# KEY INDICATORS IN STEM EDUCATION

UPDATED 2017

GATSBY

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BY DAVID SAINSBURY
TO REALISE HIS CHARITABLE OBJECTIVES.
WE FOCUS OUR SUPPORT ON A LIMITED
NUMBER OF AREAS:

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PLANT SCIENCE RESEARCH
NEUROSCIENCE RESEARCH
SCIENCE AND ENGINEERING EDUCATION
ECONOMIC DEVELOPMENT IN AFRICA
PUBLIC POLICY RESEARCH AND ADVICE
THE ARTS

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OUR EDUCATION PROGRAMME FOCUSES
ON STRENGTHENING SCIENCE AND
ENGINEERING SKILLS IN THE UK WORKFORCE
THROUGH A RANGE OF INNOVATIVE
PROGRAMMES AND PARTNERSHIPS.

# INTRODUCTION

This is the third edition of Key Indicators in STEM Education, bringing together key data relating to science, technology, engineering and mathematics (STEM) education. It focuses on trends in the numbers of individuals studying STEM subjects at GCSE, A level and undergraduate degree levels. Data comparing uptake of apprenticeships at level 2 and 3 and gender imbalance within STEM subjects are also included. We hope this leaflet will be of use to policymakers, members of the STEM education community, employer groups and others involved in discussing policy interventions in this area.

When drawing together data that span many years, some issues of consistency can arise. Retrospective adjustments can be made to GCSE and A level datasets post-publication for example, or undergraduate subjects may be reclassified into different subject groupings. Notwithstanding such issues, we have satisfied ourselves that the data included in this leaflet fairly represent the major trends in STEM education. We have also identified the source for each dataset used.

# GCSEs

While separate GCSEs in biology, chemistry and physics (referred to as 'Triple Science' when all three are sat together) have been available for many years, only a minority of the cohort have taken them. The majority have taken combined science GCSEs, either as a single or double award, or more recently as Core Science, Additional Science and Further Additional Science. In 2016 this changed again with the introduction of a new, double award Combined Science GCSE as part of a wave of reforms to curriculum content, assessment and grading.

The most striking trend in the last decade has been the rise in Triple Science, with entries increasing threefold in the decade to 2013. This rise can be traced to government policy announced in 2006, which required all state schools to make Triple Science available to their students.

In 2014 and 2015 there were falls in the numbers taking Triple Science. However, 2016 saw an upswing, alongside increases in numbers taking Core Science and Additional Science. This is likely due to the introduction of the EBacc – the school performance measure that recognises schools whose pupils achieve Grade C or above in the core academic subjects, including science.

To achieve the science element of the EBacc, pupils need to achieve A*–C in at least two qualifications from a range designated by government. The majority are GCSEs, and the subjects now include computing. This explains a 76% increase in entries to Computing GCSE between 2015 and 2016.

> 2016 SAW AN UPSWING IN THE NUMBERS TAKING TRIPLE SCIENCE

| Year | Triple Science | | | Computing | Single Science | Double Science | Core Science | Additional Science |
|---|---|---|---|---|---|---|---|---|
| | Biology | Chemistry | Physics | | | | | |
| 2006 | 60,082 | 56,764 | 56,035 | | 96,374 | 479,789 | | |
| 2007 | 63,208 | 59,216 | 58,391 | | 98,485 | 478,028 | 57,316 | |
| 2008 | 85,521 | 76,656 | 75,383 | | 4,445 | 8,433 | 537,606 | 433,468 |
| 2009 | 100,905 | 92,246 | 91,179 | | 3,954 | 7,594 | 493,505 | 396,946 |
| 2010 | 129,464 | 121,988 | 120,455 | | 4,060 | 7,497 | 449,697 | 352,469 |
| 2011 | 147,904 | 141,724 | 140,183 | | | | 405,977 | 306,312 |
| 2012 | 166,168 | 159,126 | 157,377 | | | | 552,504 | 289,950 |
| 2013 | 174,428 | 166,091 | 160,735 | | | | 451,433 | 283,391 |
| 2014 | 141,900 | 138,238 | 137,227 | 16,773 | | | 374,961 | 323,944 |
| 2015 | 139,199 | 133,618 | 133,610 | 35,414 | | | 395,484 | 332,960 |
| 2016 | 144,148 | 141,245 | 139,805 | 62,454 | | | 408,569 | 368,033 |

