

The Supply and Demand for Science, Technology, Engineering and Mathematics Skills in the UK Economy

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Technology, Engineering and
Mathematics Skills in the UK Economy*

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Key Findings

The findings have been broken down into three broad sections; Supply, Demand and the balance between the two now and in the future.

Supply:

- The UK's stock of science and Engineering graduates compares well internationally.
- The stock of graduate scientists in the UK labour force is increasing at a steady rate.
- Women and minority ethnic groups are forming an increasing proportion of STEM graduates.
- The entrants to higher education are also quite steady, but there are falling numbers of UK-domiciled degree entrants in Engineering and the Physical Sciences, particularly Chemistry.
- The flow of A-Levels qualifiers in some STEM subjects is declining, particularly Mathematics; STEM A-levels have an important role in progression to STEM at higher education.
- Evidence suggests the quality of STEM subjects are increasing; there are consistently more firsts, and A grades at A-level, awarded for STEM relative to non-STEM subjects.

Demand:

- Physics, Chemistry and Engineering graduates have higher lifetime earnings than the average graduate.
- There are high returns to Mathematics and Computing qualifications, with high and increasing returns to Engineering.
- Projections suggest that the demand for workers with professional level skills in Science and Engineering is likely to increase over the next 10 years.

Demand/Supply Balance:

- Currently there are skills shortages and gaps prevalent in Engineering and Health associate professions and for Draughtspersons & Building Inspectors.
- The projections of the stock of Science and Engineering graduates suggest they will rise substantially by 2014.
- These gains vary by subject, with lower growth in the numbers of Engineers and Physical scientists and higher growth in Medicine and the Biological Sciences.
- Most STEM graduates are using their 'knowledge' and 'skills' in their employment though those in Natural Sciences make relatively less use, at least in the first two years after graduation.

INTRODUCTION

1. This paper sets out an analysis of the trends in the current and prospective supply and demand of Science, Technology, Engineering and Mathematics (STEM). It refers to and builds upon a previous report by the DTI; *Science, Engineering and Technology Skills in the UK* and presents some new analysis, including the latest data on entrants to STEM at Higher Education (HE), progression from STEM A levels to HE, the quality of STEM skills and the current supply and demand balance of STEM.
2. The paper has been split into three broad sections. The first examines the current supply of STEM in the UK economy. It looks at the stocks and flows of STEM subjects into the labour force, the quality of these skills, and how the UK compares internationally on the supply of these skills. The second section examines the demand for STEM skills – using earnings, returns to STEM qualifications and rates of employment assess current demand and considering employment projections to paint a picture of the future. The final section brings the first two together, to assess the extent to which the supply of these skills is likely to meet increases in the demand for them over the next 10 years.

A: SUPPLY OF STEM

3. The current shape and recent trends in supply of STEM must be examined to help determine whether or not supply will satisfactorily meet the demand now and in the future. Within this section the stock of graduates in the UK workforce will be examined. Most of the analysis in this section is taken from a previous DTI report¹, but we extend it by examining the recent trends of entrants to HE in Science, Technology, Engineering and Mathematics (STEM).

The stock of graduate scientists is steadily increasing

4. Table 1 provides a measure of the stock of first degree graduates in the working age population, in the UK. From 1997 to 2004 there has been an increase of 57% in the estimated number of STEM graduates to 2.1 million.² The corresponding increase of 49% in non-STEM subjects shows a higher growth for STEM than for non-STEM. As a proportion of the working age population STEM graduates have increased from 4% to 6% and as a proportion of all graduates in the working age population they have increased slightly from 43% to 44% in the time period.
5. In Figure A1 (See Annex A), the stock of graduates in STEM in the UK is broken down by the subjects they study. Engineering has historically been

¹ *Science, Engineering and Technology Skills in the UK* (DTI Economics paper No. 16, March 2006). Available at

<http://www.ecdti.co.uk/CGIBIN/priamlnk.cgi?MP=CATSER^GINT65&CNO=1&CAT='EC01'>

² The LFS has only collected detailed information of the subjects studied within dual degrees from 2004 onwards and so the data presented is on the stock of graduates of single subject degrees only. In 2004 there were a further 500,000 first degree graduates whose main area of study was a STEM subject, raising the total stock of STEM graduates to 2.6 million.

and continues to be the subject with the largest stock of graduates in the population, and the stock of engineers has increased by 21% over this period. In recent years increases in the numbers holding biological sciences, subjects allied to medicine (including pharmacy and nursing), and mathematical sciences and computing degrees of 110%, 98% and 88% respectively have closed the gap somewhat.

Table 1: First degree graduates

		1997	2000	2004	% increase 1997-2004
STEM subjects	Absolute number	1,350,000	1,669,000	2,123,000	57.2%
	As % of working age population	3.9%	4.8%	6.0%	
Non-STEM subjects	Absolute number	1,788,000	2,189,000	2,670,000	49.3%
	As % of working age population	5.2%	6.3%	7.6%	

Source: Science, Engineering and Technology Skills in the UK (DTI March 2006) based on Labour Force Survey, 2004 Autumn data, GB, single subject degrees and working age only (16-59/64)

6. Where sample sizes permit, the LFS can also tell us how these increases have come about at a more disaggregated subject level. The increase in the biological sciences has been partially driven by newer subjects, such as microbiology (111%) with traditional subjects like biology (40%) showing slower growth. Psychology graduates are a significant component of biological sciences. All psychologists, including those who studied it as a social science, are now classified within the data as biological sciences. This reclassification is partly responsible for the 110% growth in biological sciences between 1997 and 2004. However, biological sciences would still have increased by 64% when psychology is removed³. Within the mathematical sciences and computing it is computing that accounts for most of the growth (144%) rather than those mathematics/statistics graduates. Chemistry and Physics graduate numbers only grew by 24% and 20% respectively, whilst physical/environmental sciences graduates overall grew by 41%. There is also a mixed picture within engineering. Production & manufacturing systems engineering graduate numbers grew by 45% and civil engineering numbers by 44%. Meanwhile, general and chemical engineering numbers grew 13% and mechanical engineering numbers just 5%.⁴

7. The supply of doctorates is also important to the needs of the science base and the wider economy. Doctorate level qualifications reflect more

³ The removal of psychology reduces the growth in STEM graduates from 57% (as reported in Table 1) to 51% between 1997 and 2004.

⁴ Source: *Science, Engineering and Technology Skills in the UK (DTI March 2006)* based on Labour Force Survey, Autumn data, GB single subjects only and working age only. Growth factors for these more disaggregated subject groupings are biased slightly downwards, because there was also an increase in the numbers of graduates allocated to a major subject grouping, but not to a minor one.

specialised STEM skills and are requested as a prerequisite to some jobs in STEM intensive businesses, particularly those involved in R&D.

8. Between 1997 and 2004 there has been an increase in the proportion of those in the working age population holding doctorates in STEM subjects of 40%, as shown in Table 2⁵. Again the corresponding increase in non-STEM subjects is slightly lower, at 37%

Table 2: Holders of doctorates

		1997	1999	2001	2004	% increase 1997-2004
STEM subjects	Absolute number	127,000	169,000	140,000	178,000	40.3%
	As % of working age population	0.37%	0.49%	0.41%	0.50%	
Non-STEM subjects	Absolute number	33,000	43,000	43,000	46,000	37.4%
	As % of working age population	0.10%	0.13%	0.12%	0.13%	

Source: Science, Engineering and Technology Skills in the UK (DTI March 2006) based on Labour Force Survey, Autumn data, GB, single subject degrees and working age only

Women and ethnic minority groups form an increasing proportion of STEM graduates

9. Traditionally only a small proportion of STEM graduates have been female. Since 1997 women have formed an increasing proportion of STEM graduates in all subjects apart from mathematical sciences and computing (Table A1 in Annex A). Overall the female proportion of the stock of STEM graduates has increased from 27% to 36% between 1997 and 2004. The biggest increases have been in biological sciences, medicine and the physical and environmental sciences of 11, 7 and 7 percentage points respectively. The female proportion of STEM graduates still falls well below the non-STEM figure of 53%. In particular the proportion of mathematical sciences and computing graduates has fallen 2 percentage points to 25%, but the weakest female representation occurs in engineering where, despite an increase of 3 percentage points, only 7% of graduates are female.
10. The ethnic composition of STEM graduates is changing too. Table A2 (within Annex A) shows the proportion of non-white STEM graduates has risen from 9% to 12% between 1997 and 2004, compared to slower growth among all those in the working population from 8% to 9%. The relative increase in ethnic minority STEM graduates has been spread across the four main ethnic groups (Asian or Asian British, Black or Black British, Chinese and mixed).

The flow of First Degree entrants in STEM is relatively steady

11. Despite this position of relatively steady growth in the stock of graduates in

⁵ These figures should be treated with caution due to the relatively small sample of doctorate holders interviewed by the LFS.

the UK, long term skill deficiencies may also arise if the flow of those from HE is declining. Thus to gain a clear picture as to the supply of STEM skills it is necessary to observe the entrant numbers studying for degrees in STEM subjects. The supply of HE is analysed here with only the use of entrant data to highlight recent trends.

12. Analysis on the absolute numbers of first degree entrants to STEM subjects (see figure A2) shows Engineering & Technology and Physical Science entrants (including Chemistry and Physics) has fallen. Chemistry entrants have also fallen, whereas entrants to Physics appear to be relatively constant over the period. The most recent data for Computer Sciences also shows sharp fall but it is too early to tell if this is a trend. Subjects Allied to Medicine have had quite large increases in entrants over the period. All other STEM subjects have stayed relatively constant over the period 1994/95 to 2004/05.
13. However, there is also a need to take into consideration the expansion of HE during this period and look at STEM subjects as a proportion of all subjects taken for first degree.
14. STEM first degree entrants in Physical Sciences (Chemistry and Physics included), Engineering & Technology and Architecture, Building and Planning have all fallen as a proportion of all entrants (see figure A3). More recently there has also been a decline in Computer Studies.

The Flow of Foundation Degrees in STEM is making a promising start

15. Foundation degrees were launched in 2001 – and entrants have grown rapidly to nearly 15,000 in 2004/05. Although too early to identify trends in the composition of foundation degrees, the early signs are encouraging (see figure [A4]). The proportion undertaking STEM qualifications has remained relatively constant.
16. Still, the proportion of entrants by subject area (see figure [A8]) highlights that the overall proportion of STEM entrants is lower in foundation degrees than both HNC/ HND and First Degree qualifications – although this disguises significant variation at the individual subject level where for example foundation degrees have a larger proportion of Engineering & Technology and Computer Science than first degrees..
17. Although it is still early for Foundation Degrees it appears encouraging that the proportion undertaking STEM are similar to First Degrees and that on the whole STEM subjects are also keeping up with the general increase that Foundation Degrees.

A-level a key element of the decision to pursue STEM in Higher Education

18. This section looks at the progression from STEM A-levels into the same subject area at HE.

Table 3: Progression from A-level to Higher Education

A-level Subject Area of study (two or more in given area)	STEM	English, Languages & Arts	Social Sciences & Humanities ⁶	All A-level subjects (2 or more attained)
Propensity to enter HE by 19 (2003)	91% (92%) ⁷	83%	87% (86%) ⁸	82%
Propensity to enter HE by 19 (2005)	92% (93%) ⁷	84%	88% (87%) ⁸	83%

Source: Youth Cohort Study 10 (2003) and 11 (2005). STEM here does not include sports science. A level attained by academic age 18 and HE subject of study is measured at 19; this includes those who took a gap year after A-levels but not those who drop-out prior to 19.

19. The Youth Cohort Study shows that those with A-levels have a very high probability of progressing into HE even by 19. If this relationship is maintained, the trends in A-levels will have quite an impact on the eventual numbers entering HE. Looking at broad subject areas, those with Mathematics and Science A-levels appear to have an even higher propensity to progress into HE⁹ than in other subjects.

20. However, do those with STEM A-levels actually progress to undertake the same subject area in HE? Table 4, below, shows of those with two or more STEM A-levels who progress to first degree, nearly three-quarters pursue STEM subjects. The exclusion of Psychology (shown in brackets) appears to make little difference to the findings here, the strong progression relationship in STEM subjects still holds. Although comparisons with progression rates from other subject groups are difficult, these progression rates appear similar.

Table 4: Area of study at both A-level and first degree

STEM A-levels	Proportion of first degree participants taking STEM	
	Cohort 10 (2003)	Cohort 11 (2005)
2 or more	73% (71%) ⁷	73% (75%) ⁷
one	56% (54%) ⁷	51% (53%) ⁷

Source: Youth Cohort Study 10 (2003) and 11 (2005). STEM here does not include sports science. A level attained by academic age 18 and HE subject of study is measured at 19; this includes those who took a gap year after A-levels but not those who drop-out prior to 19.

