per cent in each case took GCSE physics or double-award science, and the gender ratio reached parity. Chemistry and biology have increased similarly.

Chart 2: Science GCSEs



Source: Updated from Smithers, A. and Robinson, P. (1994). *The Impact of Double Science*. London: The Engineering Council.

5. As we can see from Chart 2, the growth has been mainly accomplished through a switch to double-award science. From only 22 per cent of science GCSE entries in 1989 it now accounts for 79 per cent. Over the same period, the separate sciences have contracted from some 200,000 entries to, on average, about 47,000. Interestingly, 1996 was the first year since the inception of the double-award that entries in the separate science have gone up - physics by 5.7 per cent, chemistry by 6.5 per cent and biology by 5.6 per cent. This compares with a 1.8 per cent increase for the double-award suggesting perhaps some return to the separate sciences.

Chart 3: O-Level/GCSE Results *per cent grades A-C*

Subject	1980		1996	
	m	f	m	f
Physics	60.0	61.8	89.4	86.6
Chemistry	62.9	59.1	88.9	89.0
Biology	59.9	52.0	87.6	87.7
Double-Award Science	-	-	48.1	49.0
English	50.7	57.1	47.0	64.3
Mathematics	60.3	52.1	46.3	46.0

Source: *Statistics of Education, School Leavers, CSE and GCE. London: DES; Statistics of Education, Public Examinations GCSE and GCE in England* (1996). London: HMSO.

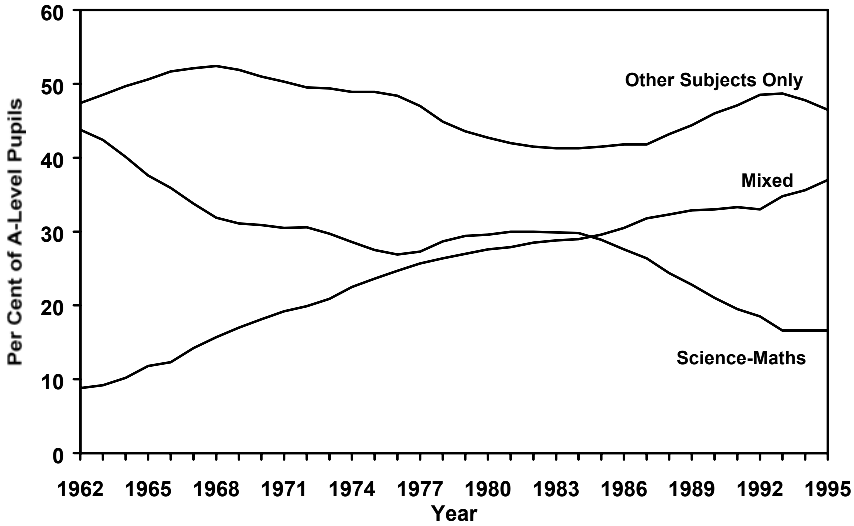
6. In terms of performance (Chart 3), just under half of both sexes passed GCSE double science at grades A-C, about the same as boys in English, and both sexes in maths. (In English, however, as has been widely commented upon, the girls have raced ahead.) Interestingly, the pass rate at A-C for the small highly selected group continuing to take the separate sciences approached 90 per cent. In the single-award combined science, however, it was only 14 per

cent for boys and 22 per cent for girls suggesting that the exam is something of a fallback for those finding the subject difficult.

A-Levels

7. The bad news though is that the greatly increased participation up to age 16 does not appear to be feeding through to science A-levels. Chart 4 shows that the proportion of A-level students specialising in the sciences has declined from 44 per cent in 1962 to less than 17 per cent in 1994 (the last year for which these statistics were collected). The drop is balanced by the progressively increasing proportion mixing science A-levels with the non-sciences, but, in a sense, they are swinging away from the sciences, since an early study showed that only about one in five went on to science-based courses at university (Smithers and Robinson, 1988).

Chart 4: A-Level Combinations



Source: *Annual Statistics of Education, Schools.* London: DES, DFE, DFEE and HMSO.

8. If we look at single subjects rather than combinations, as in Chart 5, we find that there has been a reduction in the numbers taking A-level physics from 45,716 in 1988 to 32,801 in 1996 (28 per cent), partly reflecting the 22.7 per cent fall in 18 year-olds. Biology numbers rose by 22 per cent and those in chemistry fell by six per cent, but both can be considered increases relative to the size of the age group.

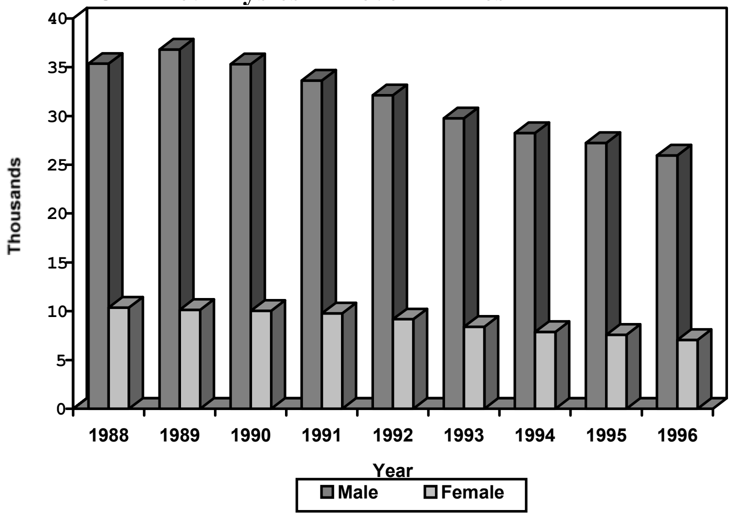
Chart 5: A-Level Entries (Thousands)

Subject	1988	1997	% Change
Physics	45.7	33.5	-26.7
Chemistry	43.3	42.5	-1.8
Biology	42.5	56.5	+32.9
18-Year-Olds	715.1	602.4	-15.8

Source: *Inter-Board Statistics. Guildford: AEB; Science and Maths: A Consultation Paper on the Supply and Demand of Newly Qualified Young People* (1994). London: DFE.