Table 1: Entries to science GCSEs in the UK (all ages). Source: JCQ

# A LEVELS

In 2016, the number of entries to A levels declined 1.7%, compared to an overall 3.1% decline in the number of 18 year olds in England, Wales and Northern Ireland. For the first time in a decade, entries to maths A level have declined. Continuing the trend from 2015, there were also drops in entries to physics (2.6%), chemistry (1.6%) and biology (1%).

There are several notable policy changes currently coming on stream: the content of A levels is being reviewed and updated; the assessment for AS and A levels will now be by examination at the end of the 1- or 2-year course; and AS and A levels are being decoupled – this means that AS results will no longer count towards an A level. This has led, unsurprisingly, to a 13.7% drop in AS level entries in 2016 compared with 2015.

Biology, chemistry and physics were among some of the first subjects to be reformed and the new qualifications have been taught since September 2015. We await the results in summer 2017 to see what effect the changes mentioned above have had on science A level entries.

> FOR THE FIRST TIME IN A DECADE, ENTRIES TO MATHS A LEVEL HAVE DECLINED. THERE WERE ALSO DROPS IN ENTRIES TO PHYSICS, CHEMISTRY AND BIOLOGY

| Year | Maths | Further Maths | Physics | Chemistry | Biology |
|---|---|---|---|---|---|
| 2006 | 55,982 | 7,270 | 27,368 | 40,064 | 54,890 |
| 2007 | 60,093 | 7,872 | 27,466 | 40,285 | 54,563 |
| 2008 | 64,593 | 9,091 | 28,096 | 41,680 | 56,010 |
| 2009 | 72,475 | 10,473 | 29,436 | 42,491 | 55,485 |
| 2010 | 77,001 | 11,682 | 30,976 | 44,051 | 57,854 |
| 2011 | 82,995 | 12,287 | 32,860 | 48,082 | 62,041 |
| 2012 | 85,714 | 13,223 | 34,509 | 49,234 | 63,074 |
| 2013 | 88,060 | 13,821 | 35,569 | 51,818 | 63,939 |
| 2014 | 88,816 | 14,028 | 36,701 | 53,513 | 64,070 |
| 2015 | 92,711 | 14,993 | 36,287 | 52,644 | 63,275 |
| 2016 | 92,163 | 15,257 | 35,344 | 51,811 | 62,650 |

Table 2: Entries to maths and science A levels in the UK (all ages). Source: JCQ

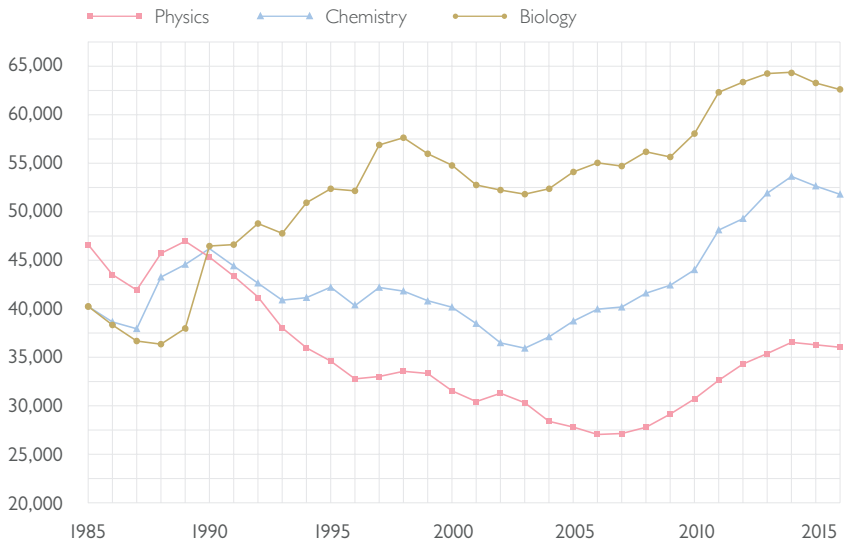


Chart 1: Entries to science A levels in the UK (all ages). Source: JCQ

# UNDERGRADUATES

Table 4 shows the growth in full-time undergraduate student numbers since 2005/06. STEM subjects account for around 46% of undergraduate numbers and this proportion has remained reasonably steady for many years.