21. This indicates that trends in the numbers with A-levels in STEM may have quite strong effects upon those who then enter HE to study STEM.

⁶ This does not include General Studies

⁷ Figure does **not** include psychology

⁸ Figure does include psychology

⁹ This does not control for other factors, eg prior attainment at GCSE or type of school (e.g. private schools may do more STEM subjects and therefore individuals have higher propensity to enter HE due to type of school and not because of the subject of study)

The flow of A-Levels in some STEM subjects are declining, particularly mathematics

22. The trends in those pursuing HE STEM qualifications will depend on the numbers taking pre requisite Level 3 qualifications in STEM. A-levels are the traditional feeder to degree courses¹⁰, as well as to technician-level STEM occupations, and also present the first opportunity for choice in whether or not to study STEM.
23. In absolute numbers, Mathematics has declined (see figure A9) over the entire period shown but in more recent years numbers have stayed relatively constant¹¹. Physics has shown a decline over the years 1996 to 2005, with Computer Studies also in decline in the last few years. Design & Technology has increased over the period shown as well as ICT in more recent years; from 1999 onwards. All other STEM subjects shown have stayed relatively constant.
24. The STEM A-level subjects as a proportion of all subjects (see figure A10) show sizeable decreases for Mathematics, Chemistry, Physics, with Biological Sciences also in decline over the period 1996-2005. In more recent years computer studies has also decreased but Chemistry has remained relatively stable. All other subjects have stayed relatively constant, apart from Design & Technology which is the only subject to have increased its share.

'Traditional' forms of study of STEM varies by subject

25. The analysis so far has only looked at those who have entered HE by 19 and with A-levels. The next section looks at the age composition of those entering HE to study a STEM subject and also the mode of study; whether enrolled full-time or part-time.
26. Analysis on the age on entry for a first degree (see figure A11) shows the different composition of STEM subjects by age upon entry. Subjects Allied to Medicine have a higher percentage of entrants entering at 30+ years of age, compared to all other STEM subjects and also compared to all first degree courses. The subject areas of Veterinary Science, Mathematical Sciences and the Physical Sciences (which includes Chemistry and Physics) have much higher proportions than both other STEM subjects and all HE subjects of their students entering under 21 years; a more 'traditional' entry.
27. Analysis on entry to STEM first degree subjects by mode of study (see figure A12) shows that the majority of STEM subject areas have a higher proportion than all HE first degrees to be studied full-time. Exceptions to this are Subjects Allied to Medicine and Architecture, Building and

¹⁰ Other vocational level 3 qualifications are also used for entry to university courses, but limited data exists on the actual subjects studied by individuals for these.

¹¹ A sharp decrease in the number of students getting an A level in Mathematics in 2002 is due to large numbers dropping out of AS level Mathematics in 2001. However those who remained were on average more able students - reflected in figure A14 by the sharp increase of A grades.

Planning. It is not clear whether this reflects demand or supply.

Quality of skills: Numbers getting top grades is consistently higher in STEM

28. Imperative for the vision for world class research outlined in the 10 year Science and Innovation Framework is not only the quantity but the quality of STEM skills. One imperfect method of measuring quality is to look at the grades of STEM over time and relative to non-STEM subjects. Figure A13 (see Annex) shows the percentage of first class degrees has steadily risen for STEM subjects; over the period 1997/98 to 2004/05. However there has also been an increase in firsts for non-STEM subjects. The proportion of STEM first degrees awarded has though been consistently higher and in recent years the gap has grown to about 4 percentage points.
29. The relative quality of achievements of those studying A-Levels is also higher in STEM. Figure A14 shows the proportion of students getting A-grades in a variety of STEM subjects in the past 10 years. The rate of increase in A-grade achievements is similar in STEM and non-STEM subjects¹² but the average in chemistry, physics and mathematics is consistently higher.

The UK's STEM graduate stock compares well internationally

30. Whilst our stocks and flows of STEM graduates appear to be quite steady, it is important to see how well we compare internationally to help determine whether or not the current supply of STEM graduates is sufficient to maintain a highly productive research position in the face of growing international competition. Figure A15, looking at the proportion of STEM graduates in the workforce between 25 and 34 years of age shows that our stock of STEM graduates compares relatively well internationally. We are well above the OECD average, ranked 5th ahead of Germany, Japan and the United States, but behind France on this measure of STEM skills.
31. Looking now at how our position is changing over time relative to other countries figure A16 shows a similar measure of graduate stock (aged 20-29 this time) over the period 2000 to 2003. Of the countries examined here the UK has had the largest increase in both the absolute number of STEM graduates and as a proportion of growth. By this measure the stock of 20-29 year old STEM graduates in the UK has increased by 16%. We are pulling away from those behind us and catching up with the French.

B: DEMAND FOR STEM SKILLS

32. The demand for STEM skills can be measured by the benefits that accrue to those who possess them. The returns to STEM skills relative to lesser

¹² A sharp increase in the number of students getting an A in A level Mathematics in 2002 corresponds with the sharp decrease in numbers, shown in figure A9, and can be interpreted as a one-off effect of the introduction of a new mathematics AS Level.

qualifications, estimated lifetime earnings profiles and unemployment rates of STEM graduates will all give an idea of how in demand scientists and engineers are. Employment projections will give some idea as to how the demand for STEM skills will appear in 10 years time.

There are higher graduate earnings premium for Medicine, Physics, Chemistry and Engineering compared to all degrees.

33. Table 5 shows the estimated additional lifetime earnings of graduates -the difference in the present value of the after tax employment lifetime earnings, of degrees in certain subjects compared to holding 2 or more A-Levels¹³.

34. Research suggests that the subjects of Medicine (£346,000), Physics (£188,000), Chemistry (£186,000) and Engineering (£220,000) all have significantly higher lifetime earnings benefit than that on average (All Degrees £129,000) suggesting that the demand relative to the supply of these skills are higher than average. The cost to the student across subjects is largely uniform although the public subsidy (via the Higher Education Funding Council) varies significantly.

¹³ This analysis holds other factors constant that might influence lifetime earnings, such as personal, regional and job related characteristics

Table 5: Total costs and revenues associated with obtaining alternative degree level qualifications

	Public and Private Investment in Higher Education					
	Individual			Exchequer		
	Direct and Indirect Costs	Additional Discounted Net Lifetime Earnings	Rate of return	Subsidy	Additional Discounted Lifetime Taxation*	Rate of Return
Law	-£24,026	£246,367	17.2%	-£15,624	£171,712	19.3%
Management	-£24,026	£152,947	16.9%	-£15,624	£107,405	19.7%
Engineering	-£32,809	£219,971	15.5%	-£30,742	£155,104	13.1%
Chemistry	-£28,037	£186,307	15.0%	-£26,705	£132,305	12.1%
Physics	-£26,661	£188,249	14.9%	-£25,156	£133,852	13.0%
European Languages	-£32,809	£163,466	14.0%	-£21,167	£117,769	16.6%
Soc. Sciences (ex Law and Psych)	-£24,026	£154,135	13.5%	-£15,624	£109,219	16.2%
Medicine (ex Dentistry)	-£53,165	£346,156	11.6%	-£78,126	£255,045	7.8%
Biological Sciences	-£24,026	£109,845	10.2%	-£22,762	£82,135	9.5%
Psychology	-£24,026	£100,479	10.1%	-£18,682	£74,079	10.9%
Linguistics/English/Celtic Studies	-£24,026	£92,797	9.7%	-£15,624	£68,330	12.1%
History	-£24,026	£89,630	8.8%	-£15,624	£65,471	10.4%
All Degrees (currently)	-£26,208	£128,771	12.1%	-£21,218	£92,781	12.1%
All Degrees (following current student finance reforms)	-£22,974	£125,315	13.2%	-£24,556	£95,388	11.0%

Source: *The Economic Benefit of Higher Education Qualifications produced for The Royal Society of Chemistry and the Institute of Physics by PricewaterhouseCoopers LLP January 2005*

There are high returns to engineering, mathematics and computing.

35. Table 6 shows the estimated returns to degrees in certain subjects between 1993 and 2002 compared to holding 2 or more A-Levels, holding other factors that might influence them constant. Thus each percentage in the table represents the extra earnings of someone holding a degree over a similar individual whose highest level of attainment is 2 A-Levels.

36. The returns to medicine, engineering, maths and computing are high relative to A-Levels. The returns to the physical sciences and especially biological sciences are lower. Interestingly only the returns to medicine and engineering have been increasing throughout the period, with an increase in the returns to an engineering degree above 2 A-Levels from 19% in 1993 to 26% in 2002. This suggests demand might be exceeding the supply of engineering graduates, perhaps partially driven by the decreasing supply of graduates with engineering skills.

37. It is worth remembering here that there are probably unobservable differences that are associated with subject choice that might also be related to earnings. Thus these returns may not just be the returns to these subjects but also to these unobservable characteristics.

Table 6: The return to degrees by subject relative to holding 2+ A-levels

Subject group		1993	1996	1999	2002
STEM subjects	Medicine	24%	22%	27%	29%
	Engineering	19%	20%	23%	26%
	Maths	23%	25%	26%	25%
	Computing	24%	21%	29%	24%
	Physical science	18%	12%	14%	16%
	Biological science	9%	9%	7%	11%
	Architecture	16%	8%	10%	10%
	Agricultural science	15%	12%	7%	2%
Non-STEM subjects	Law	32%	24%	39%	31%
	Business	31%	22%	22%	25%
	Education	24%	20%	18%	17%
	Social science	10%	15%	11%	13%
	Languages	18%	13%	8%	8%
	Librarian	*	*	*	*
	Arts & Humanities	9%	*	*	*

Source: *Science, Engineering and Technology Skills in the UK (DTI March 2006)* based on McIntosh, chapter 8 of *What's the good of education? The economics of education in the UK*, eds. (Steve Machin and Anna Vignoles, 2005)
 * indicates a return not significantly different from zero

38. The DTI find that only 46 per cent of STEM graduates are employed in STEM occupations¹⁴. Since STEM graduates don't all progress to STEM occupations it is of interest to examine the differences in earnings between those that do and those that don't. Figure A17 (a) shows estimated gross weekly earnings for STEM graduates in STEM¹⁵ jobs, teaching, and other occupations. The earnings are similar for all three groups, with teaching being the lowest both in 2001 and 2004. The wages of those in STEM occupations have increased the most, suggesting that the incentive for STEM graduates to go into STEM occupations is increasing. Looking at the same figures for non-STEM graduates in figure A17 (b) shows that they earn a lot less in STEM occupations, as you would expect, and less in teaching too.

Earnings for STEM graduates are increasing over time

39. Figure A18 shows the variation of annual average earnings of graduates, four years after graduation, by subject area. The subject areas of Mathematics & Computing and Medicine & related subjects have two of the highest average annual earnings for both men and women. Law was the only subject that was greater and this was only for men. Natural Sciences are found to have relatively low average earnings, especially for women. The earnings for this subject are comparable with the subjects like Social Sciences and Languages. The other STEM subject area;

¹⁴ From *Science, Engineering and Technology Skills in the UK (DTI March 2006)* based on Labour Force Survey, Autumn 2004 data

¹⁵ The following have been classed as science, engineering and technology jobs: science professionals, engineering professionals, ICT professionals, architects, town planners, surveyors, science and engineering technicians, draughts persons and building inspectors, health professionals and health associate professionals.

Engineering, is also fairly comparable with the other subjects (both STEM and non-STEM), although women appear to earn less, on average, in this subject area.

40. Figure A19 shows the average earnings gain by subject for the graduates in 1995 and 1999, using Social Sciences as the reference¹⁶. Maths & Computing had a nearly 15% earnings gain in 1995, compared to Social Science, however this has now dropped to just 10% for the 1999 graduates. Medicine, which had strong gains in 1995, has further increased its earnings gain to over 20% compared to Social Science. Engineering has stayed relatively stable between the two cohorts at around 7-8%. Science graduates are found to earn 3% less relative to Social Science graduates in 1995 but are insignificantly different for those in 1999. This has interesting implications for the changing balance between the demand for and supply of STEM graduates. It suggests that doctors, teachers and engineers have become more in demand whilst demand has fallen in different degrees for those with maths, computing and business degrees.

Unemployment of STEM graduates is similar to non-STEM

41. Figure A20 shows Maths, Natural Science and Engineering graduates have a higher chance of being unemployed for 6 months or longer following graduation compared to Medicine (base case), holding other things constant such as age, social class, degree class and type of institution. These three subject areas were all fairly even compared to each other and also with most other non-STEM subject areas, apart from Arts graduates, where there was a much higher chance of being unemployed for 6 months or more.