9. The pattern of A-level physics take-up is examined in more detail in Chart 6. There was an apparent increase in 1989 over 1988 but that was because the number of 18 year-olds also went up that year. Otherwise the fall in physics entries has continued remorselessly. What is striking too is the gender ratio. This has been brought to parity pre-16 through the double-award GCSE, but post-16 it not only re-emerges but the ratio of males to females actually increases from 3.41 to 3.59 to 1.

Chart 6: Physics A-Level Entries



Source: *Statistics of Education, School Leavers, CSE and GCE. London: DES; Statistics of Education, Public Examinations GCSE and GCE in England* (1995). London: HMSO.

10. The pass rate in A-level physics was 86 per cent. If we consider just A-C grades we find that in spite of the overall decline in entries the number of passes at that level has held up at about 19,000 per year, which could mean that it is the potentially weaker candidates who are turning to other subjects.

GNVQs

11. I notice that science GNVQs will be receiving a lot of attention at this conference. For those of you who think that the opening up of the foundation-intermediate-advanced ladder will compensate for the decline in GCE science A-levels let me put it in a quantitative context. Chart 7 shows that, in 1996, against the 300,000 passing a science GCSE only 1876 completed the intermediate science GNVQ. Compared with the 30-40,000 obtaining science A-levels, there were only 612 advanced GNVQs in science. And that is to

Chart 7: Science Passes, 1997

GCE A-Level		**Advanced GNVQ**	
Physics	29353		
Chemistry	37151	Science	975
Biology	48393		
GCSE A*-C		**Intermediate GNVQ**	
Combined Science	243849		
Physics	38697	Science	1784
Chemistry	39752		
Biology	40343		

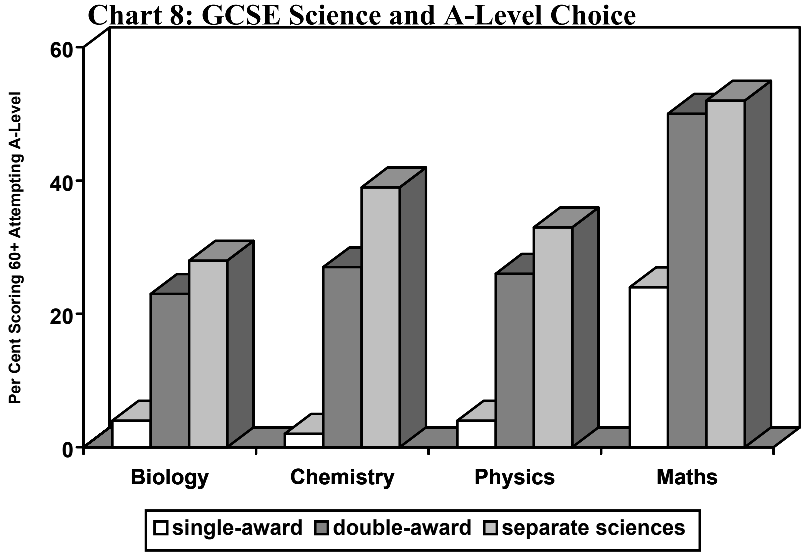
Source: Press Releases of Joint Forum for the GCE and GCSE, 15 August 1996; Joint Council for GCSE, 22 August 1996; Joint Council of National Vocational Awarding Bodies, 28 August1996.

leave aside the question of whether the science GNVQ is intended to be a technician qualification (as was its BTEC forerunner) or a general entry qualification for university.

Progress from GCSE to A-Level

12. But why aren't science A-levels growing, as other A-levels are, given the greatly increased pool of science students to age 16 from which to draw? Analysis by the DFE (1994) has shown, as we can see in Chart 8, that students taking physics, chemistry and biology at GCSE are more likely than those taking the double-award science to progress to science A-levels.

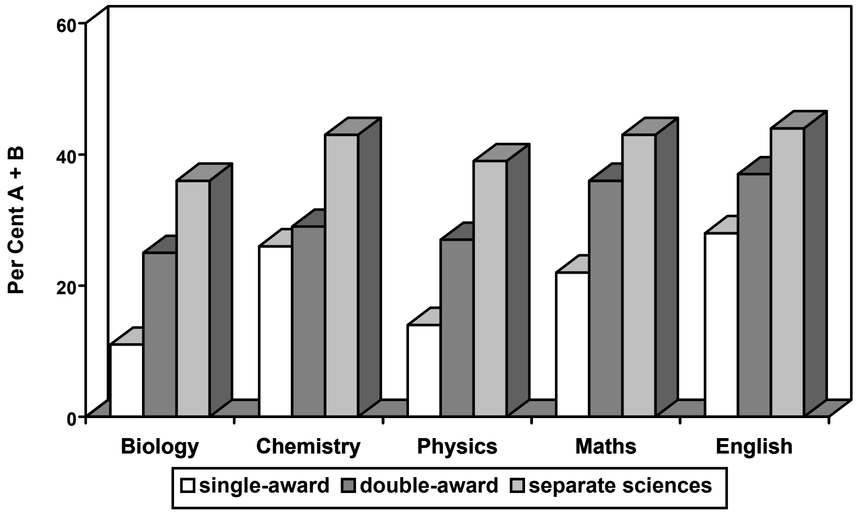
Chart 8: GCSE Science and A-Level Choice



Source: *Science and Maths: A Consultation Paper on the Supply and Demand of Newly Qualified Young People* (1994). London: DFE.

13. Chart 9 shows students from the separate sciences are also more likely to do well at A-level. Remember though that those taking the separate sciences are a small highly selected group, and the difference may have less to do with the GCSEs themselves than the people taking them. The Dearing Review (1996)

Chart 9: A-Level Grades By GCSE



Source: *Science and Maths: A Consultation Paper on the Supply and Demand of Newly Qualified Young People* (1994). London: DFE.

of qualifications for 16 to 19 year-olds, however, showed that there was an appreciable difference - three-quarters of a grade at A-level - so we should also look to content and standards.

The Gentrification of Science

14. We can explore the differentiation in more detail in Chart 10. Separate sciences are now taken mainly in independent and grammar schools. Independent schools are not bound by the national curriculum and are able to offer one or two separate sciences as well as all three. Maintained schools can only offer all three as an alternative to the science GCSEs, and it is only the especially committed who are able to tackle three subjects in a slot for two.

