KEY INDICATORS IN STEM EDUCATION

UPDATED 2020

GATSBY

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BY DAVID SAINSBURY
TO REALISE HIS CHARITABLE OBJECTIVES.
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NUMBER OF AREAS:

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NEUROSCIENCE RESEARCH
SCIENCE AND ENGINEERING EDUCATION
ECONOMIC DEVELOPMENT IN AFRICA
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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 fifth 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, vocational and technical qualifications and diversity within STEM are also included.

This year we have included a section on the reforms to technical education, as the system continues to undergo significant change. We expect 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. 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

Perhaps the most striking trend over the last decade has been the more than doubling of entries to GCSEs in Biology, Chemistry and Physics (referred to as 'Triple Science' when all three are taken together), which are now at their highest levels since 2001.

As part of major reforms in England, GCSEs in science subjects examined from 2018 have new content, no coursework that counts towards a final grade, and all exams are taken at the end of the course. Patterns of early entry and resits also changed, and single GCSEs in Combined Science were withdrawn.

At the same time, the Government continued its emphasis on the EBacc – a performance measure which requires students to gain at least two GCSEs in science subjects. This followed a major shift in government policy in 2006, requiring all maintained schools to make Triple Science available to their students.

Computing GCSE was reformed for 2014 and has taken the place of what was previously ICT GCSE. Entries have more than doubled since 2015, though in 2019 they were still less than half of those entering the other separate science subjects.

Design and Technology GCSE numbers have dropped by 70% since 2008, in a relatively steady fashion, possibly due to a number of factors including changes to school accountability measures and a decline in teacher recruitment over the last decade.

COMPUTING GCSE WAS REFORMED FOR 2014 AND HAS TAKEN THE PLACE OF WHAT WAS PREVIOUSLY ICT GCSE. ENTRIES HAVE MORE THAN DOUBLED SINCE 2015

Year	Triple Science			Computing	Single Science	Double Science	Core Science	Additional Science	Further Science	Maths	Design & Technology
	Biology	Chemistry	Physics								
2008	85,521	76,656	75,383		4,445	8,433	537,606	433,468		738,451	332,787
2009	100,905	92,246	91,179		3,954	7,594	493,505	396,946		754,738	305,809
2010	129,464	121,988	120,455		4,060	7,497	449,697	352,469		762,792	287,701
2011	147,904	141,724	140,183				405,977	306,312		772,944	253,624
2012	166,168	159,126	157,377				552,504	289,950		675,789	240,704
2013	174,428	166,091	160,735				451,433	283,391		760,170	219,931
2014	141,900	138,238	137,227				374,961	302,825		736,403	213,629
2015	139,199	133,618	133,610	35,414			395,484	332,960	23,389	761,230	204,788
2016	144,148	141,245	139,805	62,454			408,569	368,033	17,409	757,296	185,279
2017	143,340	141,867	141,977	66,751		14,254	295,889	376,347	14,606	770,034	165,815
2018	176,325	168,273	166,462	74,621		400,540	6,785			747,169	127,232
2019	177,454	170,034	168,330	80,027		419,629	6,719			778,858	99,659

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

A-LEVELS

Similarly to GCSEs, A-levels and AS-levels have been undergoing reforms over the last four years. In 2017 the first wave of students taking new A-levels in Computing, Biology, Chemistry and Physics sat their exams. Two years later, numbers in these sciences are at their highest levels in the last decade.

2019 was the first year all A-level Maths and Further Maths candidates in England sat the new exams. In contrast to the other sciences, entries for Maths dropped by 5.9% and Further Maths by 10% between 2018 and 2019. This drop brings numbers back down to pre-2015 levels, although Maths remains the most popular A-level subject.

Possible reasons include a reaction to tougher GCSEs and A-levels in Maths, and that there are fewer opportunities to take AS-level Maths – often used as a steppingstone for less confident students – since it was decoupled from A-level (meaning an AS-level no longer counts towards the overall A-level grade).

This was the third year that some practical skills in science A-levels were assessed using a separate teacher endorsement. In the endorsement, teachers verify students' skills when completing their practicals, which leads to a reported 'Pass' or 'Not Classified' on the A-level certificate. It was introduced to replace coursework that contributed to the student's final A-level grade.