While overall undergraduate numbers in STEM subject areas have increased by 17% since 2005/06, this includes a significant growth in the number of non-UK students.

Table 3 below shows the number of STEM and non-STEM undergraduates broken down by domicile. UK student numbers in STEM grew 12% since 2005/06, while other EU and non-EU student numbers in STEM grew by 52% and 60%, respectively. The effect on these numbers of the UK's decision to leave the European Union remains to be seen.

| | Domicile | 2005/06 | 2008/09 | 2011/12 | 2014/15 | % change since 2005/06 |
|---|---|---|---|---|---|---|
| STEM subjects | UK | 496,020 | 507,830 | 553,565 | 557,515 | 12.4% |
| | Other EU | 19,700 | 23,975 | 29,020 | 29,995 | 52.3% |
| | Non-EU | 34,685 | 39,370 | 49,655 | 55,330 | 59.5% |
| Non-STEM subjects | UK | 570,865 | 607,040 | 658,455 | 619,275 | 8.5% |
| | Other EU | 29,070 | 37,200 | 44,630 | 42,435 | 46.0% |
| | Non-EU | 48,480 | 56,635 | 76,640 | 87,120 | 79.7% |
| All subjects | UK | 1,066,885 | 1,114,870 | 1,212,020 | 1,176,790 | 10.3% |
| | Other EU | 48,770 | 61,175 | 73,650 | 72,430 | 48.5% |
| | Non-EU | 83,165 | 96,005 | 126,295 | 142,450 | 71.3% |
| Total | All | 1,198,820 | 1,272,050 | 1,411,965 | 1,391,670 | 16.1% |

Table 3: Full-time student enrolments on undergraduate courses (UK HEIs). Source: HESA

| | 2005/06 | 2008/09 | 2011/12 | 2014/15 | % change since 2005/06 |
|---|---|---|---|---|---|
| Mathematical sciences | 20,765 | 24,315 | 29,065 | 30,340 | 46.1% |
| Biological sciences | 104,580 | 115,545 | 135,975 | 148,140 | 41.7% |
| Veterinary science | 3,570 | 4,240 | 4,645 | 5,010 | 40.3% |
| Physical sciences | 49,820 | 54,565 | 62,860 | 66,660 | 33.8% |
| Engineering & technology | 75,905 | 83,765 | 95,725 | 101,030 | 33.1% |
| Agriculture & related subjects | 10,040 | 10,490 | 12,240 | 11,785 | 17.4% |
| Medicine & dentistry | 41,035 | 44,740 | 46,300 | 45,400 | 10.6% |
| Computer science | 65,465 | 56,030 | 61,135 | 63,470 | -3.0% |
| Architecture, building & planning | 27,560 | 33,340 | 31,405 | 26,610 | -3.4% |
| Subjects allied to medicine | 151,665 | 144,145 | 152,880 | 144,415 | -4.8% |
| Subtotal: STEM subject areas | 550,405 | 571,175 | 632,230 | 642,860 | 16.8% |
| Social studies | 106,325 | 116,940 | 132,175 | 135,305 | 27.3% |
| Business & administrative studies | 152,165 | 166,265 | 191,630 | 191,495 | 25.8% |
| Education | 44,385 | 54,275 | 58,555 | 54,375 | 22.5% |
| Creative arts & design | 123,260 | 132,700 | 149,610 | 138,385 | 12.3% |
| Law | 52,350 | 56,450 | 59,405 | 58,340 | 11.4% |
| Mass communications & documentation | 34,410 | 36,390 | 41,565 | 36,960 | 7.4% |
| Historical & philosophical studies | 51,945 | 53,105 | 56,555 | 53,945 | 3.9% |
| Languages | 75,890 | 79,475 | 85,025 | 76,535 | 0.8% |
| Combined | 7,680 | 5,260 | 5,225 | 3,515 | -54.2% |
| Subtotal: Non-STEM subject areas | 648,410 | 700,860 | 779,745 | 748,855 | 15.5% |
| Total: All subject areas | 1,198,815 | 1,272,035 | 1,411,975 | 1,391,715 | 16.1% |
| STEM as a percentage of all subjects | 45.9% | 44.9% | 44.8% | 46.2% | |