Projections suggest that the demand for workers with STEM skills is likely to increase

42. The Leitch Review looks into projections of the overall skills requirements of the economy to 2020. However it didn't break up the broad occupation types into the further detail that would be necessary for looking at employment in STEM occupations. Instead projections of employment, drawn from *Working Futures 2004-2014*, in some STEM occupations in 2014 can be seen in Table 7.
43. These projections suggest an increase in the demand between now and then for science and technology professionals and science and technology associate professionals of 18% and 30% respectively, compared to an increase for all other occupations of 4%.
44. These employment projections must be treated with a certain amount of caution. They indicate the most likely future, given a continuation of past patterns of behaviour and performance and include assumptions about what will happen to supply. They are not necessarily therefore a true

¹⁶ First 8 subjects statistically significant at 5% interval, except Education 1995 which is significant at 10% and Science which is not significant for 1999.

projection of what demand for STEM skills might be.

Table 7: Projected employment in STEM occupations in 2014¹⁷

	Science and Technology Professionals (SOC code 21)	Health Professionals (SOC code 22)	Science and Technology Associate Professionals (SOC code 31)	Health Associate Professionals (SOC code 32)	All other occupations (All other SOC)
2004 (baseline)	947,000	277,000	593,000	1,045,000	26,449,000
2014 (forecast)	1,121,000	360,000	666,000	1,122,000	27,314,000
Change (%)	18%	12%	30%	7%	4%

Source: Science, Engineering and Technology Skills in the UK (DTI March 2006) based on SSDA Working Futures 2004-2014

C: EXTENT THAT SUPPLY IS LIKELY TO MEET INCREASES IN INCREASES IN DEMAND FOR STEM SKILLS

45. Having examined the current situation on the supply of and demand for STEM skills, and looked at possible future developments in demand it remains to determine whether or not the current trends of supply of STEM graduates are sufficient to meet this demand and whether or not, on current trends, they will be in 10 years time.

Skills shortages and gaps are prevalent in science and engineering professions

46. Recruitment difficulties in STEM occupations can be seen as an indicator of the balance between demand and supply. The National Employer Skills Survey (NESS) records skill shortage vacancies and can report them for occupation types.

47. There are two measures of recruitment difficulty that are used in this analysis: the **number of skill shortage vacancies** (SSVs) in the occupational group and the **density of skill shortage vacancies** – i.e. the measure of skill shortage vacancies per 1,000 employees in the occupational group.

48. The table 8 (below) gives details of these measures; the highlighted figures represent above-average indicators.

¹⁷ These estimates do not include the possible impact of Government policies to promote the number of people with STEM skills, nor the target to increase research and development to 2.5% of GDP by 2014.

Table 8: Science, Technology, Engineering and Mathematics occupations

Occupation area ¹⁸	No. of SSVs	SSVs per 1,000 in workforce
211 - Science Professionals	309	3
212 - Engineering Professionals	3,222	8
213 - Information & Communication Technology Professionals	1,426	4
221 - Health Professionals	425	1
232 - Research Professionals	418	7
311 - Science and Engineering Technicians	1,010	5
312 - Draughtspersons and Building Inspectors	1,128	22
313 - IT Service Delivery Occupations	357	2
321 - Health Associate Professionals	4,320	8
Average of all occupational groups	1,767	6

Source: National Employers Skills Survey (2005)

49. In terms of size, the NESS 2005 data show that two of the STEM occupational groups were above average; the Engineering Professionals Group and the Health Associate Professionals.
50. On the second measure, density, four STEM occupational groups were above the average of 6 skill shortage vacancies per 1,000 in employment (also see figure A21). Draughtspersons/building inspectors had 22 SSVs per 1,000 in employment (second rank of all 81 occupations). Health Associate Professionals and Engineering Professionals each had 8 and Research Professionals had 7 – slight above the average of 6. The remaining five STEM occupations had densities lower than average.
51. In conclusion, three of the STEM groups in particular are experiencing recruitment difficulties. Engineering Professionals and Health Associate Professionals groups register on both the indicators above whilst the intensity of the Draughtspersons/Building Inspectors group is pronounced. This latter group disaggregates to three distinct sub-groups (Architectural Technologist/Town Planning Technicians; Draughtspersons and Building Inspectors) and it would be interesting to know if one of the three is more influential in these data – though this is beyond the scope of our current data. Still, it is notable that five of the nine groups above are experiencing fewer recruitment difficulties than the average of all occupational groups.

Stock of STEM graduates projected to rise considerably by 2014

52. Projections in the supply of those qualified in STEM subjects will depend on a range of factors including the number of individuals undertaking the requisite entry qualifications as well as the propensity to progress. The DTI have extrapolated the stock of STEM graduates using HESA data on new

¹⁸ The data does not allow further disaggregation, and so may hide variation within subject areas.

graduations in the UK which includes both UK and non-UK nationals.

53. Table 9 shows projections of the number of graduates in STEM in 2014. Overall the stock of STEM graduates is projected to rise considerably by 2014 with an increase in STEM graduates of 62% by 2014. The analysis provides subject break-downs. The highest growth, of 113% over the period, is in subjects Allied to Medicine. Biological Science graduates are projected to increase by 77%, Mathematical and Computer Science graduates by 70% but Physical Science and Engineering graduates by just 32% and 36% respectively.

Table 9: Projected stock of STEM graduates in 2014 by subject

Subject group	2004 total population	2014 total population	Percentage change 2004 to 2014
Medicine	138,000	203,000	46.7%
Subjects allied to medicine	302,000	641,000	112.5%
Biological sciences	364,000	643,000	76.7%
Agricultural sciences	50,000	78,000	57.6%
Physical/environmental sciences	345,000	456,000	32.2%
Mathematical sciences and computing	346,000	588,000	70.1%
Engineering & Technology	454,000	617,000	36.1%
All STEM subjects	1,997,000	3,226,000	61.5%

Source: Science, engineering and technology skills in the UK (DTI March 2006); numbers may not add due to rounding

54. This analysis suggests that if past trends continue, and including the contribution of migrants, there will be significant increases in the overall stock of STEM skills.

Not all STEM graduates are progressing to STEM occupations

55. Figures A22 and A23 show the relationship between subjects studied with graduates' employment against time following graduation. For all subjects there is an increase in the use of graduate skills and knowledge within their employment as time progresses. All graduates are also more likely to use their graduate skills, rather than their 'graduate knowledge'. However this is less true for the STEM subject of Medicine and related subjects. After 46 months from graduation, graduates in the subjects that are least likely to be using their graduate knowledge in their jobs are Arts, Humanities, Languages, Social Sciences and also Natural Science. This is the only STEM subject, given the coding that was used in this study, to fare relatively poorly with regards to using their 'graduate knowledge'. This same phenomenon is echoed with the use of 'graduate skills'. All the other STEM subjects; Mathematics & Computing, Medicine and Related subjects and Engineering fared much better with regards to graduates using their acquired knowledge or skills. This suggests that graduates of STEM subjects apart from Natural Sciences are going into jobs that use

their degree skills quite soon after graduation, whereas for Natural Sciences it may either take longer than the other subjects, and or, not so many actually go on to use them.

56. Figure A24 concerns the appropriateness of one's degree to their employment after graduation. Medicine and related subjects were regarded as more appropriate, especially for female respondents, relative to most other subjects. Again, Natural Sciences fares relatively poorly, where their appropriateness of their qualifications to their current job was comparable to subjects like Social Sciences. However, Natural Science is quite a broad subject range; this may not be a true scenario for all the sciences such as Biology, Chemistry and Physics.
57. The Destinations of Leaver from Higher Education surveys graduates on their destination after 6 months of leaving HE. It only includes those who's occupation was known and working in the UK. Figure A25 shows the proportions of graduates in various STEM subjects not going on to degrees in STEM subjects.
58. Subjects that perform relatively poorly with regards to the percentage of respondents who had studied them and not gone into STEM occupations are Biological Sciences (79%), Mathematical Sciences¹⁹ (87%) and Physical Sciences (69%), particularly Physics (67%) within this latter subject area.
59. These projections do not take teaching into account as a STEM occupation, but the stocks and flows of teachers and lecturers are important for the development of future scientists and engineers. From HESA staff records (Tables A3 and A4) the only subjects for which there has been a fall in academic staff are chemistry (10%), physics (10%), mathematical sciences (10%) and engineering (14%). These are also subjects with some of the highest numbers of non-British lecturers, suggesting that the supply of STEM lecturers may not be meeting demand.

Migration is one way to alleviate potential shortfalls in supply

60. Demand for workers with STEM skills can be alleviated by international labour flows. In 2004, 6.9 per cent of STEM graduates resident in Great Britain were foreign nationals, up from 4.1 per cent in 1997. The proportion of all those of working age who are foreign nationals was similar, rising from 4.7 to 6.4 per cent, suggesting that the STEM market is only marginally more likely to attract foreign nationals than average. This incidence of foreign nationals varies by degree subject. The proportion of

¹⁹ Using the classifications that are used for DLHE, STEM occupations have been decided as (Standard Occupational Classification code in brackets) Science professionals (211), Engineering professionals (212), Information & communication technology professionals (213), Health professionals (221), Research professionals (232), Science and engineering technicians (311), Draughtspersons and building inspectors (312), IT service delivery occupations (313) and Health associate professionals (321). Many Mathematical jobs may fall outside of these occupational categories.

medical degree holders who are foreign nationals has increased dramatically, reaching 17 per cent in 2004, compared to just 5 per cent in physical and environmental sciences.²⁰

CONCLUSIONS

61. The overall position of the UK in terms of its stock of STEM skills is a strong one – according to the OECD we compare favourably on the supply of STEM skills and there are signs that the UK's relative position has recently improved further. There is a steady increase in the stocks of these skills and a relatively constant flow of them into the working age population.
62. Breaking down these headline figures by subject reveals an increasing number of UK entrants to HE in subjects Allied to Medicine but falls in entrants to Engineering & Technology and the Physical Sciences (particularly Chemistry).
63. In the immediate future, the fall in numbers taking mathematics and physics A-Levels may reduce numbers progressing from A-level. Whilst the numbers entering Mathematics degrees have remained relatively constant, Mathematics A-Level is a requirement for most Engineering and Physical Sciences degrees and first degree entry to these subjects has been falling in recent years.
64. High returns to subjects like Mathematics, Engineering, Computing and the Physical Sciences suggest there is high (and for Engineering, increasing) demand for graduates with these skills. Returns and estimated earnings for those with Biological Science qualifications are lower, and maybe the demand for these skills is not so high. As students become more aware of the information on earnings and employment prospects we would expect the supply of graduates to respond to these market signals and we should monitor the extent to which this occurs.
65. Projections suggest an increasing demand for STEM skills over the next 10 years. However they do not project by detailed subject and rely on a number of assumptions, in particular the continuation of historic growth in demand for skills.
66. The projections of increases in supply of STEM skills and progression rates to STEM jobs would suggest that, at a broad level, supply is likely to meet the increase in demand for these skills over the next 10 years. However there may be problems with specific subjects. On current trends the increases in supply of engineering and physical sciences are relatively low and with over half the graduates in these subjects not going on to STEM occupations straight away there is a possibility that demand for

²⁰ Statistics on foreign nationals from Labour Force Survey, Autumn 2004, resident in Great Britain, working age and single subject degree holders only, adapted from *Science, Engineering and Technology Skills in the UK* (DTI March 2006).

these skills will not be met by supply. Still, the increasing returns to engineering suggest that the market for these skills is adjusting to the reduced flow.

67. Overall, the UK has a large stock of STEM skills and with a largely steady flow into the labour market is well-placed to take advantage of a likely growing demand in these areas. However, falls in Maths and Science A-levels are a cause for concern and suggest that, if current trends continue, we may see further falls in the number of UK students taking these subjects. In addition, it is not yet clear whether the supply of graduates will respond to the high and increasing wage premiums in particular subjects.