The 98.7% pass rate (average across Biology, Chemistry and Physics) for this teacher endorsement contrasts with the significant numbers of science students who got less than a C grade in their A-level.

> BETWEEN 2018 AND 2019 ENTRIES FOR MATHS DROPPED BY 5.9% AND FURTHER MATHS BY 10%

Year	Maths	Further Maths	Physics	Chemistry	Biology	Computing	Design & Technology
2008	64,593	9,091	28,096	41,680	56,010	5,068	
2009	72,475	10,473	29,436	42,491	55,485	4,710	
2010	77,001	11,682	30,976	44,051	57,854	4,065	
2011	82,995	12,287	32,860	48,082	62,041	4,002	18,249
2012	85,714	13,223	34,509	49,234	63,074	3,809	17,105
2013	88,060	13,821	35,569	51,818	63,939	3,758	15,641
2014	88,816	14,028	36,701	53,513	64,070	4,171	13,691
2015	92,711	14,993	36,287	52,644	63,275	5,383	13,240
2016	92,163	15,257	35,344	51,811	62,650	6,242	12,477
2017	95,244	16,172	36,578	52,331	61,908	8,299	12,415
2018	97,627	16,157	37,806	54,134	63,819	10,286	11,448
2019	91,895	14,527	38,958	59,090	69,196	11,124	10,870

Table 2: Entries to science, maths and technology A-levels in the UK. Source: JCQ

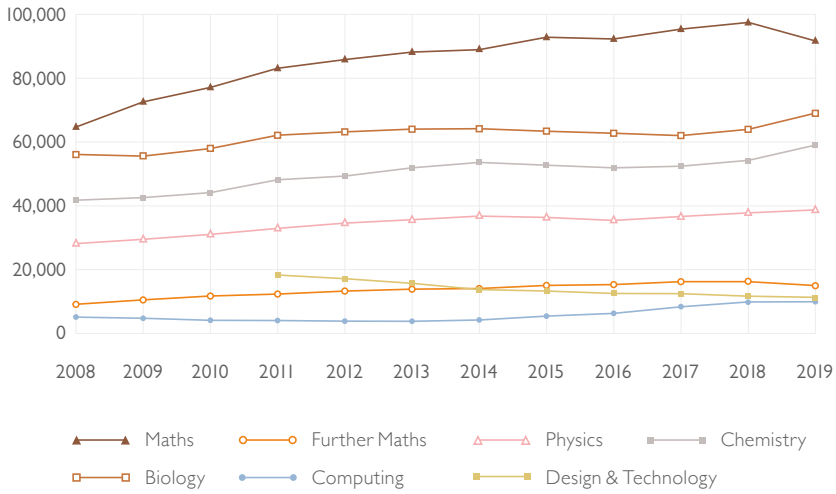

Chart 1: Entries to science, maths and technology A-levels in the UK. Source: JCQ

VOCATIONAL QUALIFICATIONS

It is important to understand that there are a very large number of vocational qualifications available to young people and adults at a range of education levels. Over the years there has been considerable churn in the qualifications offered and in the way that they have been classified.

Table 3 and Chart 2 show the number of certificates issued in England for vocational qualifications and selected other qualifications (e.g. functional skills and key skills) regulated by Ofqual. The number of certificates has been summed over the four quarters of an academic year. These data do not include academic qualifications such as A-levels, and others such as basic skills and English for Speakers of Other Languages (ESOL).

Table 3 shows the proportions of learners, both young people and adults, on vocational qualifications at different levels. Consistently over the years Level 2 certificates (equivalent to GCSE grades A*–C) have been awarded in the highest numbers – in fact more certificates have been awarded at or below Level 2 than above it, although there have been some welcome increases in the numbers at Level 3 (equivalent to A-level).