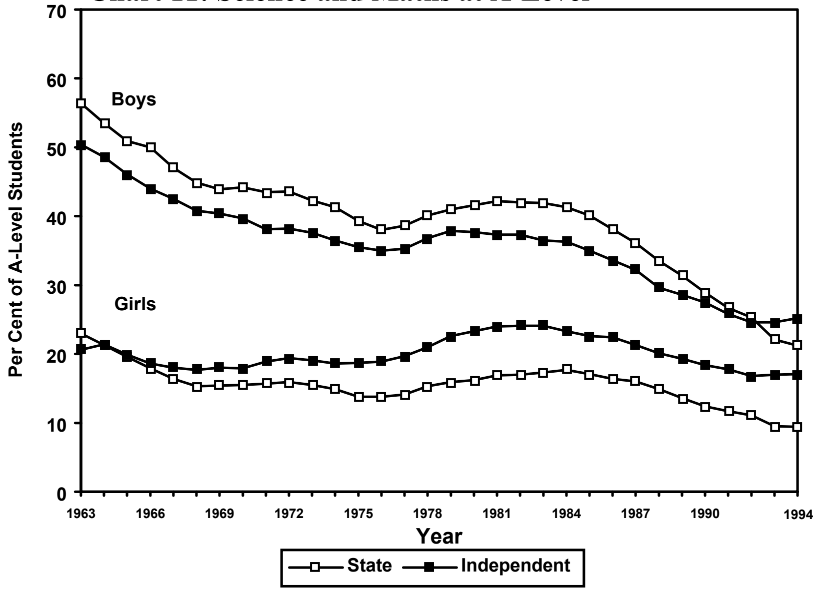
Chart 10: Science 14-16 *per cent of pupils*

Courses	Comp16 (N=138)	Comp18 (N=172)	Sec Mod (N=15)	Gram (N=16)	Ind (N=64)
3 Separate Sciences	2.5	3.3	0.0	32.5	35.8
Double-Award Science	95.4	94.8	97.2	66.1	45.2
Single-Award Science	2.1	1.9	2.8	1.3	6.3
2 Separate Sciences	-	-	-	-	8.6
1 Separate Science	-	-	-	-	4.1

Source: Smithers, A. and Robinson, P. (1994). *The Impact of Double Science*, London: The Engineering Council.

15. The net effect is to make the sciences increasingly middle class subjects. The sociological literature of the sixties (e.g. Box and Ford, 1967) pointed to the sciences as predominantly an avenue for bright working class young men. The theory was that they were better able to express their intelligence in numerical-spatial terms than words, having grown up in a relatively impoverished linguistic environment. But Chart 11 shows that science take-up by boys in independent schools having been behind that of boys in state schools from the outset has since the national curriculum and double science GCSE moved ahead. The study of the sciences by girls in independent schools has held up well and it is now not far behind that of the state school boys in percentage terms.

Chart 11: Science and Maths at A-Level



Source: *Annual Statistics of Education, Schools.* London: DES, DFE, DFEE and HMSO.

International Comparisons

16. The importance of course structures is borne out by international comparisons (Chart 12). Particularly interesting are the results of the second international science study conducted by the International Association for the Evaluation of Educational Achievement in 1983-85 (Postlethwaite and Wiley, 1992).

Chart 12: International Comparisons

Study[1]	Year	Rank[2]	
		Age 13,14	Final Year
IEA FISS	1970-72	9/14	5/14
IEA SISS	1983-85	17/19	P2/16 C2/16 B3/16[3]
IEA TIMSS	1993-94	7/27	

1. International Association for the Evaluation of Educational Achievement (IEA) first international science study (FISS), second international science study (SISS) and third international maths and science study (TIMSS); International Association for the Evaluation of Educational Progress (IEAP), science 1 and science 2.
2. England except IAEPS 1 which is UK.
3. Physics, chemistry and biology.

Source: Reynolds, D. and Farrell, S. (1996). *Worlds Apart?* London: HMSO; Keys, W., Harris, S. and Fenandes, C. (1996). *Third International Mathematics and Science Study. First National Report. Part I.* Slough: NFER.

17. In the comparisons of 14 year-olds, England came seventeenth out of the 19 broadly comparable participating countries, yet among sixth formers it was second in chemistry and physics, and third in biology. Hong Kong and Singapore which inherited our educational system had similar patterns. Hong Kong was bottom for the 14 year-olds and top for final year school students; Singapore was fifteenth and fifth. This reversal seems to be the outcome of a system designed to identify and educate the specialists. At that time not all English 14 year-olds were studying science, but the highly-selected A-level students were among the best in the world.

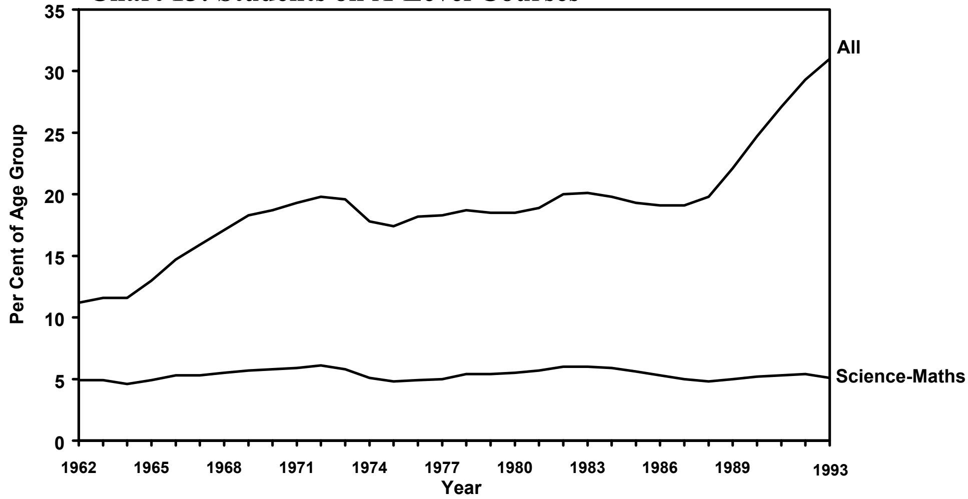
18. With science becoming a core subject in the national curriculum there has been substantial improvement in the science standing of 14 year-olds. In the latest IEA study (Keys, Harris and Fernandes, 1996) they came sixth out of the 25 countries satisfying the specifications and sampling procedures. In a more detailed comparison of ten countries, England came fourth behind only Singapore (which has similarly transformed itself), Japan and Hungary.