ANNEX A: TABLES AND FIGURES

Table A1: Female proportion of STEM graduates by subject

	1997	2000	2004
Subjects allied to medicine	66%	70%	71%
Biological sciences	47%	47%	58%
Medicine	36%	38%	43%
Agricultural sciences	*	*	43%
Technology	*	24%	35%
Physical/environmental sciences	22%	24%	29%
Mathematical sciences & computing	27%	25%	25%
Architecture and related studies	18%	20%	21%
Engineering	4%	4%	7%
STEM subjects	27%	29%	36%
Non-STEM subjects	49%	52%	53%

Source: Science, Engineering and Technology Skills in the UK (DTI March 2006) based on Labour Force Survey, Autumn data, GB, single subject degrees and working age only

** indicates results not reported due to small sample sizes (less than 10,000 individuals)*

Table A2: STEM graduates by ethnicity

Ethnicity	Population	2001	2004
White	STEM graduates	90.7%	87.7%
	All of working age	91.6%	90.7%
Asian or Asian British	STEM graduates	5.5%	6.6%
	All of working age	4.4%	4.5%
Black or Black British	STEM graduates	1.6%	2.4%
	All of working age	2.1%	2.3%
Chinese	STEM graduates	*	1.1%
	All of working age	0.4%	0.5%
Mixed	STEM graduates	0.8%	1.1%
	All of working age	0.6%	0.8%
Other	STEM graduates	1.0%	1.1%
	All of working age	0.9%	1.2%

Source: Science, Engineering and Technology Skills in the UK (DTI March 2006) based on Labour Force Survey, Autumn data, GB, single subject degrees and working age only

** indicates results not reported due to small sample sizes (less than 10,000 individuals)*

When analysing the nine STEM subject groupings, sample sizes prevent disaggregation into each of the non-white groups identified in Table 3. Instead it is only possible to identify white and non-white groups. The pattern of relative over-representation of non-whites is most pronounced for medicine, followed by mathematical and computing science graduates. This group of individuals are also relatively under-represented amongst agricultural science graduates and technology graduates.²¹

²¹ Source: Labour Force Survey, Autumn data, GB, singles subjects and working age only. Sample sizes too small to allow disaggregation into constituent non-white groups for nine STEM subject groupings.

Table A3: Numbers of permanent academic staff by subject area

Subject	1995-96	2000-01	2003-04	% Change (1995-2003)
Subjects allied to medicine	3,117	4,615	5,178	66%
Biological sciences	4,656	5,493	5,882	26%
Veterinary sciences/agriculture and related	474	498	547	15%
Chemistry	1,642	1,552	1,484	-10%
Physics	1,833	1,765	1,646	-10%
Other physical sciences	1,316	1,537	1,562	19%
Mathematical sciences	2,212	2,130	2,000	-10%
Computer science/librarianship/info science	1,935	2,560	3,018	56%
Engineering/technology/building/architecture	5,700	5,233	4,922	-14%
Social/political/economic studies	6,172	6,787	6,893	12%
Law	1,562	1,794	1,914	23%
Business/administrative studies	3,014	3,504	3,858	28%
Languages	3,965	4,055	4,051	2%
Humanities	3,158	3,458	3,458	9%
Creative arts/design	2,561	3,170	3,634	42%
Education	2,894	3,214	3,545	22%
Unknown and combined subjects	5,098	3,280	5,717	12%
All subjects	51,309	54,645	59,309	16%

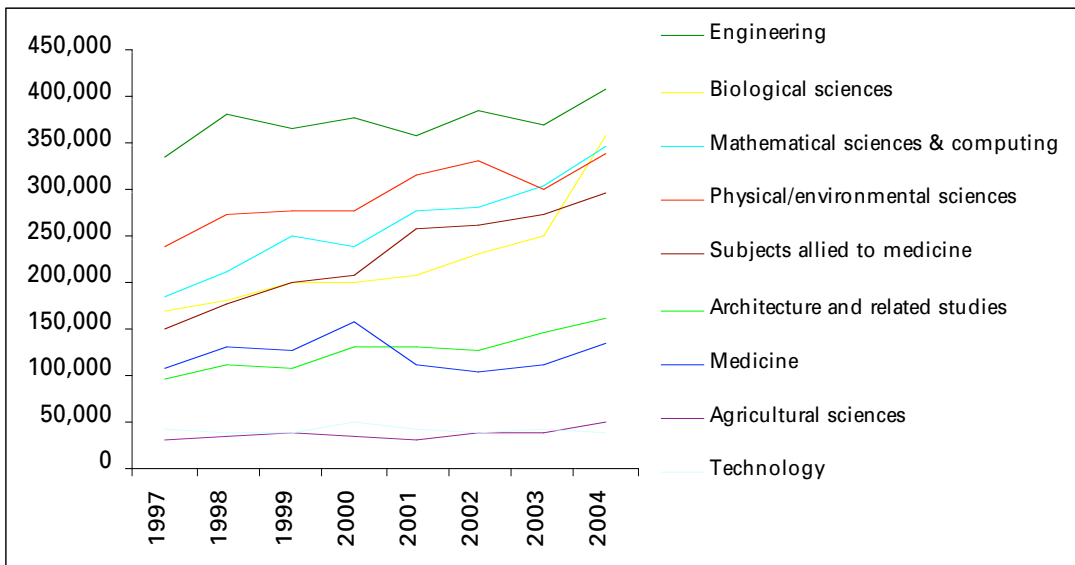
Source: HESA Staff Records

Table A4: Permanent academic staff by subject and nationality, 2003-04

Subject	Number	Total known	% Non-UK national
Subjects allied to medicine	5,178	5,105	8%
Biological sciences	5,882	5,814	10%
Veterinary sciences/agriculture and related	547	542	8%
Chemistry	1,484	1,468	9%
Physics	1,646	1,625	15%
Other physical sciences	1,562	1,541	7%
Mathematical sciences	2,000	1,987	15%
Computer science/librarianship/info science	3,018	2,929	16%
Engineering/technology/building/architecture	4,922	4,820	15%
Social/political/economic studies	6,893	6,731	14%
Law	1,914	1,841	14%
Business/administrative studies	3,858	3,763	11%
Languages	4,051	3,984	19%
Humanities	3,458	3,416	14%
Creative arts/design	3,634	3,499	7%
Education	3,545	3,467	4%
Unknown and combined subjects	5,717	5,329	25%
Total	59,309	57,861	13%

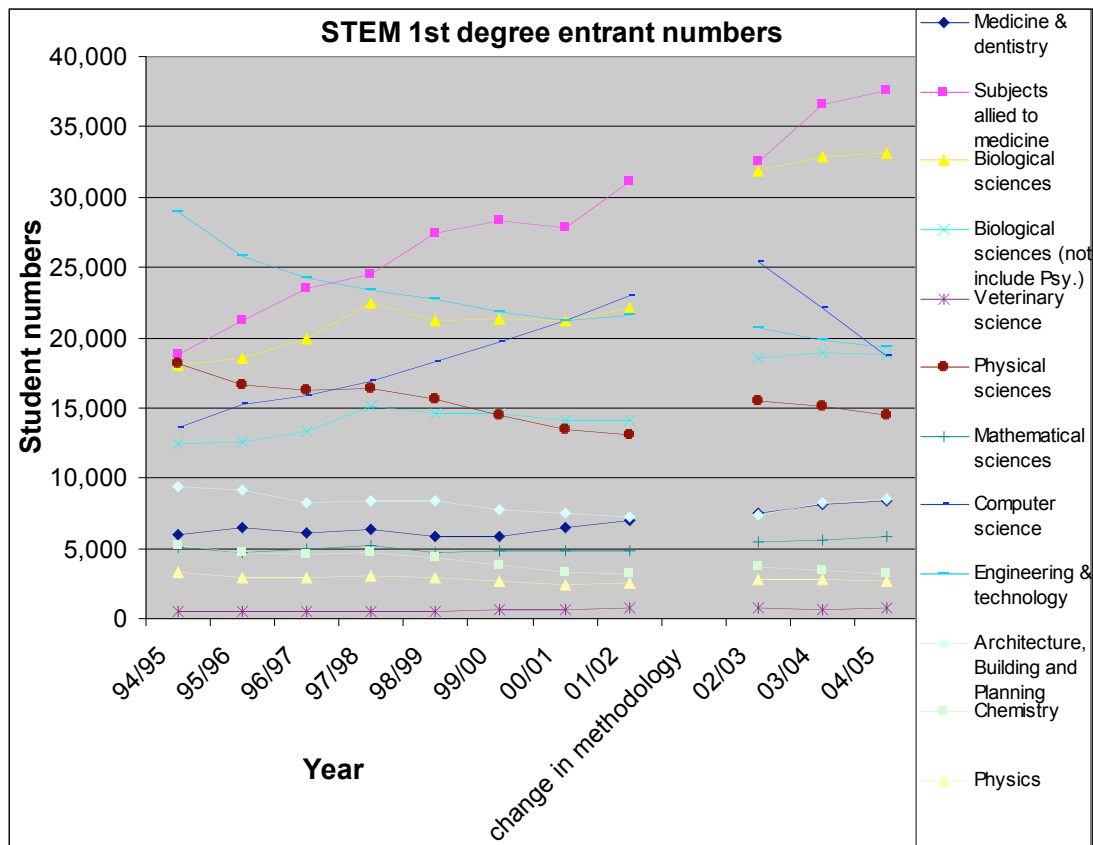
Source: HESA Staff Records

Figure A1: Stock of STEM graduates by subject



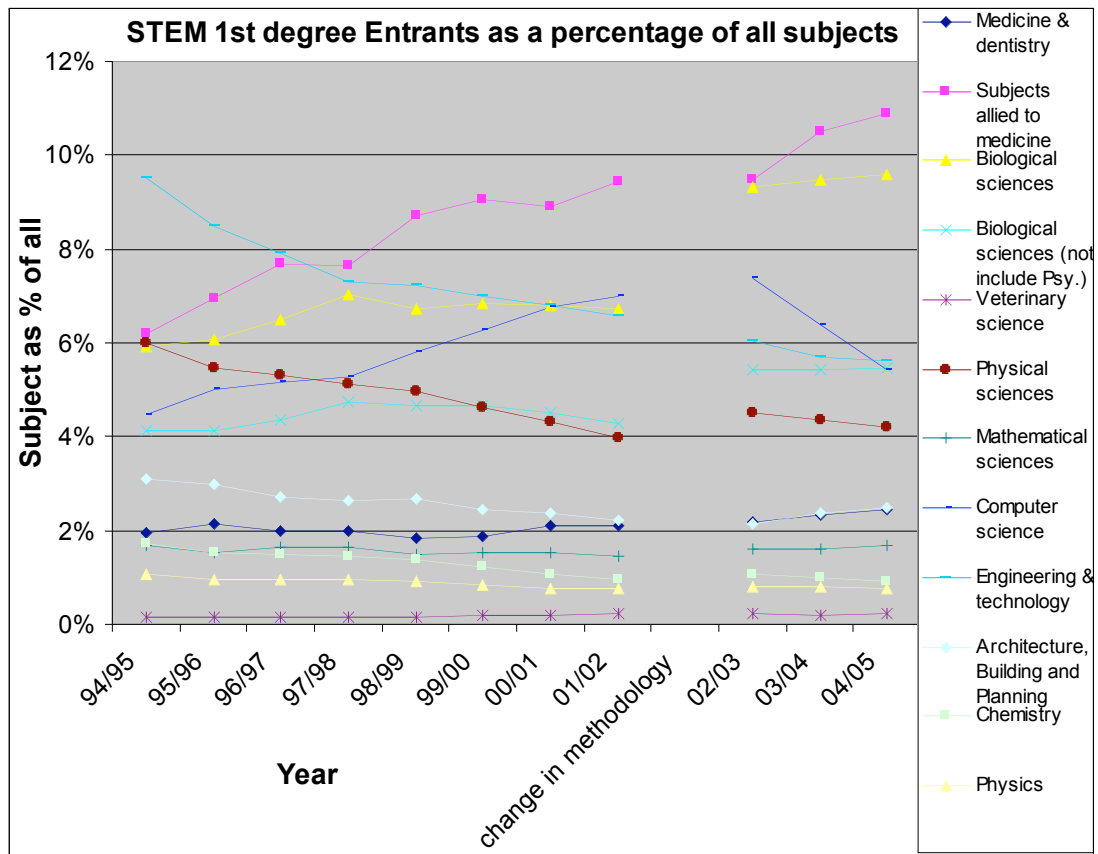
Source: Science, Engineering and Technology Skills in the UK (DTI March 2006) based on Labour Force Survey, 2004 Autumn data, GB, single subject degrees and working age only