> MORE CERTIFICATES HAVE BEEN AWARDED AT OR BELOW LEVEL 2 THAN ABOVE IT

	Percentage of certifications						
	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Entry Level	7.7%	8.3%	8.2%	9.2%	8.2%	7.5%	7.3%
Level 1	22.8%	22.2%	20.8%	19.6%	18.3%	18.3%	17.6%
Level 1/2	0.0%	0.2%	3.0%	4.9%	4.3%	4.4%	4.2%
Level 2	53.9%	52.1%	48.0%	44.3%	44.8%	39.1%	36.4%
Level 3	14.0%	15.7%	18.2%	19.7%	21.8%	27.6%	31.3%
Level 4	0.9%	0.8%	0.9%	1.2%	1.3%	1.6%	1.7%
Level 5	0.4%	0.4%	0.6%	0.7%	0.9%	1.0%	1.1%
Level 6+	0.2%	0.2%	0.3%	0.4%	0.4%	0.5%	0.6%
Total student numbers	6,719,070	6,270,330	5,662,355	5,142,705	4,693,655	4,502,380	4,238,490

Table 3: Proportion of certificates in vocational qualifications by level in England.
Source: Ofqual Vocational Qualifications Dataset

The subjects of vocational qualifications are classified using Sector Subject Areas (SSAs). Most vocational qualifications have been taken in the SSA 'Preparation for Life and Work', the majority of which are at Entry Level and Level 1. These qualifications therefore account for much of the lower level provision shown in Table 3, and the decline in the total number of vocational certifications has been largely driven by falls in the numbers taking Preparation for Life and Work qualifications. These falling numbers are probably a result of changes to school accountability measures at 16.

From September 2020 new technical qualifications at Level 3, T-levels, will be introduced for young people. Three T-level pathways will be offered by 50 institutions from September 2020, with the other 22 pathways phased in across England by 2023/24.

The content of T-levels is specified by employers and draws on the occupational standards held by the Institute for Apprenticeships and Technical Education. These features of their design mean T-levels should align much better than existing provision to the needs of employers and the labour market.

