KEY INDICATORS IN STEM EDUCATION

UPDATED 2016

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
PUBLIC POLICY RESEARCH AND ADVICE
THE ARTS

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

INTRODUCTION

This updated version of Key Indicators in STEM Education brings 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

The overall GCSE cohort size has been declining for several years. In 2007 there were approximately 800,000 16 year olds, falling to around 680,000 by 2015.

From 2008 in England and Wales, and 2010 in Northern Ireland, Core Science and Additional Science replaced Single Science and Double Science (which counted as two GCSEs). Further Additional Science was introduced in 2014 and offers students studying Core and Additional Science the opportunity to cover the remaining units of the separate science GCSE exams in biology, chemistry and physics.

There have been a number of changes in the last decade to the accountability measures and assessment rules that influence the entry patterns of schools in science. These include: the removal of the requirement for academies to follow the National Curriculum; changes in the way that applied/vocational qualifications such as BTECs are counted in school league tables; introduction of the EBacc measure; and changes to rules around coursework, terminal assessment and the resitting of modules.

The most striking trend in the last decade has been the rise of separate GCSEs in biology, chemistry and physics (referred to as 'Triple Science' when all three are sat together). Entries to Triple Science increased 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.

> THE MOST STRIKING TREND IN THE LAST DECADE HAS BEEN THE RISE OF SEPARATE GCSES IN BIOLOGY, CHEMISTRY AND PHYSICS (REFERRED TO AS 'TRIPLE SCIENCE' WHEN ALL THREE ARE SAT TOGETHER)

Year	Triple Science			Double Science	Single Science	Core Science	Additional Science	Further Additional Science
	Biology	Chemistry	Physics					
2005	56,522	53,428	52,568	494,450	89,348			
2006	60,082	56,764	56,035	479,789	96,374			
2007	63,208	59,216	58,391	478,028	98,485	57,316		
2008	85,521	76,656	75,383	8,433	4,445	537,606	433,468	
2009	100,905	92,246	91,179	7,594	3,954	493,505	396,946	
2010	129,464	121,988	120,455	7,497	4,060	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			374,961	323,944	21,119
2015	139,199	133,618	133,610			395,484	332,960	23,389

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

In 2014 and 2015 there have been falls in the numbers taking Triple Science. This was most likely the result of a combination of factors, including: a shift from students studying Triple Science into Core/Additional/Further Additional Science courses; a move to iGCSEs for some schools; and teacher concerns about the assessment load of Triple Science – especially on borderline grade C students – now that the majority of assessment is terminal rather than modular.

When looking at GCSEs alongside A-Level trends (see next section), a correlation can be observed between the increase in the number of students studying Triple Science at GCSE and an increase in the number of science A-Levels achieved two years later. In 2015 however, despite an increase in Triple Science GCSE entries in 2013, science A-Level student numbers are down. At this stage, we cannot be certain of whether this is a 'blip' or a continuing trend. We await any indication of whether the introduction in 2014 of Further Additional Science GCSE will encourage more pupils to study science at A-Level.

A-LEVELS

Both maths and further maths continue to show significant increases in participation. It is worth noting, however, that there was a significant drop in A-Level maths numbers in 2002 following government reforms made to A-Levels in 2000. It took until 2007 for maths A-Level numbers to return to 2000 levels.

A-Level science numbers had been rising steadily. In 2015, however, we saw a drop of 1.1% in physics entries, 1.6% in chemistry and 1.2% in biology. These 2015 falls must also be considered in the light of a 2.0% rise in the overall number of A-Levels taken compared with 2014. For a longer-term perspective, Chart 1 shows the trend since 1985.

> A-LEVEL SCIENCE NUMBERS HAD BEEN RISING STEADILY. IN 2015, HOWEVER, WE SAW A DROP OF 1.1% IN PHYSICS ENTRIES, 1.6% IN CHEMISTRY AND 1.2% IN BIOLOGY

Year	Maths	Further Maths	Physics	Chemistry	Biology
2005	52,897	5,933	28,119	38,851	53,968
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