Figure A2: First degree entrant numbers by STEM subject area



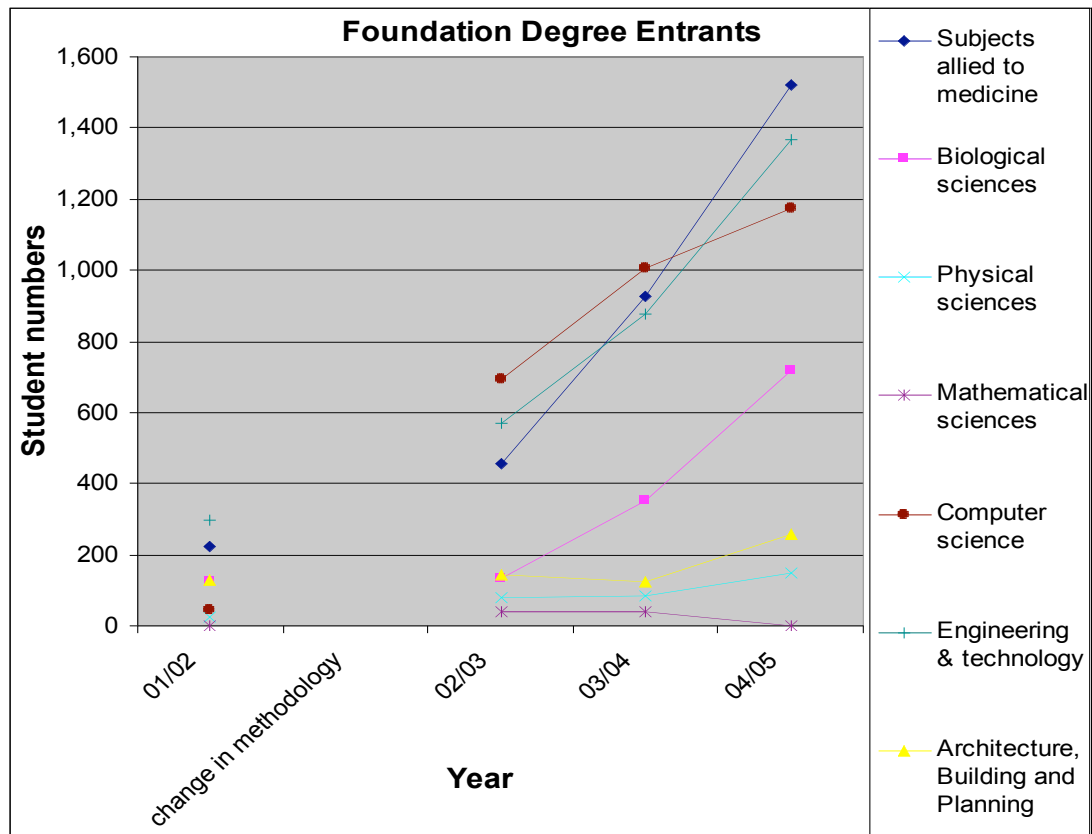
Source: HESA, see Annex B for definition of data

Figure A3: STEM first degree entrants as a proportion of all entrants



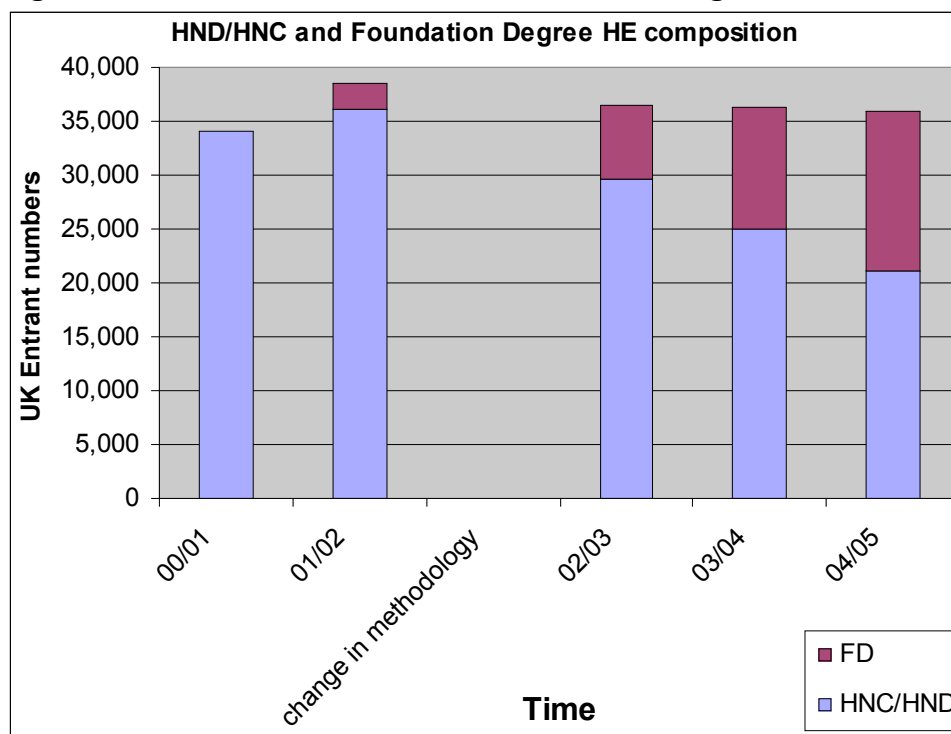
Source: HESA, see Annex B for definition of data

Figure A4: Foundation degree entrant numbers by subject area



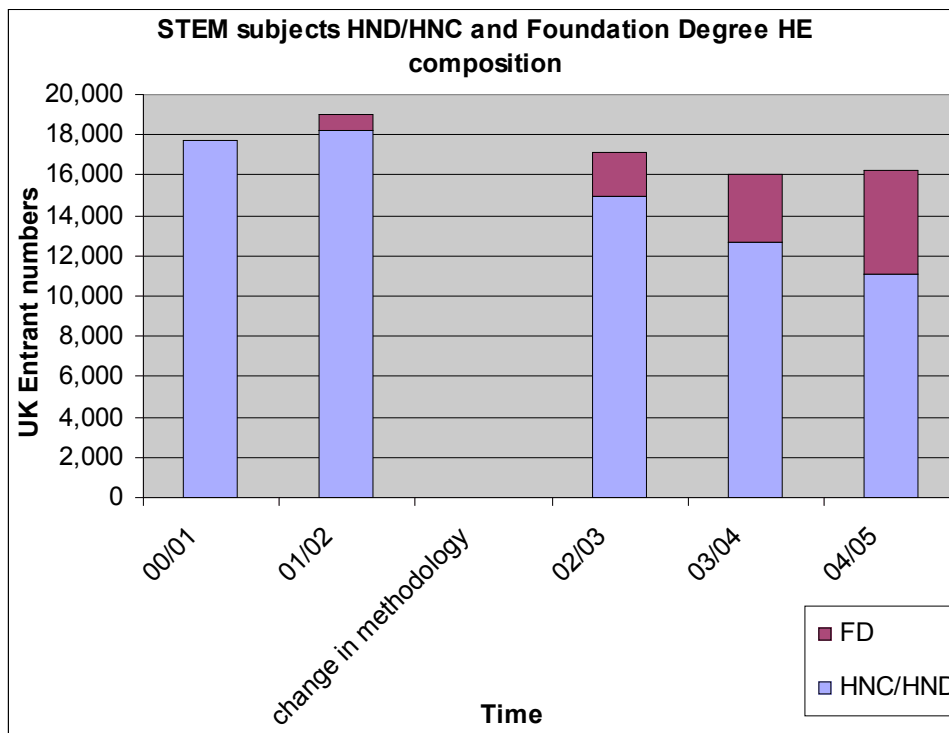
Source: HESA, see Annex B for definition of data

Figure A5: Total HND, HNC and Foundation Degree entrants



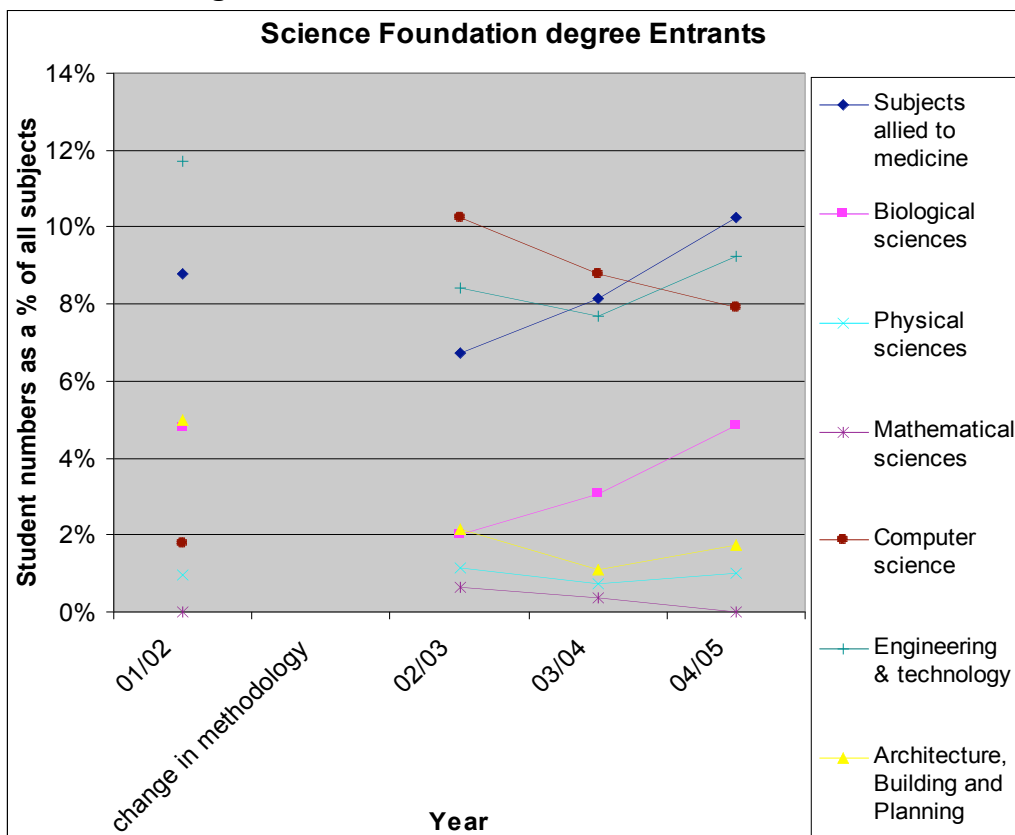
Source: HESA, see Annex B for definition of data

Figure A6: STEM HND, HNC and Foundation Degree entrants



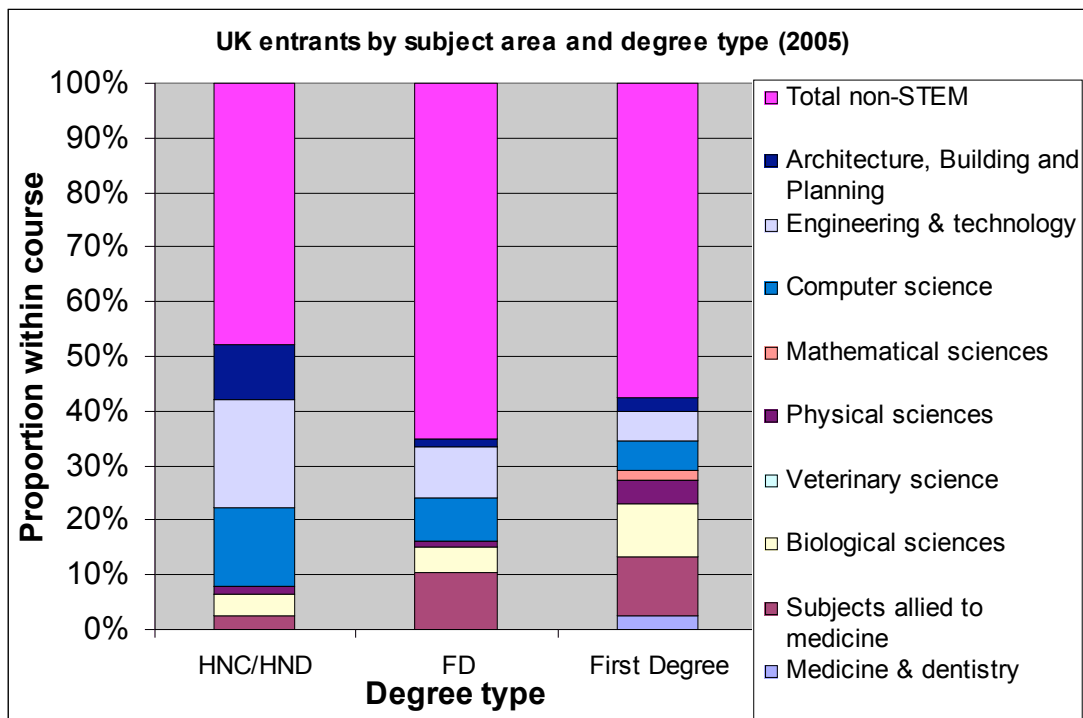
Source: HESA, see Annex B for definition of data

Figure A7: STEM Foundation degree entrants as a percentage of all foundation degree entrants