> FROM SEPTEMBER 2020 NEW TECHNICAL QUALIFICATIONS AT LEVEL 3, T-LEVELS, WILL BE INTRODUCED FOR YOUNG PEOPLE

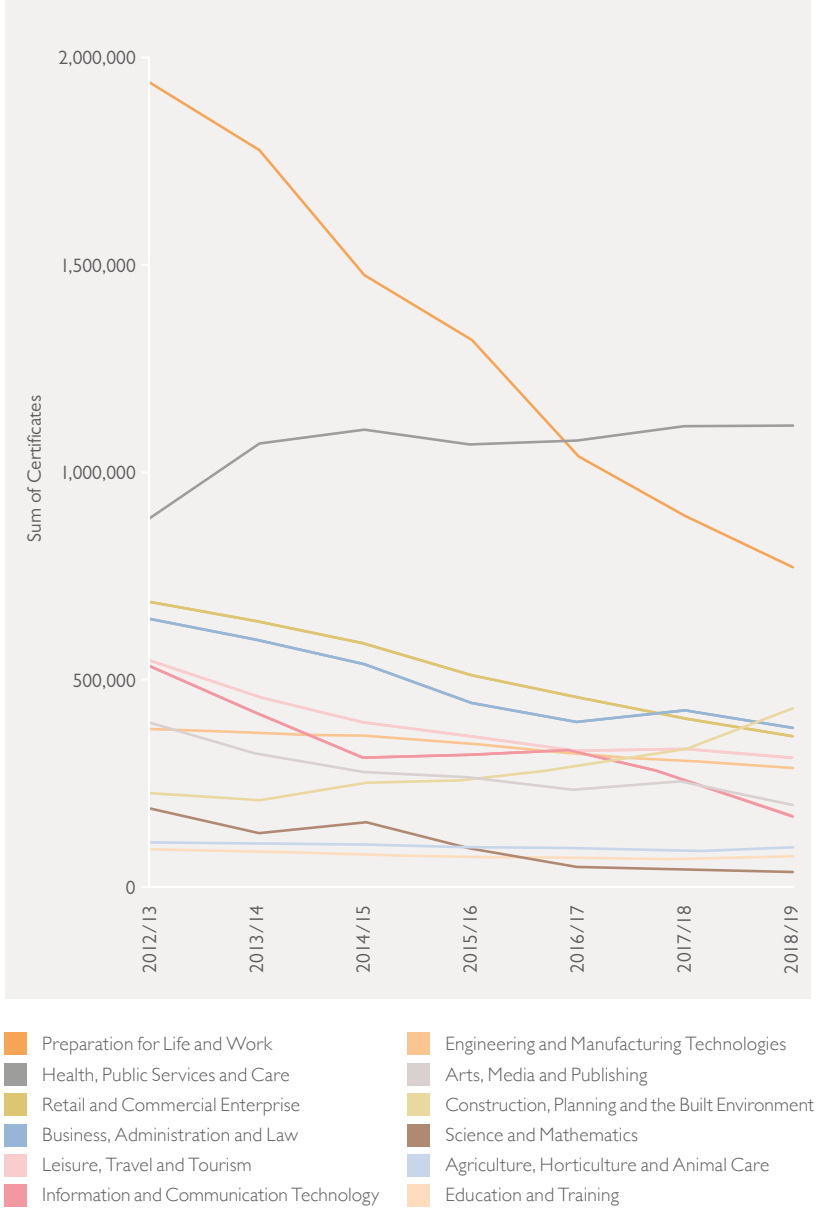

Chart 2: Proportion of certificates in vocational qualifications by Sector Subject Area in England.
Source: Ofqual Vocational Qualifications Dataset

APPRENTICESHIPS

In the last 10 years there have been two significant shifts in apprenticeship starts, both driven by eligibility criteria and funding. Firstly, the huge growth in people over the age of 25 starting apprenticeships from 2010/11 means that in 2019 those under 25 make up only 54% of the total number of apprenticeships starts, as shown in Chart 3.

Secondly, the introduction of the apprenticeship levy in 2017 has caused a fall in the number of apprentices. However, as Chart 4 shows, this fall has not been uniform across all levels. While Level 2 apprenticeship starts have fallen by 50%, Level 3 starts have only fallen by 8%, starts at higher technical (Levels 4 and 5) have doubled since 2015/16 (albeit from a very low base), and degree level apprenticeships have grown from around 750 to over 20,000.

As with vocational qualifications, apprenticeships are normally classified by Sector Subject Area (SSA). Chart 5 shows the starts by SSA from 2004/05 to 2018/19. Four SSAs stand out in terms of the numbers of apprenticeship starts: Business, Administration and Law; Health, Public Services and Care; Retail and Commercial Enterprise; Engineering and Manufacturing Technologies. Together they accounted for over 80% of apprenticeship starts in 2018/19.