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

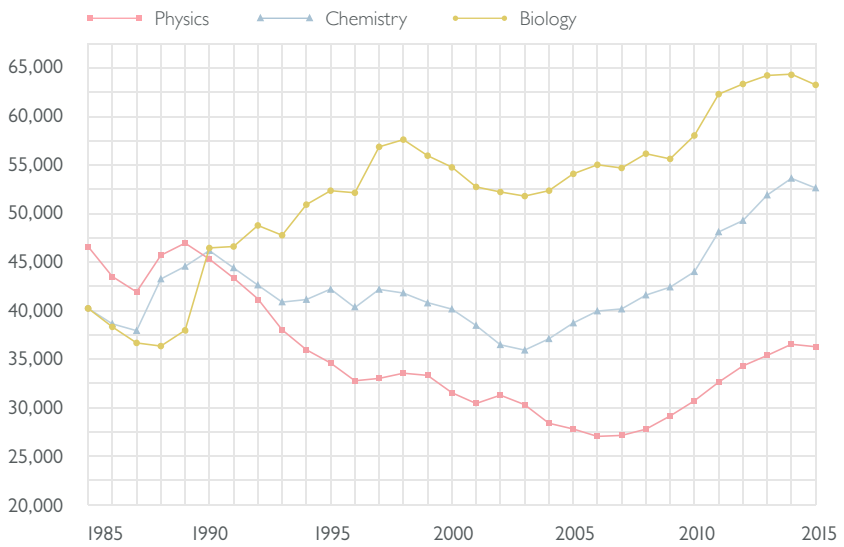

Chart 1: Entries to science A-Levels in the UK (all ages). Source: JCQ

UNDERGRADUATES

Table 4 shows the growth in full-time undergraduate student numbers since 2004/05. STEM subjects account for around 46% of undergraduate numbers and this proportion has remained reasonably steady for many years.

However, while overall undergraduate numbers in STEM subject areas have increased by 18% since 2004/05, 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 14% since 2004/05, while other EU and non-EU student numbers in STEM grew by 58% and 54% respectively.

	Domicile	2004/05	2007/08	2010/11	2013/14	% change since 2004/05
STEM subjects	UK	486,010	497,430	540,860	552,590	13.7%
	Other EU	18,735	22,915	27,310	29,685	58.4%
	Non-EU	34,410	36,240	47,790	52,980	54.0%
Non-STEM subjects	UK	552,350	589,215	639,235	626,835	13.5%
	Other EU	26,250	34,440	42,020	42,350	61.3%
	Non-EU	47,685	51,770	70,075	87,110	82.7%
All subjects	UK	1,038,360	1,086,645	1,180,095	1,179,425	13.6%
	Other EU	44,985	57,355	69,330	72,035	60.1%
	Non-EU	82,095	88,010	117,865	140,090	70.6%
Total	All	1,165,440	1,232,010	1,367,290	1,391,550	19.4%

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

	2004/05	2007/08	2010/11	2013/2014	% change since 2004/05
Mathematical sciences	20,145	22,770	27,530	30,165	49.7%
Veterinary science	3,525	4,080	4,545	4,890	38.7%
Biological sciences	100,050	111,690	128,250	144,895	44.8%
Physical sciences	48,000	52,685	59,975	65,575	36.6%
Architecture, building & planning	23,865	31,455	33,450	27,775	16.4%
Engineering & technology	75,720	80,425	92,580	98,735	30.4%
Medicine & dentistry	38,395	43,820	45,920	45,670	18.9%
Agriculture & related subjects	9,665	10,050	11,765	11,540	19.4%
Subjects allied to medicine	146,290	143,910	151,580	144,380	-1.3%
Computer science	73,515	55,700	60,385	61,640	-16.2%
Total: STEM subject areas	539,170	556,585	615,980	635,265	17.8%
Education	40,970	51,735	57,830	55,815	36.2%
Social studies	102,435	110,700	125,665	133,645	30.5%
Creative arts & design	116,300	129,595	144,110	140,080	20.4%
Business & administrative studies	150,260	156,765	182,490	192,325	28.0%
Law	50,455	54,160	58,560	58,655	16.3%
Mass communications & documentation	33,605	35,750	39,620	37,950	12.9%
Historical & philosophical studies	49,615	52,560	55,680	54,435	9.7%
Languages	74,390	78,035	83,155	79,860	7.4%
Combined	8,240	6,120	4,245	3,555	-56.9%
Total: Non-STEM subject areas	626,270	675,420	751,355	756,320	20.8%
Total: All subject areas	1,165,440	1,232,005	1,367,335	1,391,585	19.4%
STEM as a percentage of all subjects	46.3%	45.2%	45.0%	45.7%	

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

In 2014/15 school-led training accounted for more than 50% of all new teachers, but only 44% of physics trainees.

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 and 2014.

The Department for Education (DfE) is attempting to address the shortage by increasing the training bursary available. The training bursary for 2016/17 for physics teaching is up to £30,000 depending on degree classification and experience. For maths, computing and chemistry it is up to £25,000 and for biology up to £20,000. In 2015 there has been a welcome upturn to 723 physics recruits but there is still a way to go if we are going to hit the required target.

	Physics	Chemistry	Biology	General Science	Design & Technology	Computer Science	Maths
2008/09	584	889	1,194	988	1,297		2,531
2009/10	571	963	1,241	924	1,437		2,897
2010/11	656	999	1,097	902	1,363		2,797
2011/12	864	1,305	696	375	976		2,687
2012/13	900	1,170	800	50	700		2,500
2013/14	700	1,080	700		380	350	2,230
2014/15	661 (24)	850 (42)	766 (159)		450 (8)	519 (11)	2,186 (230)
2015/16	723 (23)	961 (42)	920 (130)		526 (8)	509 (0)	2,197 (210)
Gov't estimate for no. required in 2015/16	1,055	1,053	1,178		1,279	723	2,581

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 given in brackets for 2014/15 and 2015/16 [these numbers are in addition to the non-bracketed numbers, to allow consistent reporting.]

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 engineering (93% male) and computing (84% 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.