Table 4: Full-time student enrolments on undergraduate courses (UK HEIs) by subject area. Source: HESA

# TEACHER RECRUITMENT

A key prerequisite for high-quality STEM education and strong progression rates post-16 is the ability of schools and colleges to attract and retain specialist teachers with in-depth knowledge of the subject(s) they are to teach.

Table 5 shows the number of secondary school teachers in STEM disciplines recruited in recent years.

2013/14 saw a number of changes to teacher training, including the introduction of School Direct (a school-based teacher training programme) and these changes appear to have affected physics recruitment in particular.

> THE INSTITUTE OF PHYSICS AND GOVERNMENT AGENCIES AGREE AROUND 1,000 NEW PHYSICS TEACHERS ARE REQUIRED EVERY YEAR

After many years of under-recruiting physics specialists into teaching during the 1990s, numbers picked up significantly from 2008/09 to 2012/13. Modelling by the Institute of Physics and government agencies agree that around 1,000 new physics teachers are required every year. This number has never been reached, and recruitment fell significantly short of this target in 2013/14 and 2014/15.

The Department for Education is attempting to address the shortage by increasing the training bursary available. In 2017/18 training bursaries and scholarships for physics teaching of up to £30,000 are available, depending on degree classification and experience. For maths, computing and chemistry it is up to £27,500 and for biology up to £15,000. There has been a welcome upturn since 2015, with 851 physics recruits this academic year. However, there is still some way to go if the Government's target is to be met.

| Year | Physics | Chemistry | Biology | General Science | Maths | Computing | Design & Technology |
|---|---|---|---|---|---|---|---|
| 2008/09 | 584 | 889 | 1,194 | 988 | 2,531 | | 1,297 |
| 2009/10 | 571 | 963 | 1,241 | 924 | 2,897 | | 1,437 |
| 2010/11 | 656 | 999 | 1,097 | 902 | 2,797 | | 1,363 |
| 2011/12 | 864 | 1,305 | 696 | 375 | 2,687 | | 976 |
| 2012/13 | 900 | 1,170 | 800 | 50 | 2,500 | | 700 |
| 2013/14 | 700 | 1,080 | 700 | | 2,230 | 350 | 380 |
| 2014/15 | 637 | 823 | 845 | | 2,170 | 519 | 409 |
| 2015/16 | 740 | 985 | 1,058 | | 2,453 | 504 | 513 |
| 2016/17 | 851 | 1,038 | 1,356 | | 2,605 | 495 | 423 |
| Gov't estimate for no. required in 2016/17 | 1,055 | 1,053 | 1,178 | | 3,102 | 723 | 1,034 |

Table 5: Secondary school teachers recruited in STEM subjects in England. Source: NCTL census (first published version each year)

Notes

The numbers of teachers recruited by Teach First are included from 2015/16. From 2013/14, general science recruits were included within biology.

# GENDER

At GCSE, STEM subjects are relatively well-balanced in terms of gender, with the exceptions of computing (80% male) and design and technology (61% male). However, post-GCSE there are significant variations in uptake of subjects by gender. Girls account for 49% of the entries to physics GCSE but only 22% of entries to physics A level. The total cohort size for physics A level has increased by almost 30% in the last decade; however, worryingly the proportion of girls has remained almost static. Computing continues to be an unpopular subject among girls at A level – they make up only 10% of entries.

The figures for advanced (level 3) apprenticeships in engineering are stark. Throughout the last decade, no more than 5% of starts were girls in any one year. Worryingly, in 2014/15 girls accounted for only 4% of starts. Science apprenticeships, although low in number, are typically taken by girls. Dental nursing and veterinary nursing, 97% and 95% female apprentices respectively, account for three-quarters of all science-based advanced apprenticeship starts.