> IN 2019 THOSE UNDER 25 MAKE UP ONLY 54% OF THE TOTAL NUMBER OF APPRENTICESHIPS STARTS

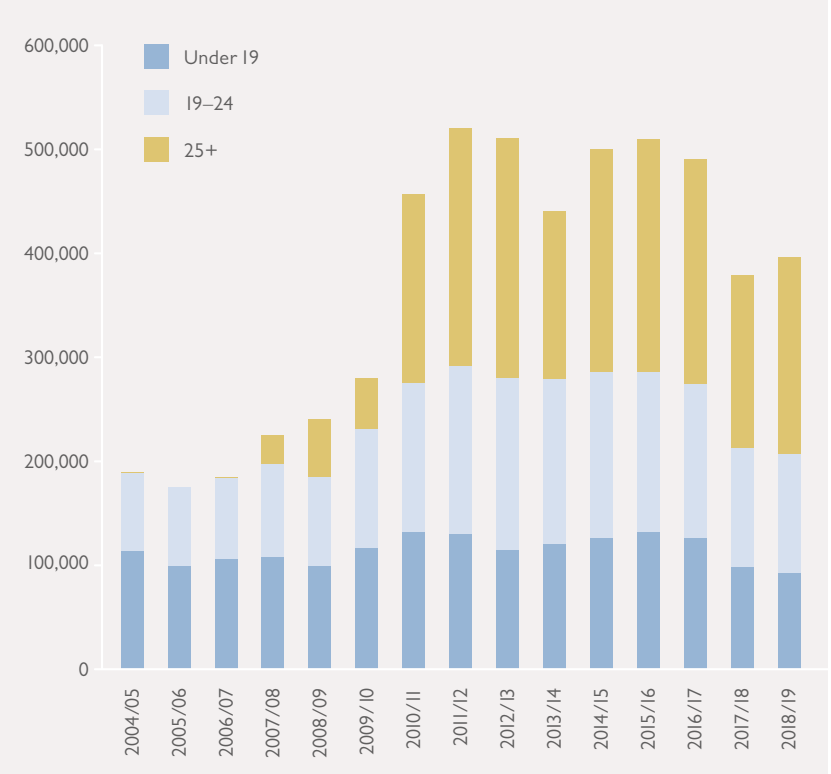

Chart 3: Apprenticeship starts in England by age over time. Source: DFE

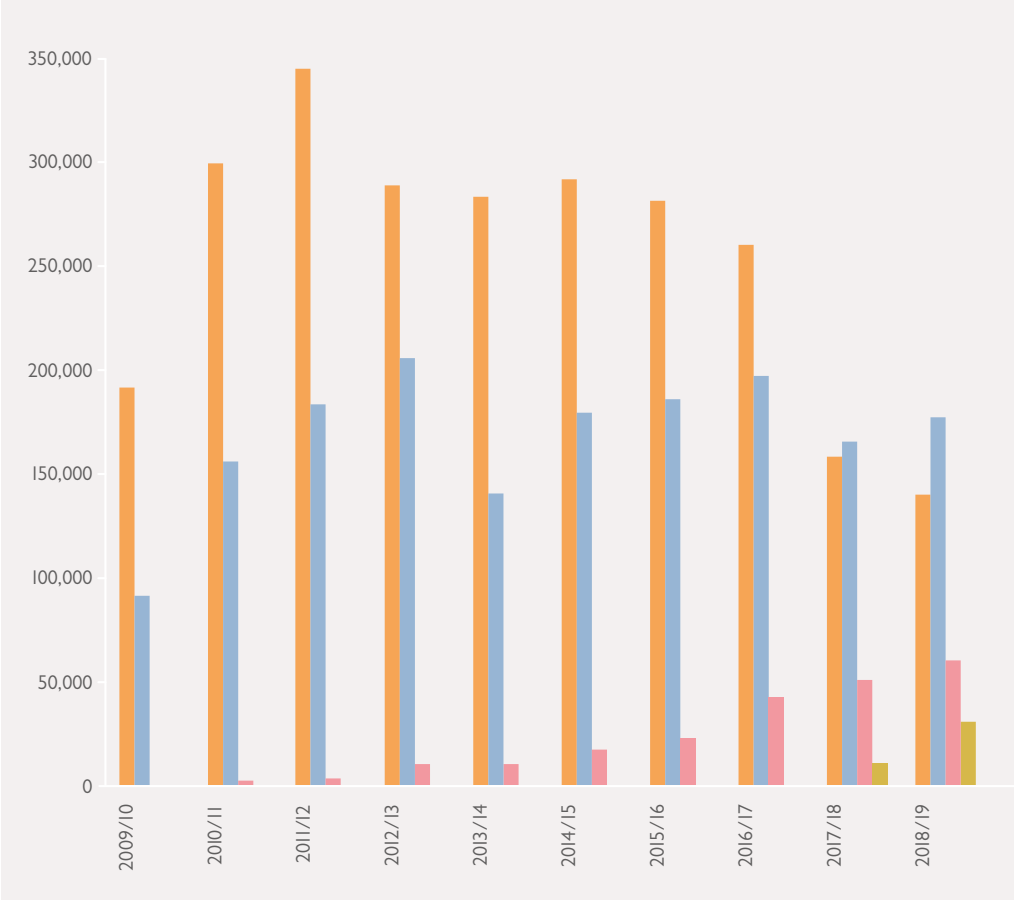

Chart 4: Apprenticeship starts in England by level over time. Source: DFE

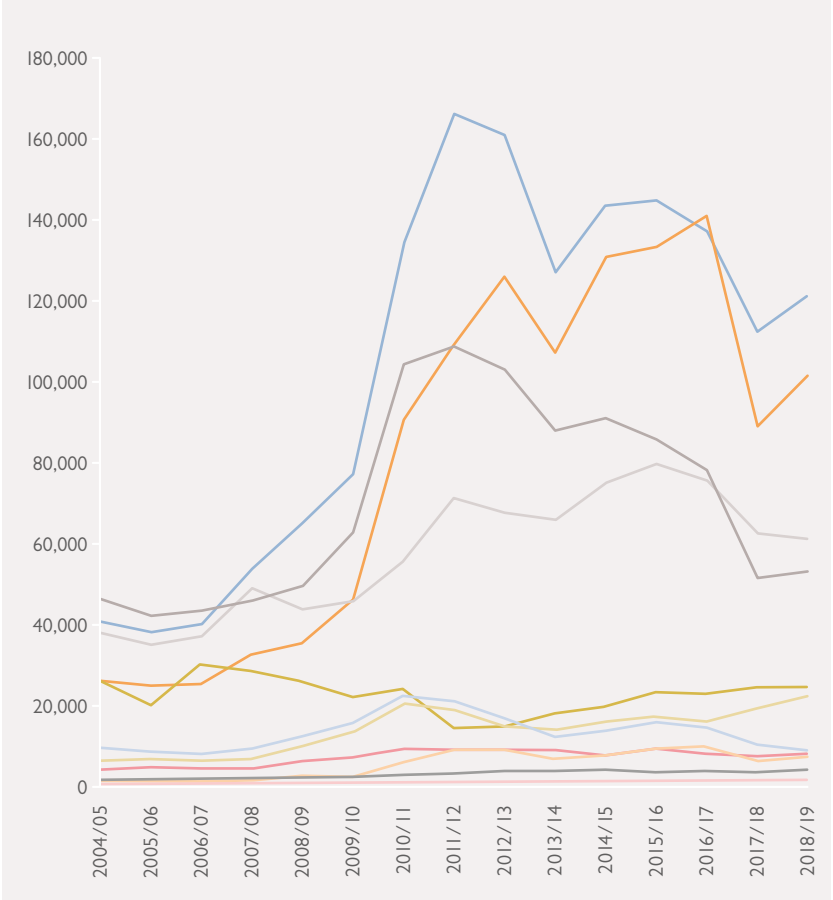

Chart 5: Apprenticeship starts in England by Sector Subject Area over time. Source: DFE

UNDERGRADUATES

Table 5 shows the growth in full-time undergraduate student numbers since 2009/10. STEM subjects account for around 47% of undergraduate numbers and this proportion has shown a small but steady increase in recent years. Subjects allied to Medicine, Biological Sciences and Engineering & Technology dominate in terms of numbers, but the largest increases since 2009/10 are to be found in Biological Sciences, Computer Science and Mathematical Sciences.

However, while overall undergraduate numbers in STEM subject areas have increased by 18% since 2009/10, this includes a significant growth in the number of non-UK students.

Table 4 shows the number of STEM undergraduates broken down by domicile. UK student numbers in STEM subjects have grown 14% since 2009/10, while other EU and non-EU student numbers in STEM subjects grew by 44% and 41%, respectively.

	Domicile	2009/10	2012/13	2015/16	2017/18	% change since 2009/10
STEM subjects	UK	528,735	548,270	576,110	604,340	14.3%
	Other EU	26,190	29,180	32,015	37,815	44.4%
	Non-EU	43,390	50,760	57,270	61,225	41.1%