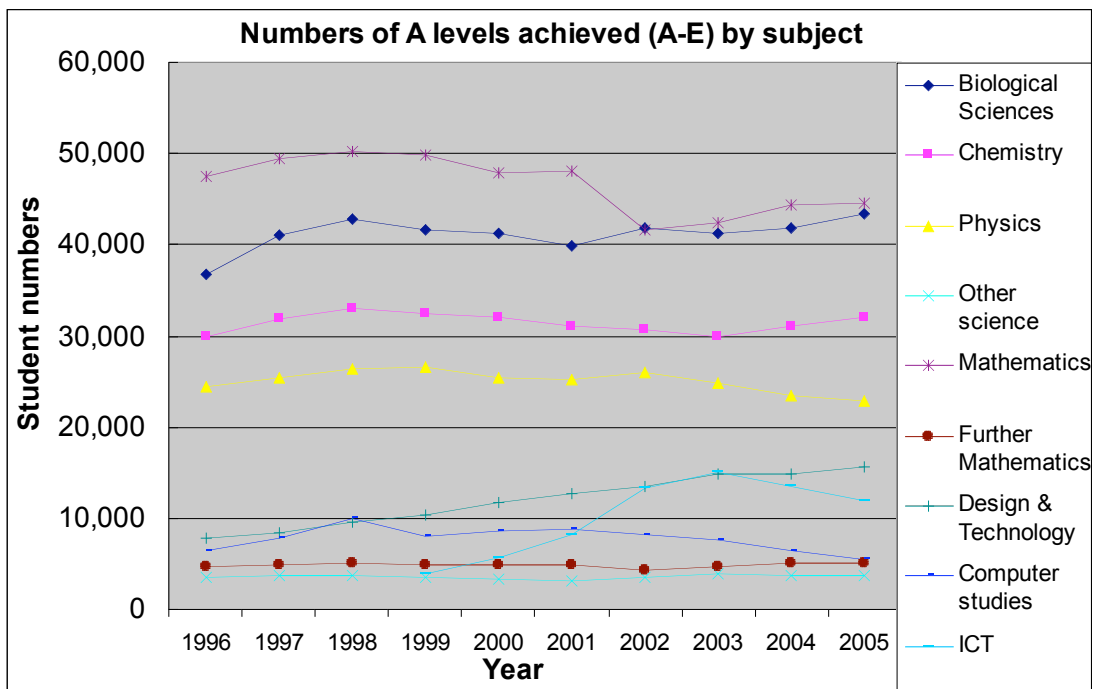
Source: HESA, see Annex B for definition of data

Figure A8: UK entrant by degree type and subject area



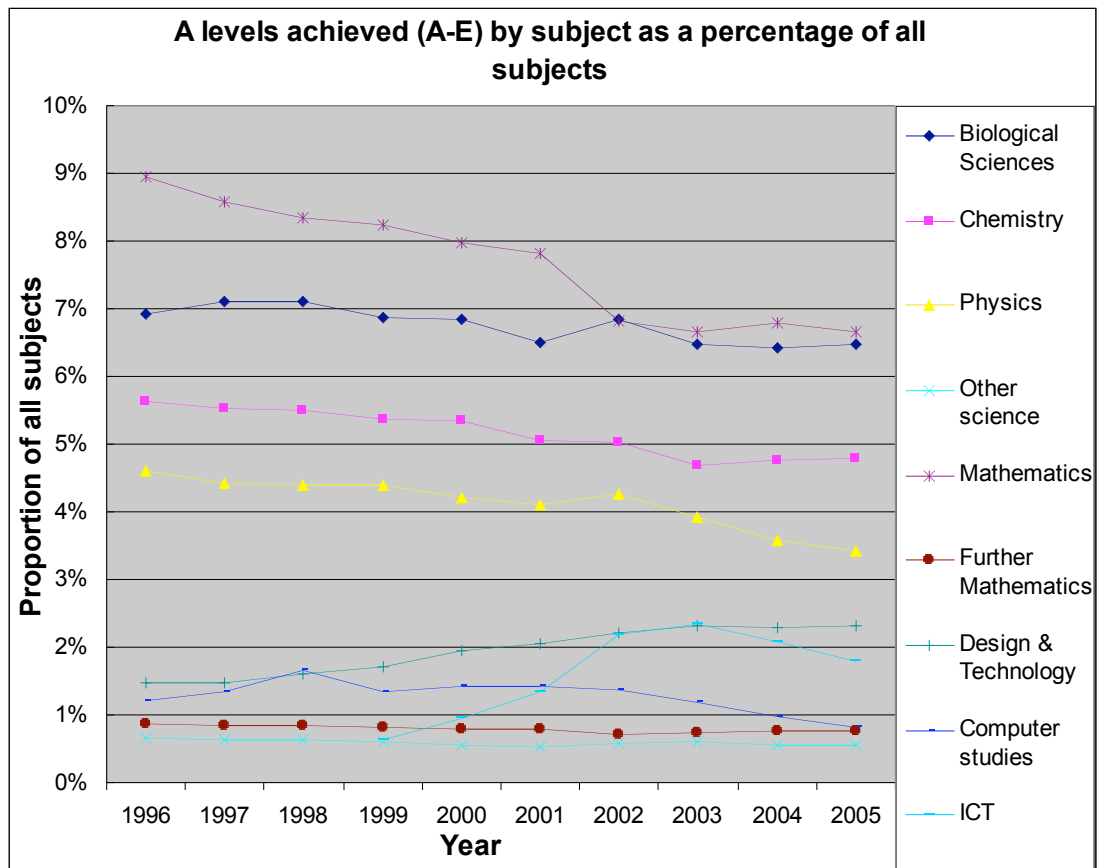
Source: HESA, see Annex B for definition of data

Figure A9: Numbers of A-levels achieved by subject



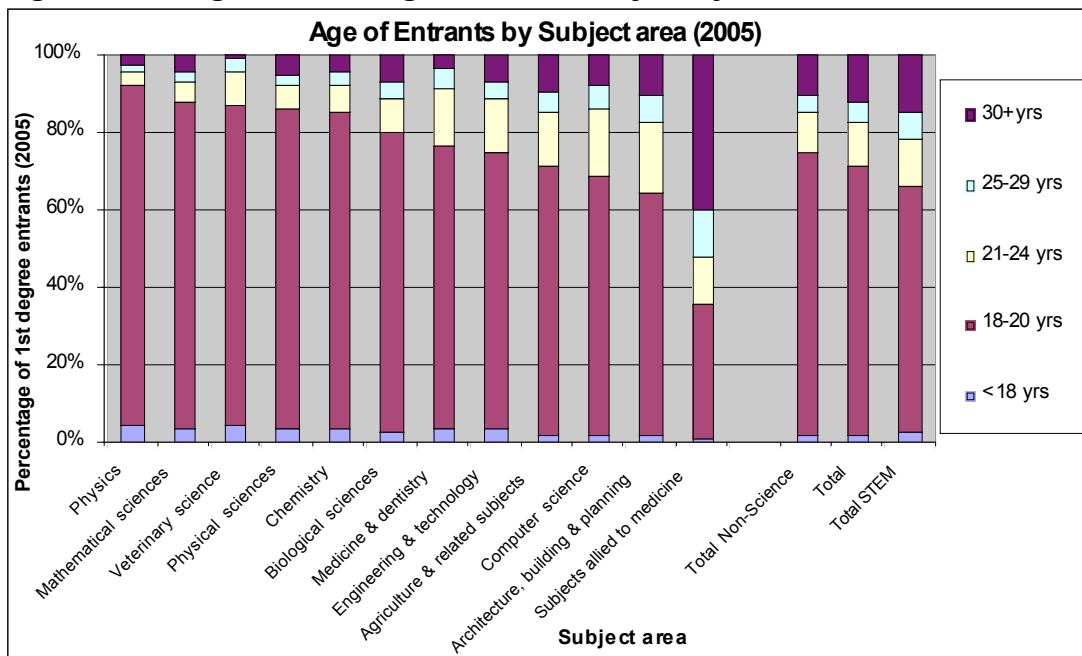
Source: School and College Achievement and Attainment Tables data, DfES

Figure A10: A-levels achieved as proportion of all subjects



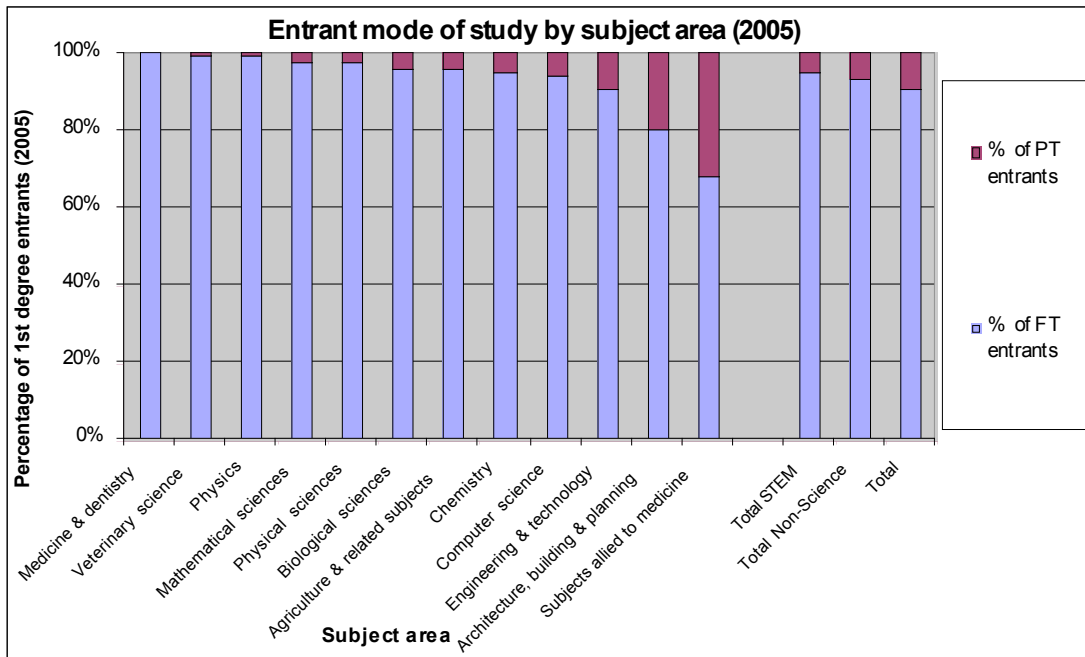
Source: School and College Achievement and Attainment Tables data, DfES

Figure A11: Age of first degree entrants by subject area



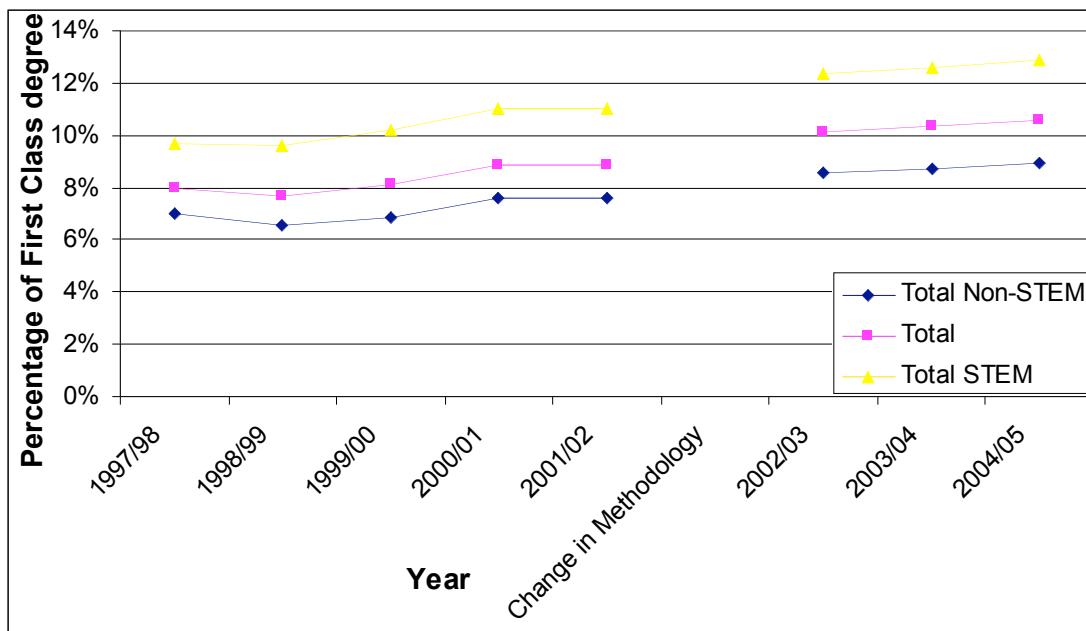
Source: HESA, see Annex B for definition of data