Chart 2 on the following page shows the gender balance, or lack thereof, across STEM GCSEs, A levels and advanced apprenticeships.

“THE FIGURES FOR ADVANCED APPRENTICESHIPS IN ENGINEERING ARE STARK. THROUGHOUT THE LAST DECADE, NO MORE THAN 5% OF STARTS WERE GIRLS IN ANY ONE YEAR”

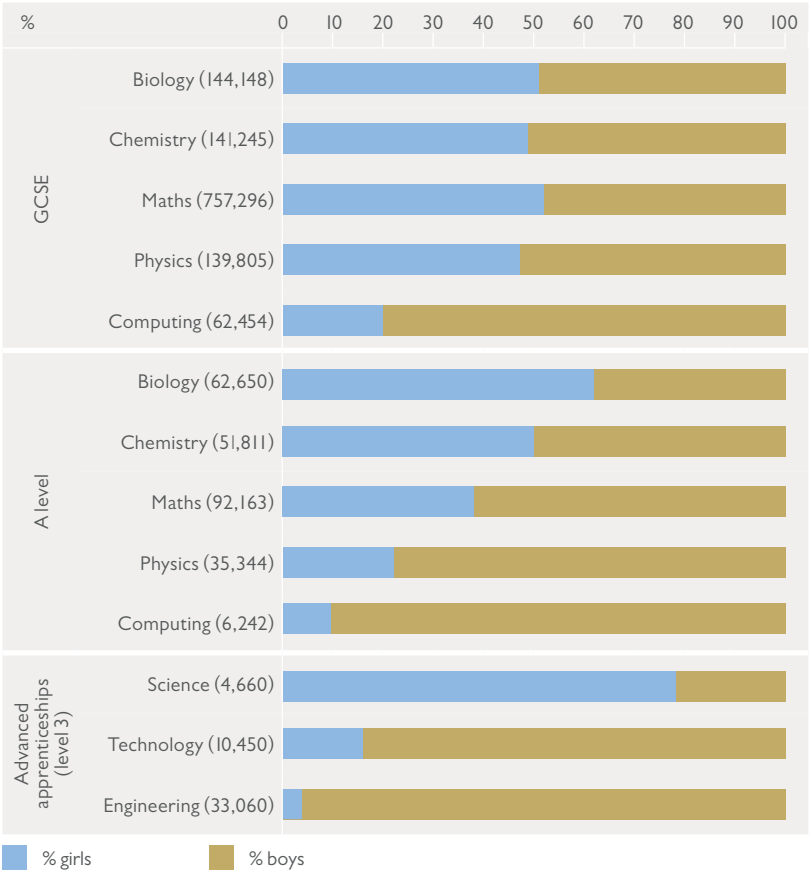


**Chart 2:** Gender balance across STEM GCSEs, A levels and advanced apprenticeships.
Sources: JCQ and SFA/DfE

Notes

All UK figures for GCSEs and A levels (2016).

England figures for advanced apprenticeships (2014/15).

Numbers of entries/starts are given in brackets.

# APPRENTICESHIPS

The government-funded apprenticeship system in England has four categories of apprenticeship:

– Intermediate apprenticeships (level 2)

– Advanced apprenticeships (level 3)

– Higher apprenticeships (levels 4–7)

– Degree apprenticeships (levels 6–7).

Following the 2012 Richard Review of Apprenticeships there has been a move away from apprenticeship frameworks based on qualifications towards apprenticeship standards focusing on occupational competence. The transition is ongoing and the data reported below are primarily based on apprenticeship frameworks.

There has been significant growth in the number of apprenticeship starts in the last decade. However, as shown in Chart 4, most of the growth has been at level 2. This is a unique feature of the English apprenticeship system compared to other European countries, where almost all apprenticeships are at level 3 and higher. It is anticipated that the new apprenticeship levy, which is due to start in April 2017, will lead to an increase in the number of apprenticeships but it is still too early to say at what level they will be.