19. In maths, however, England's performance was much less satisfactory, coming eighth out of ten, above only the USA and Scotland. Maths is the language of the sciences and failure to come to terms with it - if anything relative to other countries we seem to be slipping back - will weaken attempts to improve science education.

Higher Education

20. The massive expansion of higher education (from five per cent of school-leavers in 1962 to over 30 per cent at present) has been mainly through A-levels. Chart 13 shows they have grown in two main phases - the first in the sixties associated with the rise of comprehensive education (which allowed more pupils to take them) and the second when GCSEs came on stream. The sciences however have remained at about five per cent of the age group.

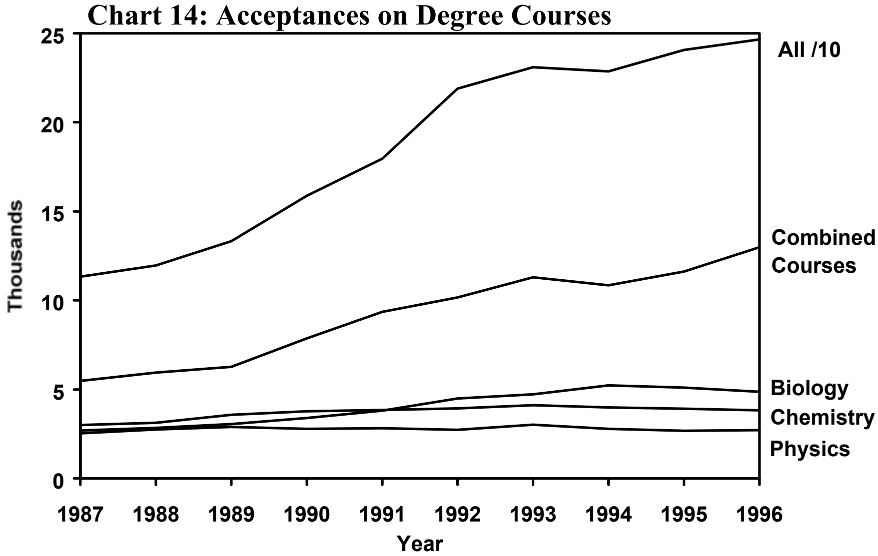
Chart 13: Students on A-Level Courses



Source: Smithers, A. and Robinson, P. (1995). *Post-18 Education, growth, change, prospect.* London: CIHE.

21. Chart 14 shows what this has meant for degree entry in the last decade. Whereas total admissions have gone up from about 112,000 to 240,000, chemistry, maths and physics have been kept to a plateau of around 3,000.

Chart 14: Acceptances on Degree Courses

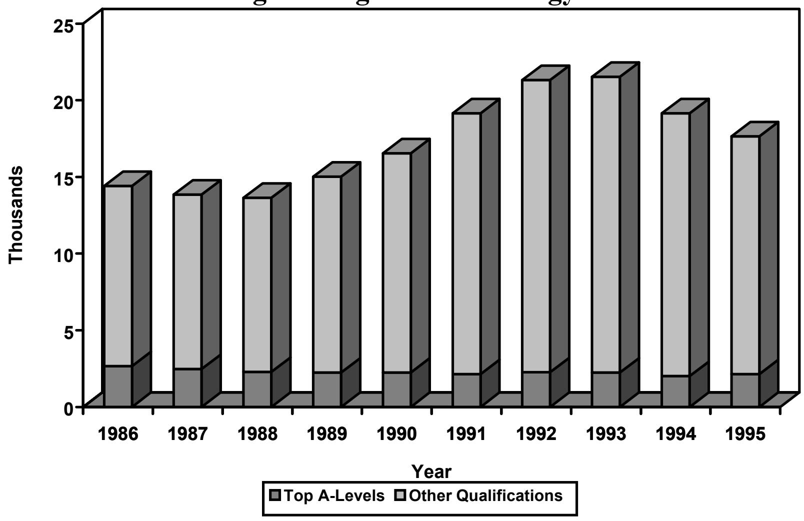


Source: *Annual Reports*. UCCA, PCAS and UCAS.

22. Where there has been an attempt to expand science-based subjects this has often run into difficulties. Chart 15 shows that engineering & technology now

attracts fewer of the best A-level students than it did in 1986 - 2144 against 2662 - and there has been some retrenchment in the number of places on offer.

Chart 15: Engineering and Technology



Source: Smithers, A. and Robinson, P. (1996). *Trends in Higher Education*. London: CIHE.

Graduate Output

23. The growth of British higher education has occurred mainly outside the sciences. However Chart 16 shows that this is not all that unusual in international terms. When the graduate output of the major industrial nations is adjusted for population size, we find that the UK is on a par with Japan and above Germany and France. It is only the USA with truly mass higher education system that educates substantially more graduates *pro rata* than we do.