All subjects	UK	1,160,855	1,180,880	1,212,055	1,263,085	8.9%
	Other EU	66,090	71,765	77,195	89,365	35.2%
	Non-EU	106,950	133,040	146,165	152,610	42.7%
Total	All	1,333,895	1,385,685	1,435,415	1,505,060	12.8%

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

The effect on these numbers of the UK's changing relationship with the European Union will become clearer in the next few years. Over the last decade the percentage increase in entrants from elsewhere in the EU is higher in STEM subjects than the average across all subjects.

	2009/10	2011/12	2013/14	2015/16	2017/18	% change since 2009/10
Medicine & Dentistry	45,455	46,300	45,665	45,075	45,700	0.5%
Subjects allied to Medicine	148,770	152,880	144,385	151,600	164,830	10.8%
Biological Sciences	122,370	135,975	144,895	154,760	162,745	33%
Veterinary Science	4,355	4,645	4,885	5,185	5,670	30.2%
Agriculture & related subjects	11,135	12,245	11,540	12,060	11,695	5%
Physical Sciences	57,190	62,860	65,575	68,550	68,825	20.3%
Mathematical Sciences	26,225	29,065	30,165	31,150	32,720	24.8%
Computer Science	58,680	61,135	61,640	66,340	74,370	26.7%
Engineering & Technology	89,480	95,725	98,735	103,825	107,940	20.6%
Architecture, Building & Planning	34,645	31,410	27,770	26,850	28,890	-16.6%
Total: STEM subject areas	598,305	632,230	635,260	665,395	703,385	17.6%
Subtotal: Non-STEM subject areas	735,595	779,740	756,330	770,020	801,680	9%
Total: All subject areas	1,333,900	1,411,970	1,391,590	1,435,415	1,505,065	12.8%
STEM as a percentage of all subjects	44.9%	44.7%	45.6%	46.4%	46.7%	