ONLY A SMALL FRACTION OF 16 YEAR OLDS – APPROXIMATELY 30,000 IN 2015/16 – STARTED AN APPRENTICESHIP COMPARED WITH THOSE CONTINUING FULL-TIME EDUCATION IN SCHOOL OR COLLEGE

Another unusual aspect of the apprenticeship system in England is the high proportion of older apprentices. Chart 3 shows the distribution of apprenticeships by age. In the past, and in other countries, apprenticeships have been generally seen as a route into a young person's first job. The majority of the apprentices in the older age groups will already work for the employer with which they start their apprenticeship.

Whilst being an important part of education, only a small fraction of 16 year olds – approximately 30,000 in 2015/16 – started an apprenticeship compared with those continuing full-time education in school or college.

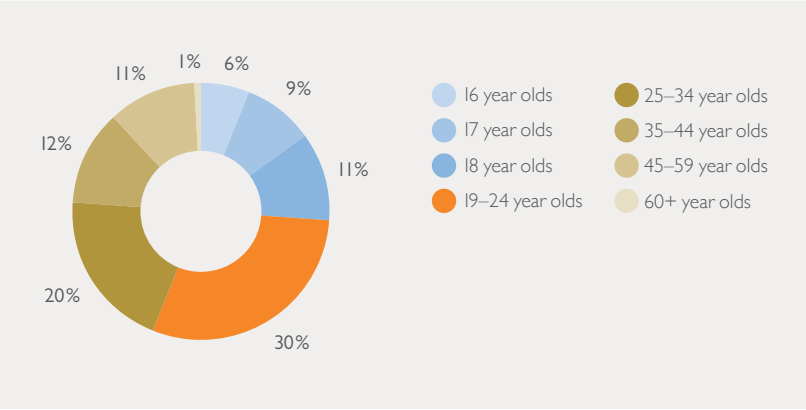


**Chart 3:** Proportion of apprenticeship starts by age in England in 2015/16.
Source: Apprenticeship Statistics: England (Briefing Paper)

Chart 4 also shows that science, engineering and technology (SET) apprenticeships make up a relatively small proportion of the total of intermediate and advanced apprenticeships. Across all levels, the apprenticeship frameworks with the most starts in total in 2015/16 are in Health & Social Care (85,810), Business Administration (50,160), Management (46,140), Hospitality and Catering (31,660) and Customer Service (26,370). Construction Skills (20,250), Industrial Applications (18,660) and Engineering (17,160) are the most popular SET apprenticeships. The trends in these frameworks over the last decade are illustrated in Chart 5.