Chart 16: Graduate Output (inc PhD) *thousands*

Subject Area	UK	Germany	France	Japan	USA
Natural Science	33	25	} 35	25	31
Maths/Comp	17	11		} 55	14
Engineering	41	46	19		32
Medicine	19	23	10	13	34
Law/Bus	64	21	51	95	112
Humanities	113	72	51	66	196
Adj. Total[1]	**287**	**198**	**166**	**256**	**419**

1. Adjusted for population size.

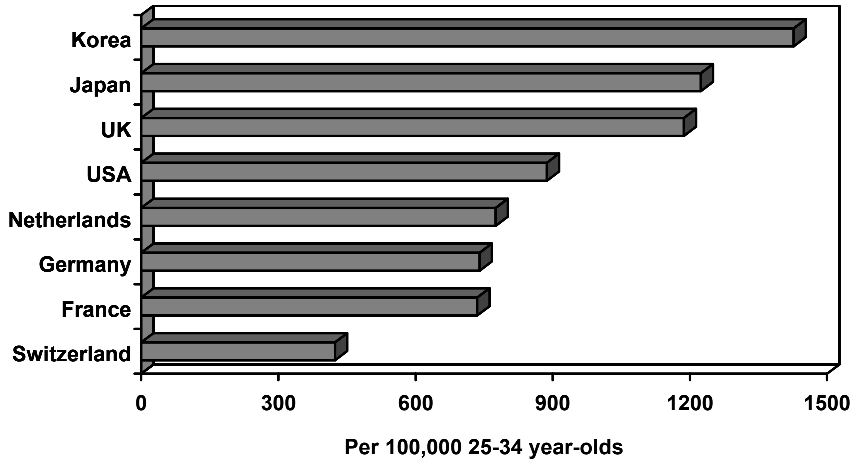
Source: Developed from OECD Indicators, *Education at a Glance* (1996). Paris: CERI.

24. Across the very different systems, however, the output of science and engineering graduates is not dissimilar. The 'extra' graduates in the USA are mainly in law, business and the humanities, though with a generous output of

medics also, perhaps not surprisingly given the rewards available in that country. The higher numbers in the UK and Japan compared with Germany and France are also in the non-sciences, with humanities predominating in the UK and law and business in Japan.

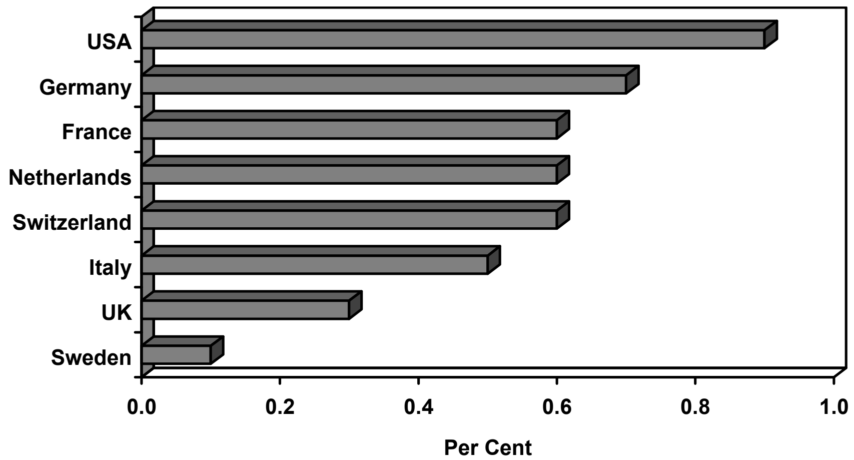
25. Chart 17 shows that compared with these and other countries, the UK does relatively well in terms of the output of science graduates, but poorly in the proportion working as science professionals, as the inversion of Chart 18 shows.

Chart 17: Supply of Science Graduates



Source: Developed from OECD Indicators, *Education at a Glance* (1996). Paris: CERI.

Chart 18: Per Cent Workers as Science Professionals



Source: Adapted from Parliamentary Office of Science and Technology note 69 (1995).

R&D Spending

26. The explanation of this apparent paradox possibly lies in R&D spending. Chart 19 shows that not only is the UK's GDP lower than that of the other countries (even adjusting for population), but the percentage gross expenditure on R&D is also lower. Although the differences may seem quite small, the decimal points become a lot of money as fractions of billions of pounds.

Chart 19: R&D Spending

Constituents[1]	UK	Germany	France	Japan	USA
GDP £b (ppp)	628	929	689	1589	3994
GERD (%)	2.19	2.48	2.41	2.80	2.79
GOVERD (%)	0.30	0.38	0.48	0.25	0.29
HERD (%)	0.36	0.43	0.39	0.25	0.39
BERD (%)	1.44	1.66	1.49	2.06	2.01
ORD (%)	0.08	0.01	0.03	0.13	0.10
Civil (%)	1.90	2.50	2.00	2.80	2.20
Defence (%)	0.30	0.00	0.40	0.00	0.60

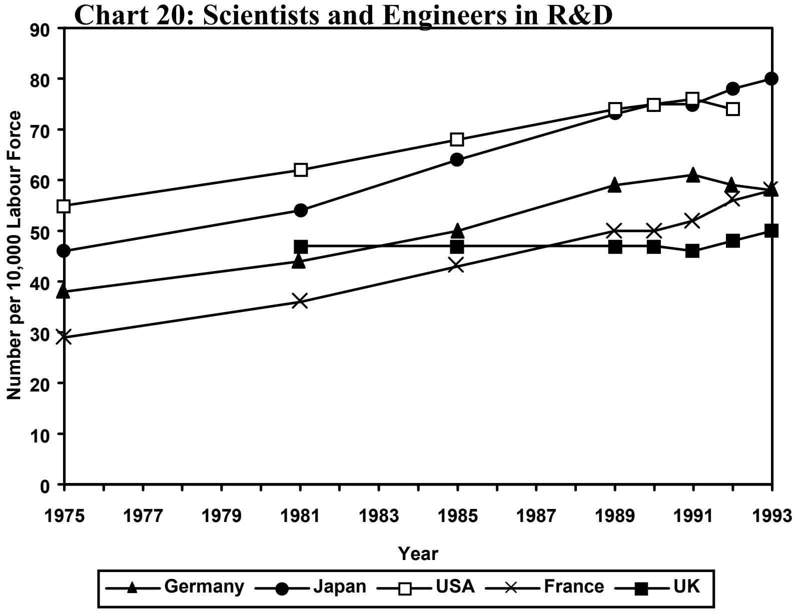
1. GDP - Gross Domestic Product in purchasing power parities; GERD - gross expenditure on R&D; GOVERD - government intramural expenditure on R&D; HERD - expenditure on R&D in the Higher Education sector; BERD - expenditure on R&D in the Business Enterprise sector; ORD - other.

Source: *Forward Look, 1995, Vol 3, Statistical Supplement*, London: HMSO.