Figure A12: Entry to STEM first degrees by mode of study



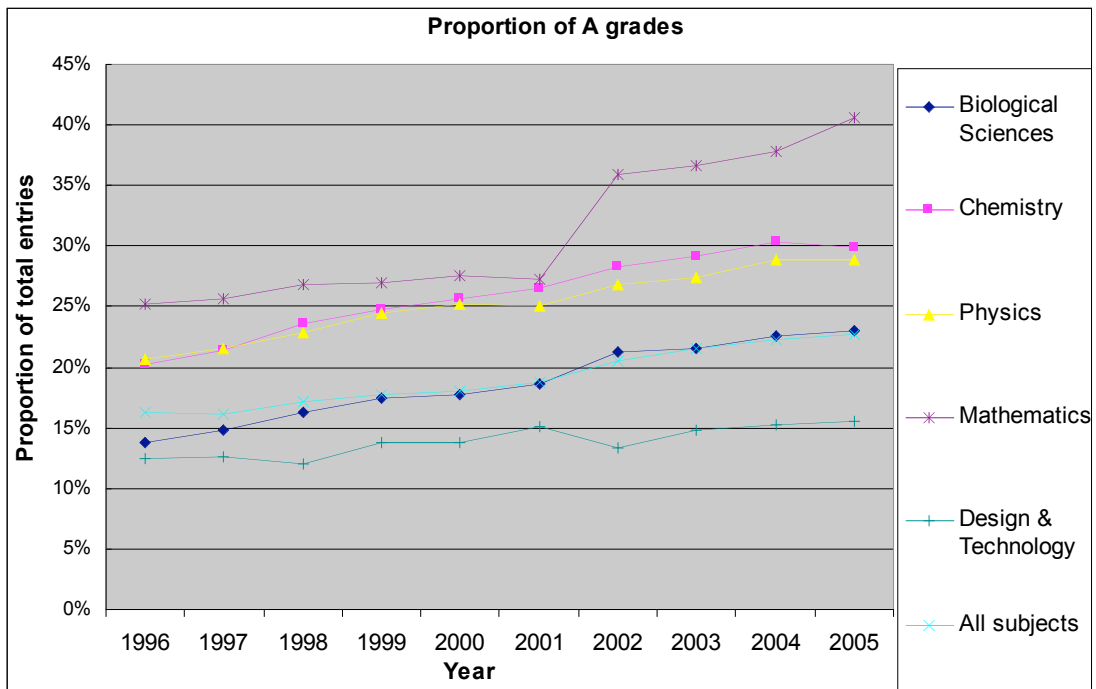
Source: HESA, figures do not include Open University; see Annex B for full definition of data

Figure A13: Proportion of first class degree attainments



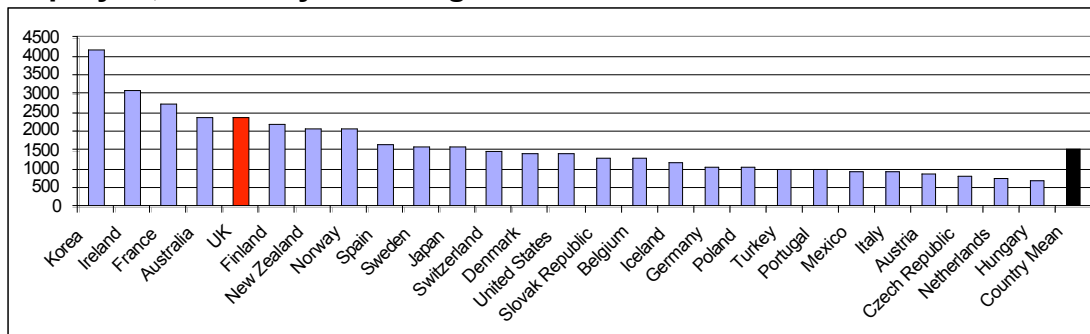
Source: HESA student record (Figures for 1997/8 to 2001/02 exclude those qualifying from dormant modes of study)

Figure A14: Proportion getting A-grades in STEM



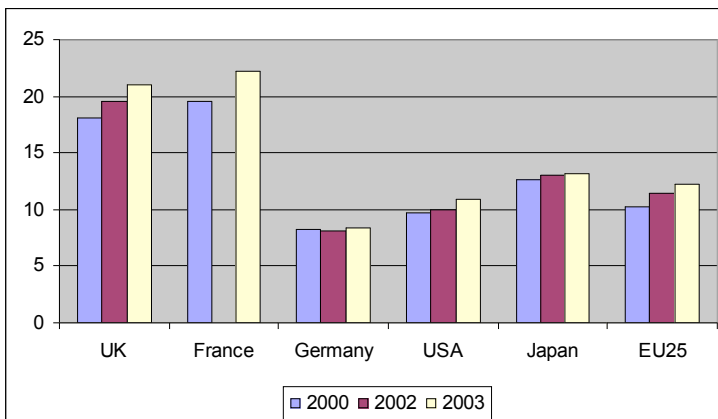
Source: DfES A-Level Attainment tables

Figure A15: Science Graduates (2003) per 100,000 persons in the employed, 25 to 34 years of age.



Source: OECD, Education at a Glance, 2005

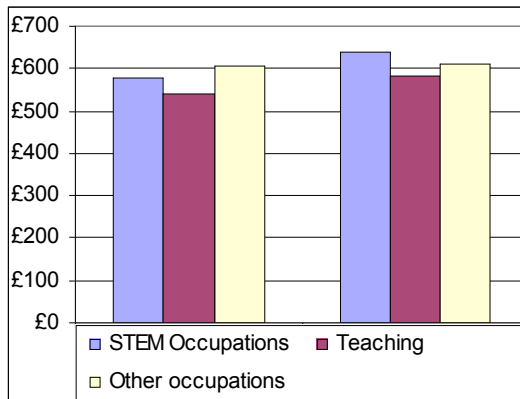
Figure A16: Number of tertiary graduates in STEM per 1000 inhabitants aged 20-29



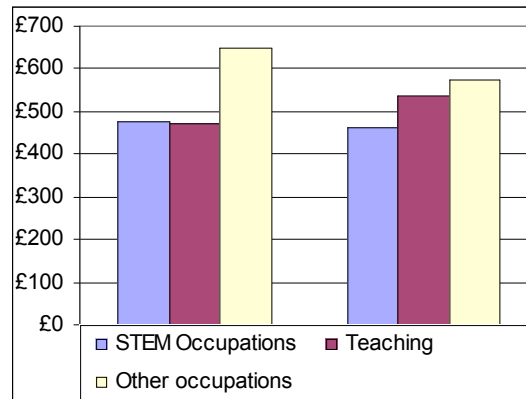
Source Progress Towards the Lisbon Objectives in Education and Training - 2006 Report to the EU Commission (Eurostat)

Figure A17: Gross weekly earnings for STEM and non-STEM graduates, 2001 and 2004

(a) STEM

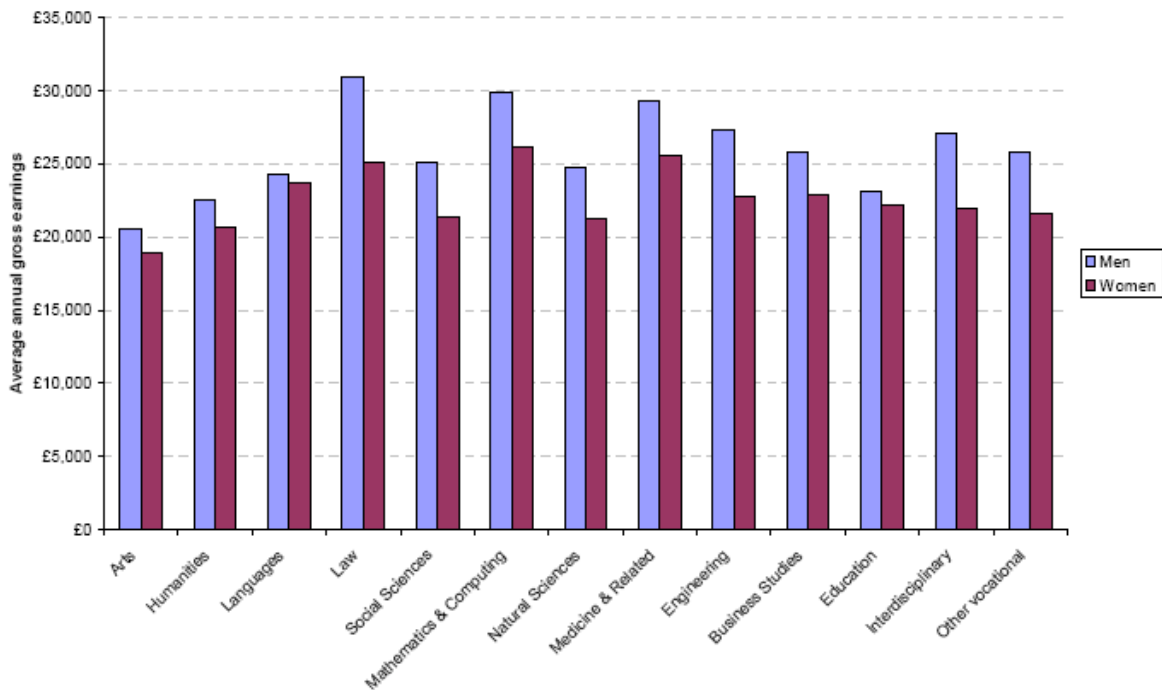


(b) Non-STEM



Source: Science, Engineering and Technology Skills in the UK (DTI March 2006) based on Labour Force Survey, 2001 and 2004

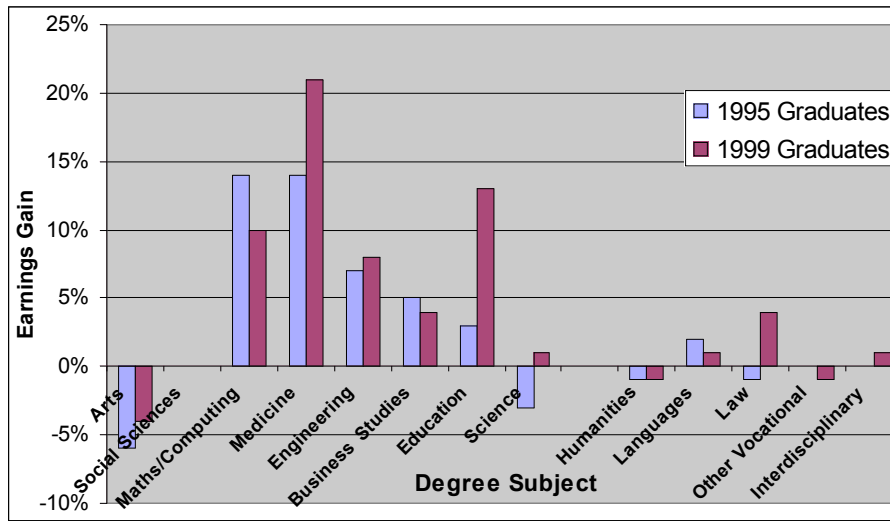
Figure A18: Average gross annual earnings of 1999 graduates in 2003/04 by subject of 1999 degree



Source: Survey of the Career Paths of 1999 Graduates and Diplomates

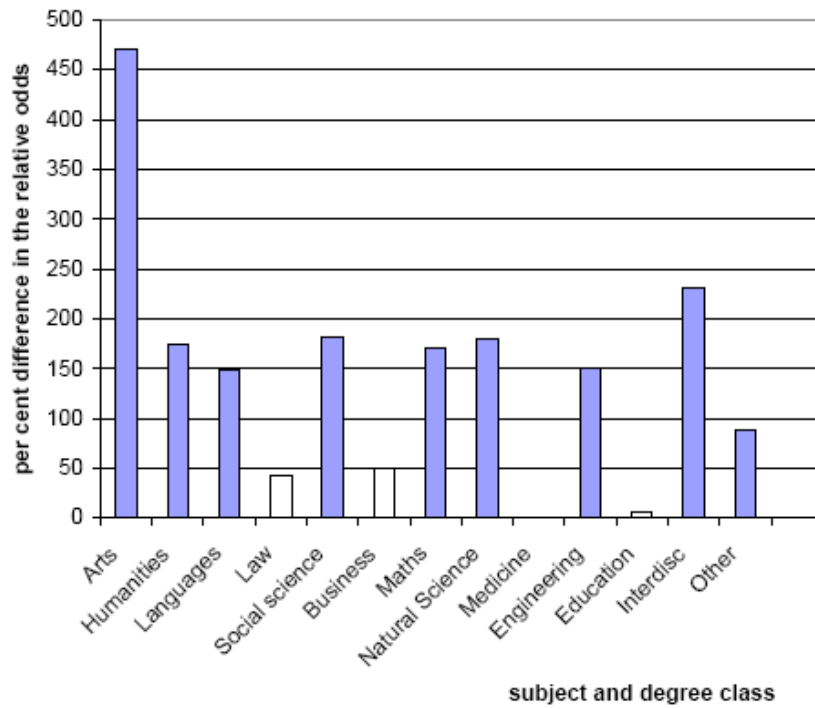
Source: *The Class of '99* by Purcell, Elias, Davies & Wilton (2005) p.99