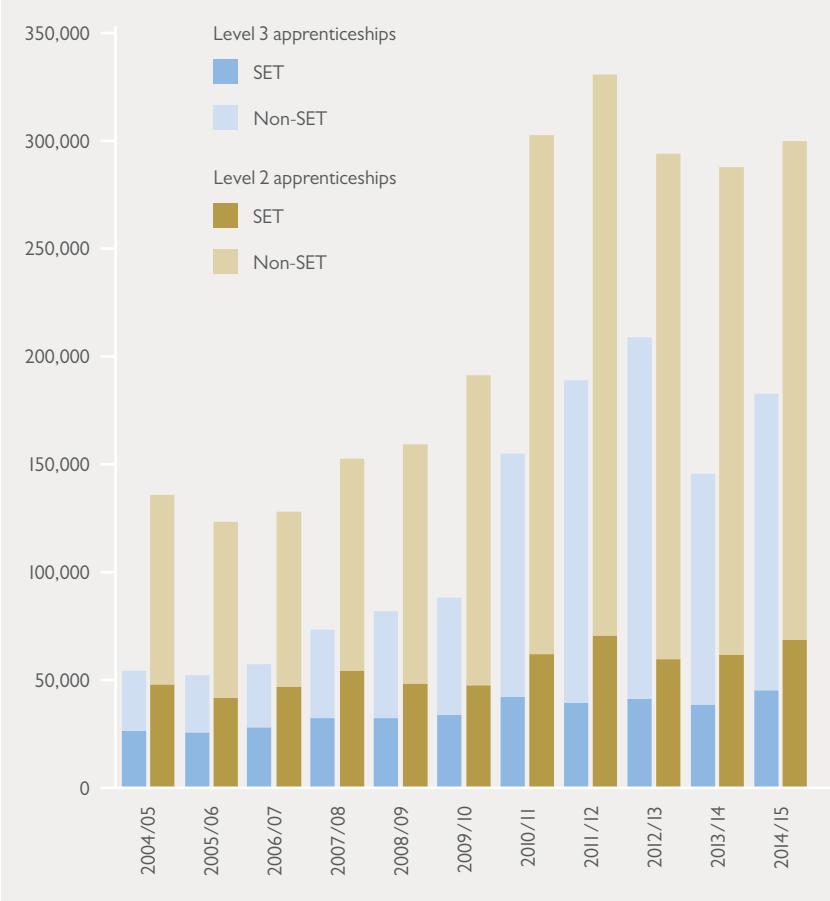


**Chart 4:** Growth in SET and non-SET apprenticeship numbers over time. Source: SFA/DfE

Notes

At time of writing, data were not available for the full 2015/16 year by framework and level, hence this chart stopping at 2014/15.

Higher apprenticeships starts have more than doubled in the last year but still remain low in number. In 2014/15 there were 19,800 higher apprenticeship starts, of which approximately 13,000 were at level 5. However, less than 10% of all higher apprenticeships (1,840) were in STEM-related areas. The most popular higher apprenticeships in 2014/15 were Business, Administration and Law (8,850 starts) and Health, Public Services and Care (8,800 starts). Provisional figures for 2015/16 indicate another increase of around 35% in the number of higher apprenticeships starts.

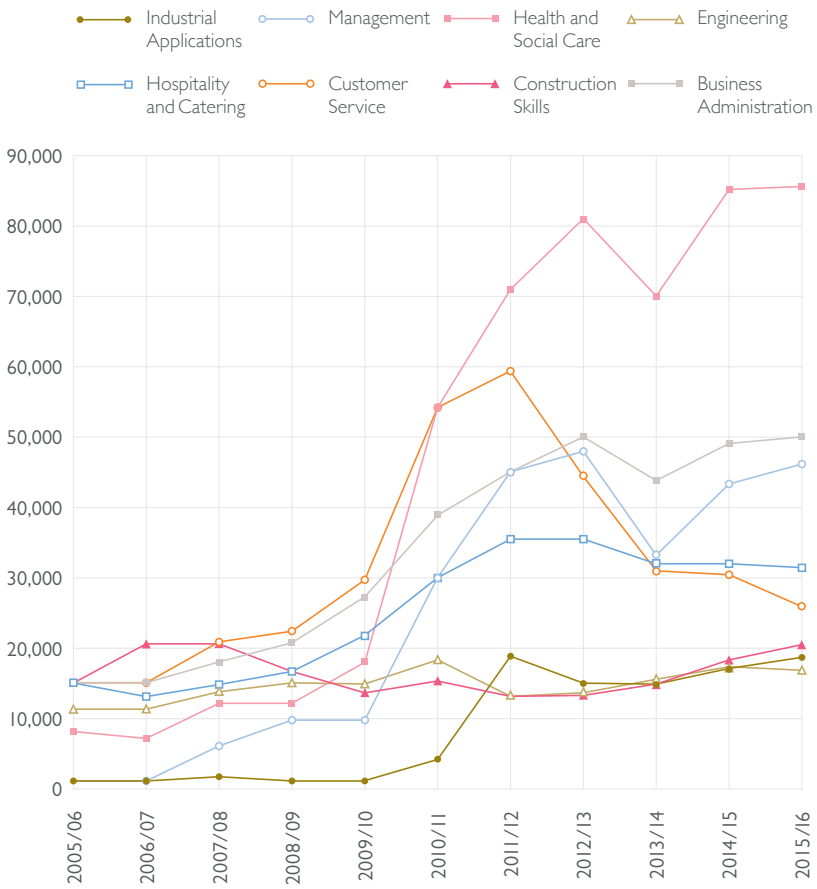


Chart 5: Trend in the total number of apprenticeship starts for selected frameworks in the last decade. Source: SFA/DfE

# NOTES

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