27. The British government has in fact reduced its funding of R&D from £6.18 billion to £5.62 billion in real terms in the decade to 1994/5 and it is due to fall to about £5 billion by the year 2000 (Parliamentary Office of Science and Technology, 1995). Private sector expenditures have been rising but still lag appreciably behind those of Japan, USA and Germany, and are highly concentrated in pharmaceuticals, chemicals and electronics.

28. We can see the overall effect on scientists and engineers in R&D in Chart 20. Britain was ahead of Germany and France in 1981 but fell back, with only a slight recovery in the last two years. Meanwhile the other countries have been charging ahead. Germany and France have overtaken us, and Japan and the USA have gone even further in front.

Chart 20: Scientists and Engineers in R&D



Source: Further analysis by Save British Science of OECD *Main Science and Technology Indicators*, *Statistics on Diskette* (1996), Paris: OECD Publications.

Employment Prospects

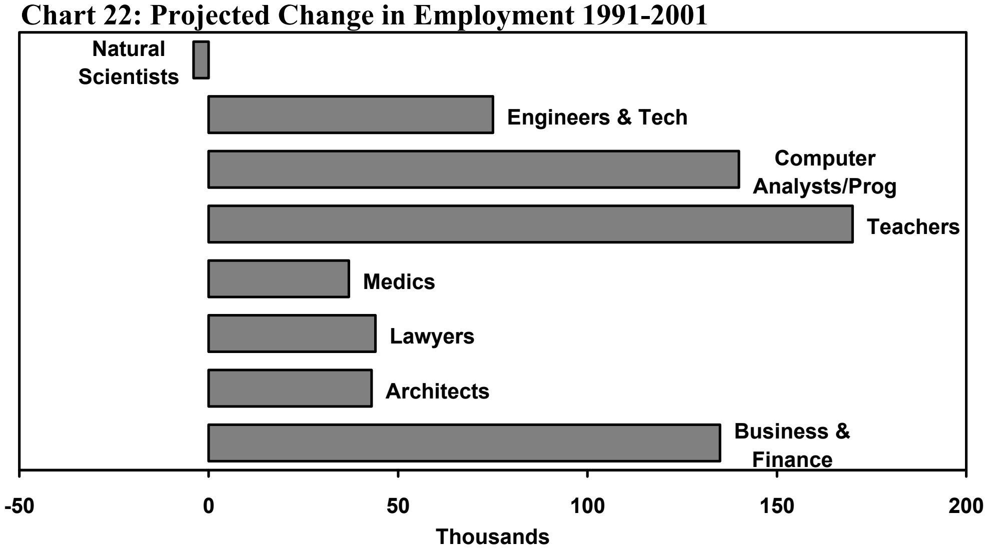
29. Scientists and engineers are also relatively poorly paid in this country (Chart 21) which may in part reflect the demand for science graduates as science professionals (though salary is also determined by many other factors). Neither do the prospects seem that bright according to the latest projections of the Institute for Employment Research (1996). Of all the professions considered, only the requirement for scientists is expected to fall.

Chart 21: Earnings by Profession, 1993

Men	£/week
Doctors	780.0
Managers	651.9
Police Inspectors	635.8
Solicitors	621.9
Accountants	489.3
Architects	479.4
All Prof Occup	***476.6***
Scientists	464.3
Engineers	458.8

Source: *Science and Maths: A Consultation Paper on the Supply and Demand of Newly Qualified Young People* (1994). London: DFE.