Table 5: Full-time student enrolments on undergraduate courses (UK HEIs). Source: HESA

TEACHER NUMBERS

A 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 6 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 changes to the administration of Subject Knowledge Enhancement, pre-initial teacher training courses designed to bring teaching candidates knowledge of a subject up to secondary teaching level. These changes appear to have affected Physics recruitment in particular, but other STEM subjects are also well under their recruitment target. The only STEM subject where the target has been met is Biology, in fact exceeding it by 66%. This means there are now more than three times as many Biology trainees than Physics trainees.

After many years of under-recruiting Physics specialists into teaching during the 1990s, numbers picked up significantly from 2009/10 to 2012/13, although the government target has never been reached and recruitment has fallen significantly short in recent years. The recruitment target continues to grow every year, partly due to school population growth and partly due to more teachers choosing to leave the profession. The Department for Education is attempting to address the shortage by increasing the training bursaries available.

> THERE ARE NOW MORE THAN THREE TIMES AS MANY BIOLOGY TRAINEES THAN PHYSICS TRAINEES

In 2019/20, training bursaries and scholarships of up to £28,000 are available for Physics, Chemistry and Computing teaching, depending on degree classification and experience.

For Biology it is up to £26,000 and for Maths it is up to £22,000 with two additional early career payments totalling £10,000.

Year	Physics	Chemistry	Biology	General Science	Maths	Computing	Design & Technology
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
2017/18	720	875	1,025		2,450	475	305
2018/19	575	835	1,815		2,195	530	295
2019/20	547	804	1,973		2,145	498	418
Gov't estimate for no. required in 2019/20	1,265	1,152	1,192		3,343	631	1,022

Table 6: Secondary school teachers recruited in science, maths and technology subjects in England. Source: DFE

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

Chart 6 shows the gender balance, or lack thereof, across STEM GCSEs, A-levels and apprenticeships. At GCSE, STEM subjects are relatively well-balanced in terms of gender, with the exceptions of Computing (79% male) and Design and Technology (70% male). However, post-GCSE there are significant variations in uptake of subjects by gender. Girls account for 50% of the entries to Physics GCSE but only 23% of entries to Physics A-level. The total cohort size for Physics A-level has increased by almost 30% in the last decade but the proportion of girls has remained almost static. Computing continues to be an unpopular subject among girls at A-level, where they make up only 13% of entries.

The figures for apprenticeships in Engineering, Information Technology and Construction are stark. In 2018/19 just 6% of Construction starts, 8% of Engineering starts and 20% of ICT starts were female.