Figure A19: Comparison of earnings between 1995 and 1999 graduates by Degree subject, 3¹/₂ - 4 years after graduation



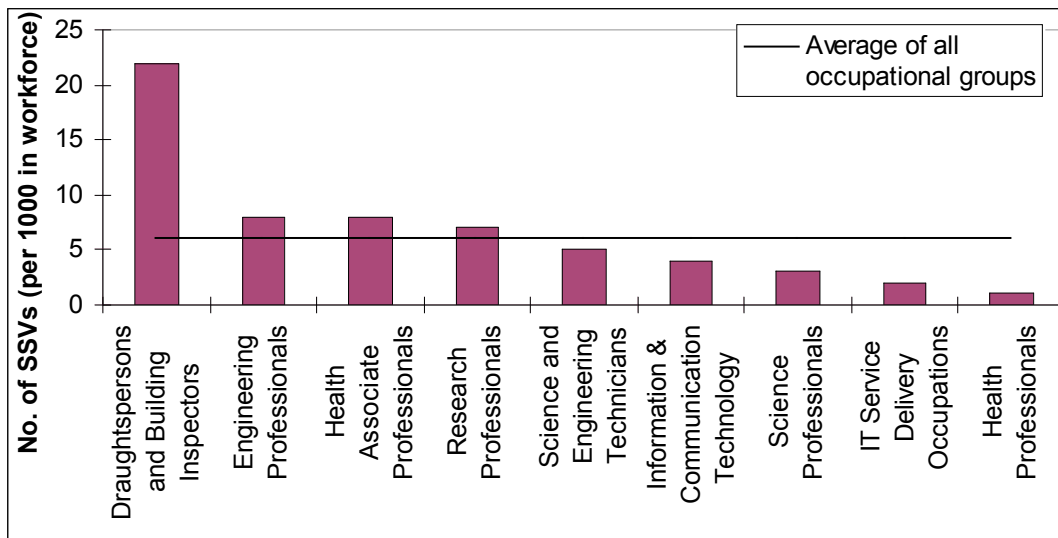
Source: *The Class of '99* by Purcell, Elias, Davies & Wilton (2005) p.223

Figure A20: The impact of qualification on the odds of respondents experiencing 6 months or longer of unemployment following graduation



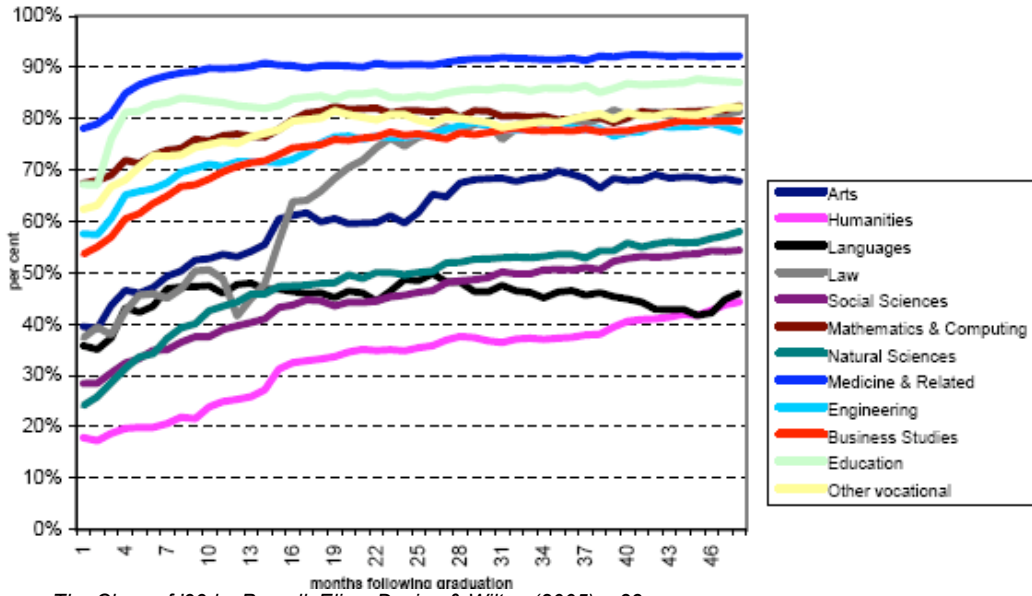
Source: *The Class of '99* by Purcell, Elias, Davies & Wilton (2005) p.58

Figure A21: STEM Skill Shortage Vacancies per 1000 employees



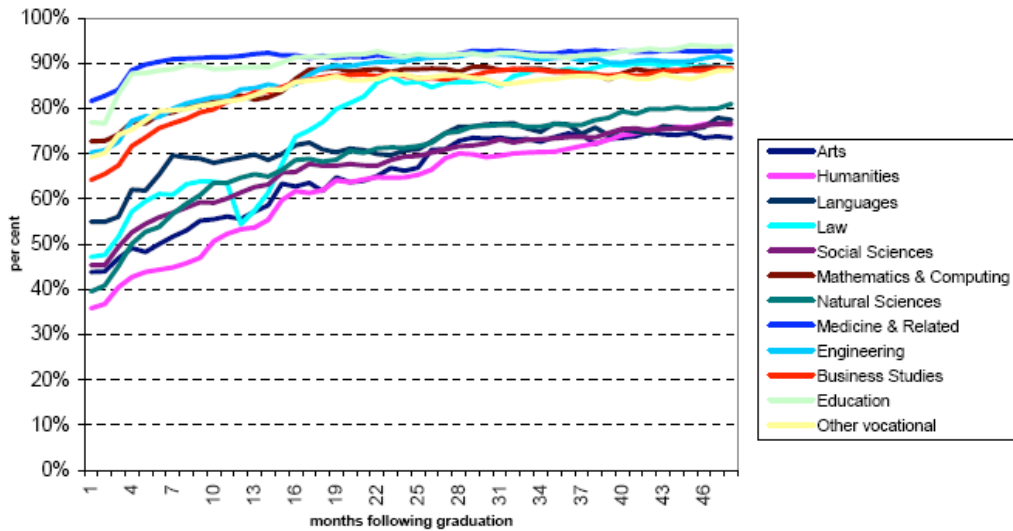
Source: NESS 2005

Figure A22: 1999 employment graduates ‘use of graduate knowledge’, by subject studied.



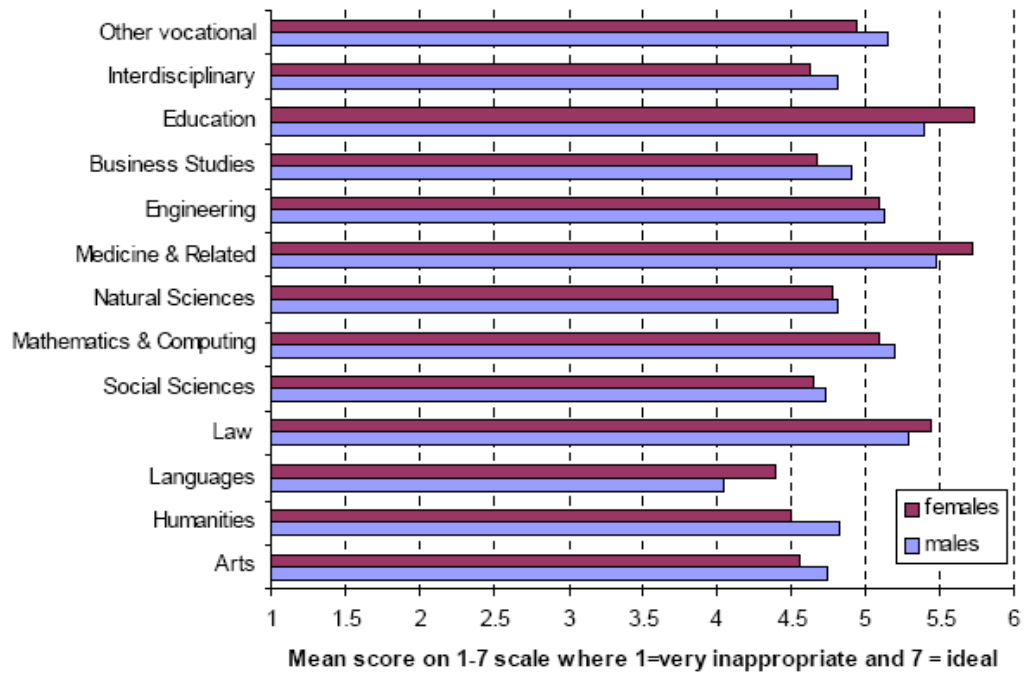
Source: *The Class of '99* by Purcell, Elias, Davies & Wilton (2005) p.33

Figure A23: 1999 employed graduates ‘use of graduate skills’, by subject studied



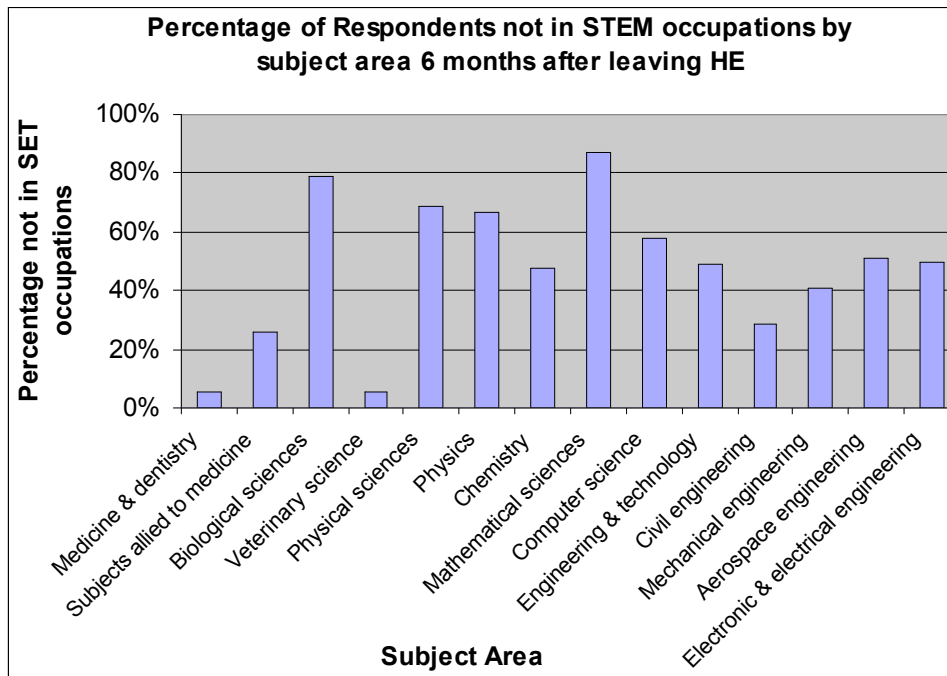
Source: *The Class of '99* by Purcell, Elias, Davies & Wilton (2005) p.33

Figure A24: Appropriateness of current job ‘for someone with your qualifications’ by subject and gender?



From *The Class of '99* by Purcell, Elias, Davies & Wilton (2005) p.41

Figure A25: Findings from Destination of Leavers from Higher Education (DLHE)²²



Source: HESA Destination of Leavers Survey 2003/04

²² Civil, Mechanical, Aerospace and Electronic & Electrical Engineering are subsets within Engineering and technology and Physics and Chemistry are subsets within Physical Sciences.

Annex B: HESA data definition

- The data shown is for **UK domiciled students** only. Figures are on a **snapshot basis** (as at 1st December) to allow consistent comparisons across the years shown. Students who are writing-up, on **sabbatical or dormant are excluded**.
- The change in coding subject of study from HESACODE to JACS in 2002/03 means that figures for **2001/2 and earlier are not directly comparable** with **2002/3** onwards.
- Entrants at the **Open University (OU)** are **excluded**, as they can not be identified for a number of years in the late 1990s; subject and level of study have not been consistently recorded across the years.

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