Chart 22: Projected Change in Employment 1991-2001

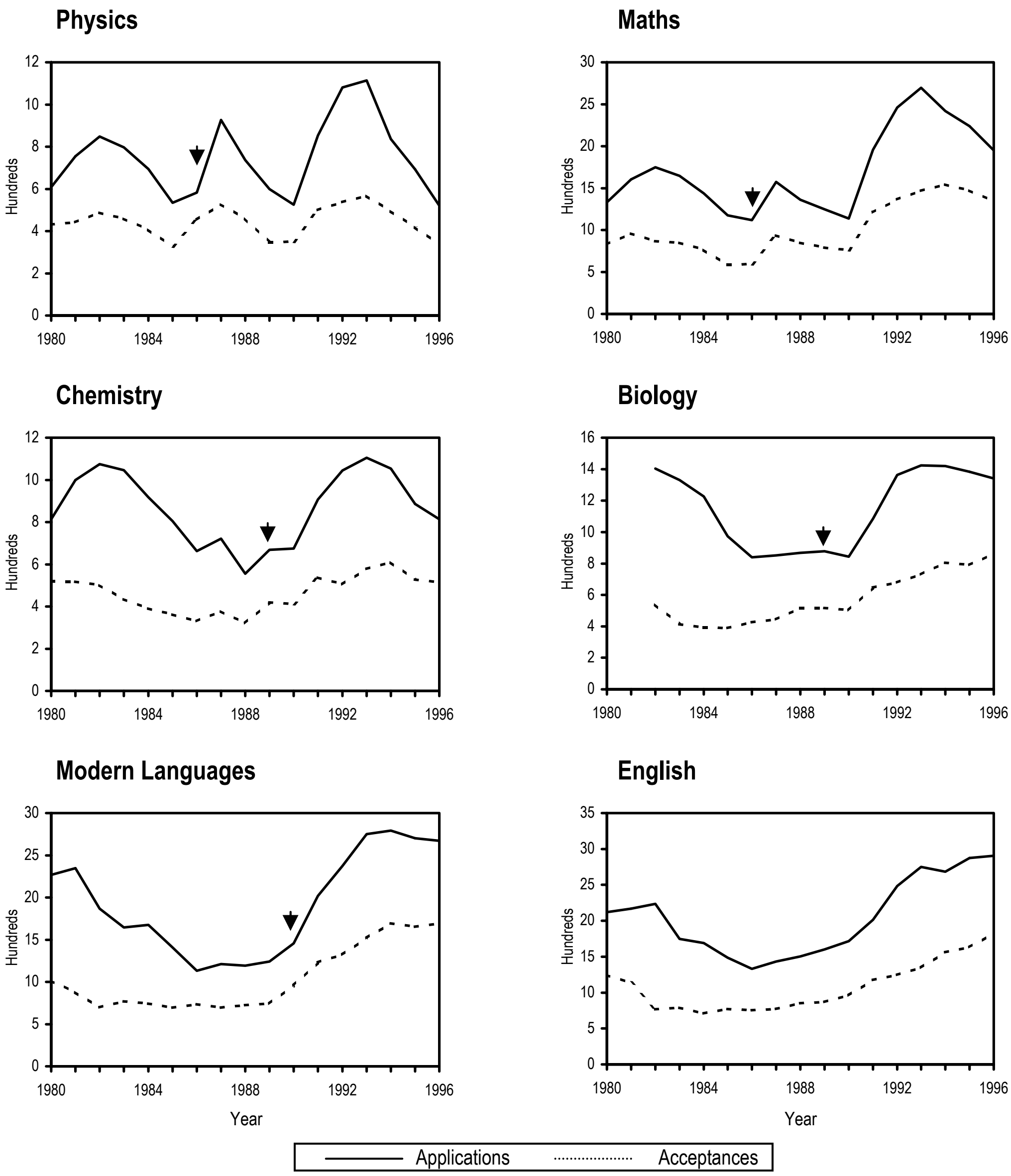


Source: Institute for Employment Research (1996) *Prospects in the Labour Market for the Highly Qualified*.

Teaching

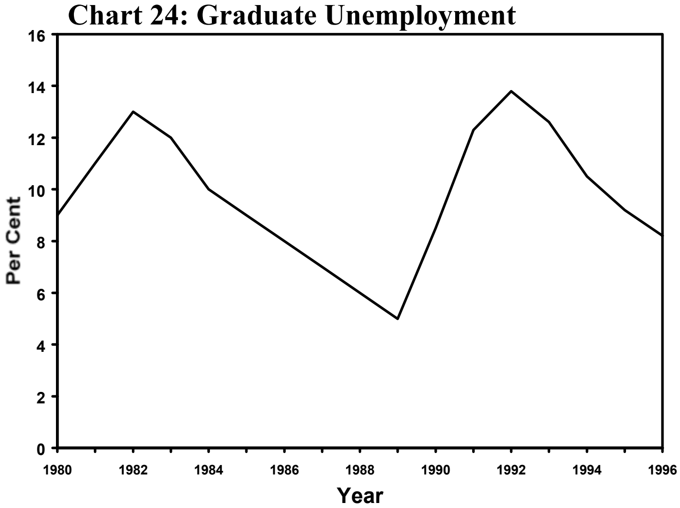
30. One area in which scientists *are* in short supply is teaching. Chart 23 shows the recruitment patterns for six subjects from 1980-1995. Given the odd bump or two associated with the introduction of bursaries (arrows on chart), the overall shapes are remarkably similar. The basic pattern for applicants is redolent of the curve for graduate unemployment (Chart 24).

Chart 23: Teacher Training



Source: Updated from Smithers, A. and Robinson, P. (1991) *Teacher Provision: Trends and Perceptions.* Manchester: CEER.

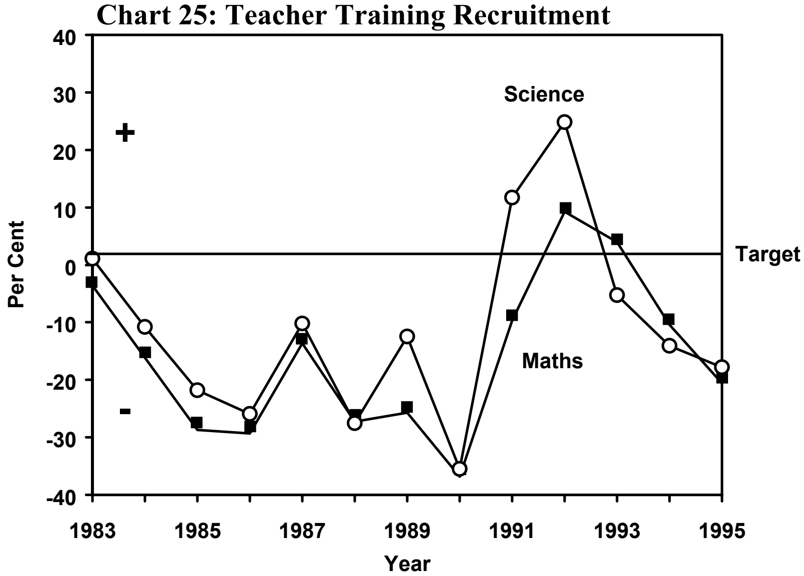
Chart 24: Graduate Unemployment



Sources: *First Destination Statistics, 1980-1994.* Manchester CSU; *First Destination Statistics of Students Leaving Higher Education Institutions, 1994/95.* Cheltenham: HESA.

31. We can see what the effect has been on recruitment to science and maths teaching in Chart 25. Only in the recession years of 1991 and 92 was the science target met, with there being shortfalls of up to 35 per cent at other times. The maths target has also barely been attained in the recession years, with a considerable deficit at other times. Inevitably, in the circumstances, the qualifications tend to be low (Chart 26).

Chart 25: Teacher Training Recruitment



Source: *A Strategic Plan for Teacher Supply and Recruitment, A Discussion Document* (1996). London: TTA.

Chart 26: Degree Classes of PGCE Entrants

Subject	**% Third or Below**
Physics	37.7
Maths	36.5
Chemistry	33.8
Biology	15.2
Geography	7.4
English	6.9
History	5.3

Source: UCET (1993). *First Destination Survey of Students Completing University Courses of Initial Training for the Teaching Profession* (Last year for which these statistics were published).

32. The contrasting situations of physics and English can be understood from the data of Chart 27. In both subjects in 1986 there were about 2400 graduates whose destinations were known. In both cases young women were much more likely to go into teaching than young men, and whereas only about a fifth of the physics graduates were female, two-thirds of the English graduates were. Moreover, both young men and young women graduating in English were more likely to go into teaching. To cap it all whereas English has expanded, physics has been stuck.