> IN 2018/19 JUST 6% OF CONSTRUCTION STARTS, 8% OF ENGINEERING STARTS AND 20% OF ICT STARTS WERE FEMALE

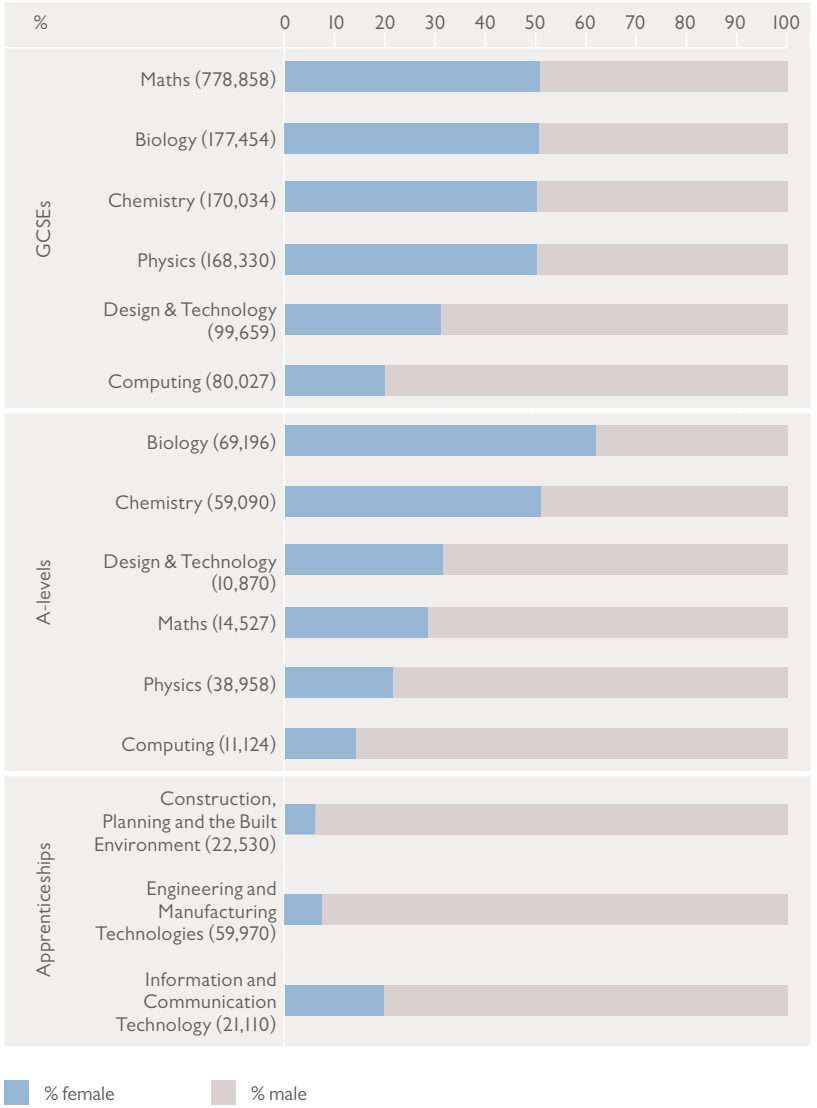

Chart 6: Gender balance across STEM GCSEs, A-levels and apprenticeships.
Source: DFE

Notes

All UK figures for GCSEs and A-levels (2019).
England figures for apprenticeships (2018/19).
Number of entries/starts are given in brackets.

UPCOMING CHANGES TO THE TECHNICAL EDUCATION LANDSCAPE

It is widely acknowledged that technical education in England has been long neglected, and that a better system is needed to give those in education a high-quality option to go into skilled employment.

In 2015 the Government set up the Independent Panel on Technical Education, chaired by David Sainsbury, which published a report with 34 recommendations in June 2016.

These recommendations were accepted in full by the Government and significant work to implement them has been done over the last three years, following the publication of the Post-16 Skills Plan.

The introduction of T-levels has been the most high-profile of these reforms, but others include the opening of Institutes of Technology, the development of employer panels (who ensure that each part of a technical education route develops the knowledge, skills and behaviours needed for the relevant occupations) and the review of apprenticeship standards.

At the heart of technical education will be the 15 routes, illustrated in Diagram 1. For each route there is an occupational map which brings together occupations with similar training requirements into pathways and occupation clusters. The maps also show typical progression pathways.

For more information on the reforms to technical education, the Sainsbury Review and the occupational maps, please visit **gatsby.org.uk/education** and **instituteforapprenticeships.org/about/occupational-maps**

> FOR EACH ROUTE THERE IS AN OCCUPATIONAL MAP WHICH BRINGS TOGETHER OCCUPATIONS WITH SIMILAR TRAINING REQUIREMENTS INTO PATHWAYS AND OCCUPATION CLUSTERS

1. Agriculture, Environmental and Animal Care
2. Business and Administration
3. Care Services
4. Catering and Hospitality
5. Construction
6. Creative and Design
7. Digital
8. Education and Childcare
9. Engineering and Manufacturing
10. Hair and Beauty
11. Health and Science
12. Legal, Finance and Accounting
13. Protective Services
14. Sales, Marketing and Procurement
15. Transport and Logistics

Diagram 1: Technical Education Routes.

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