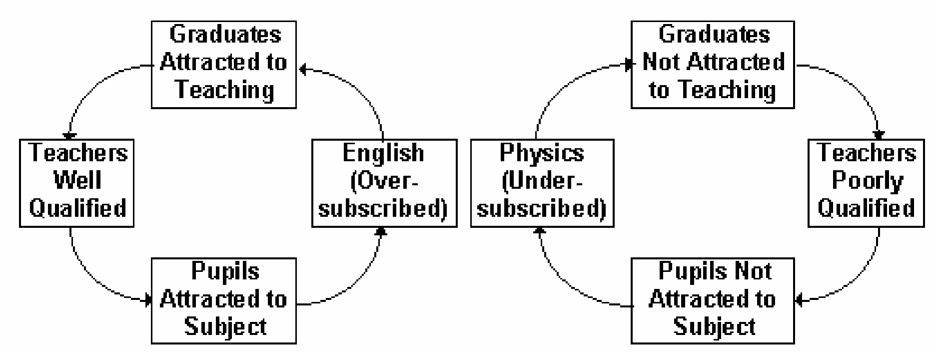
Chart 27: Graduates into Teacher Training

Subject	N		% TT	
	m	f	m	f
Physics	1749	374	5.4	11.8
Maths	1805	955	8.7	19.6
Chemistry	1815	1070	3.9	10.7
Biology	968	1284	4.9	11.1
Geography	1560	1336	4.4	12.4
English	936	2084	7.5	14.4
History	1875	1684	7.0	13.1

Source: *First Destination Statistics.* Manchester: CSU.

33. It is possible therefore to envisage the contrasting feedback loops of Chart 28. In English, graduates are attracted to teaching, those entering the profession are well-qualified, and the quality of teaching may well lead to more young people choosing the subject and university courses being greatly over-subscribed. In contrast, physics graduates are less attracted to teaching, those entering the profession are not always well qualified, and not enough young people are choosing the subject to fill the available university places.

Chart 28: Feedback Loops



Weaknesses of the Present Arrangements

34. What then do the numbers tell us?

16+ Gap

35. The analysis shows that there is a disjunction at age 16**.** Although science participation has been greatly increased at GCSE, it appears to have had little effect on the take-up of A-level physics and chemistry. This may be because GCSEs and A-level really belong to different systems. GCSE is about science for all, a threshold of scientific literacy which enables everyone to share in our scientific culture; A-levels, on the other hand, are a high-level selection device which has enabled us to identify students who could be educated to degree standard in just three years with few dropouts. This suggests that we need to go beyond the separate reforms of the national curriculum, qualifications for 16 to 19 year-olds and higher education to ensure that there is clear articulation between the different stages of education. We need also to strike

an appropriate balance between scientific literacy and identifying the research scientists of the future.

Teacher Recruitment

36. The Parliamentary Office of Science and Technology (1996) has recently reviewed the field and has made some suggestions for remedying the shortfall in the supply of science and maths teachers. It is also worth bearing in mind a consequence of A-levels. Compared with equivalent awards in other countries they are highly specialised with a norm of just three or four subjects. This means that, among other things, they tend to pick out particular personalities and the science specialists tend not to be person-oriented (Smithers and Hill, 1989). In other words, they are not likely to enjoy working with children. It is perhaps not surprising therefore that it is difficult to attract science teachers, especially when teaching is potentially very draining, and we do not have good arrangements for teachers to revitalise themselves in their own subjects.

Expansion of HE

37. Attempts have been made to expand science-based higher education in the last decade beyond the capacity of A-levels and other qualifications to provide. That has involved sucking in students from all directions. Since degree courses have generally remained three years in length, this does call quality into question (Smithers and Robinson, 1996).

R&D Spending

38. The figures also point to under-investment in R&D. This not only reduces opportunities for scientists and engineers to pursue their subjects, and may act to keep down salary levels, but it also sends back signals to schools where pupils are making their choices. Structural changes can provide appropriate channels through school and college to university, but people will only move along them if they are drawn to do so by good prospects.

What Can Be Done?

39. Returning to the four key issues:

Aligning Science Education

40. More effort needs to go into aligning GCSEs and A-levels. This is not just a matter of syllabuses, however, but depends on fundamental decisions about the purpose of science education and whether the emphasis at particular ages should be on generally informing, or educating the professionals of the future. Education 14-19 is likely to be the age range in which the emphasis shifts so the dovetailing of qualifications may not be easy. It will be interesting to see what effect the 1994 revision of the double-award syllabus has had on choice of, and performance at, A-level.

41. We also need to look to before and after education 14-19. I would argue there is a strong case for ensuring all pupils reach a certain standard in English and maths before going up to secondary school. This would give everyone the chance of making a good start there. By the age of 16 young people are wanting to go off in different directions, but there are sound arguments for more breadth in sixth form studies. The most flexible way of achieving this would be to move to a norm of five subjects. This would cause all students to think seriously about breadth without being unduly prescriptive. It would

provide a better platform for university studies and might even bring more people-oriented students through to the sciences.

Science Teachers

42. Other ways of attracting more science teachers would be to pay them more and by increasing the intrinsic satisfactions of the job through regular sabbaticals. If it was love of the subject that brought them to science in the first place they won't want to lose touch with it. Too much of the in-service education of teachers is based in education departments rather than the subject departments.

Quality

43. It will also be necessary to decide appropriate levels of investment in science both in terms of people and the subjects. As the financial support for university students changes it may be possible to devise a system which would lead to more of the most talented students thinking seriously about the sciences - perhaps through merit scholarships or remitting loans. The problem of recruitment to the sciences may be more one of quality than quantity. Our engineering courses are now spread over 105 departments though not all have the recognition of The Engineering Council. There may well be a case for greater concentration of resources. During the past decade universities have been funded (inadequately) for growth, but now there is a need to think more about quality.

Investment

44. As regards R&D, world comparisons suggest we are not investing enough. We are educating sufficient scientists and engineers to provide more R&D professionals, but we cannot afford to employ them. While there may be benefits from having science and engineering graduates spread throughout the workforce, if they are not using their talents in fields where they want to use them, it is a waste. It is to be hoped that the government's *Forward Look* (1995) at science, engineering and technology will lead to some sensible decisions about appropriate levels of investment.

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