Computing continues to be an unpopular subject among girls at A-Level – they make up only 9% of entries. The figures for Level 3 apprenticeships in engineering are stark – only 4% of all starts in 2013/14 were girls. Chart 2 on the following page shows the gender balance, or lack thereof, across STEM GCSEs, A-Levels and advanced apprenticeships.

> THE FIGURES FOR LEVEL 3 APPRENTICESHIPS IN ENGINEERING ARE STARK – ONLY 4% OF ALL STARTS IN 2013/14 WERE GIRLS

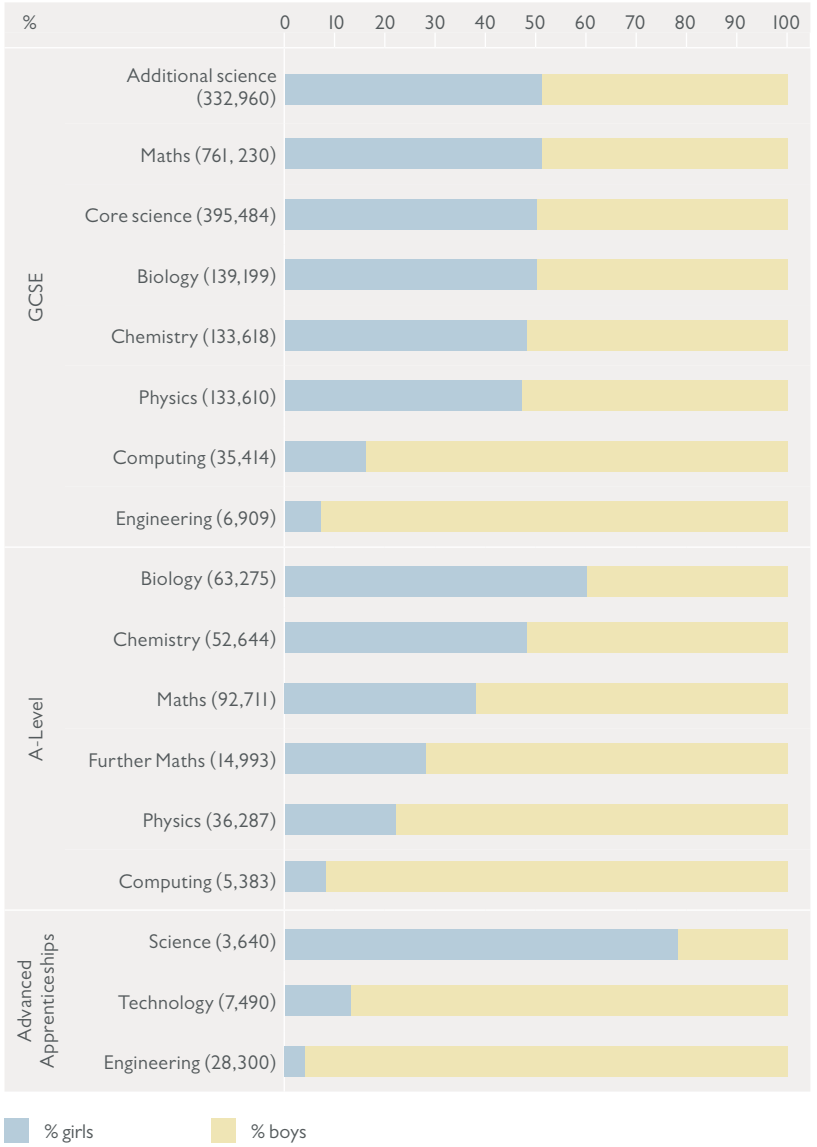

Chart 2: Gender balance across STEM GCSEs, A-Levels and advanced apprenticeships.
Sources: JCQ and SFA/BIS

Notes
All UK figures for GCSEs and A-Levels (2015),
England figures for advanced apprenticeships (2013/14).
Numbers of entries/starts given in brackets.

APPRENTICESHIPS

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

– intermediate apprenticeships (Level 2)

– advanced apprenticeships (Level 3)

– higher apprenticeships (Level 4 and above).

The system underwent significant reform in 2002/03 and since then there has been a huge expansion in the number of apprenticeships starts. Chart 3 shows that growth has mainly been at Level 2 and in sectors such as health, retail and business administration rather than in science, engineering or technology (SET). This is a unique feature of the English system compared to other EU countries where almost all apprenticeships are Level 3 and higher.

Since 2003/04 there has been a 154% increase in the overall number of Level 3 apprenticeship starts. As illustrated in Chart 4 on page 16, while the proportion of starts in SET areas has decreased over the last decade, the actual number of starts has increased by over 10,000 at Level 3. Provisional figures for 2014/15 show a welcome increase in the number of SET apprenticeships at Level 3 (provisionally 45,130 starts – the highest to date).

Higher apprenticeships (Level 4 and above), while growing in number in recent years, still represent a tiny proportion of overall apprenticeship numbers. There were 9,200 higher apprenticeship starts in 2013/14 and 1,040 of these were in SET-related areas. The most popular higher apprenticeships in 2013/14 were in care leadership and management (3,450 starts), management (1,850 starts) and accountancy (1,280 starts).

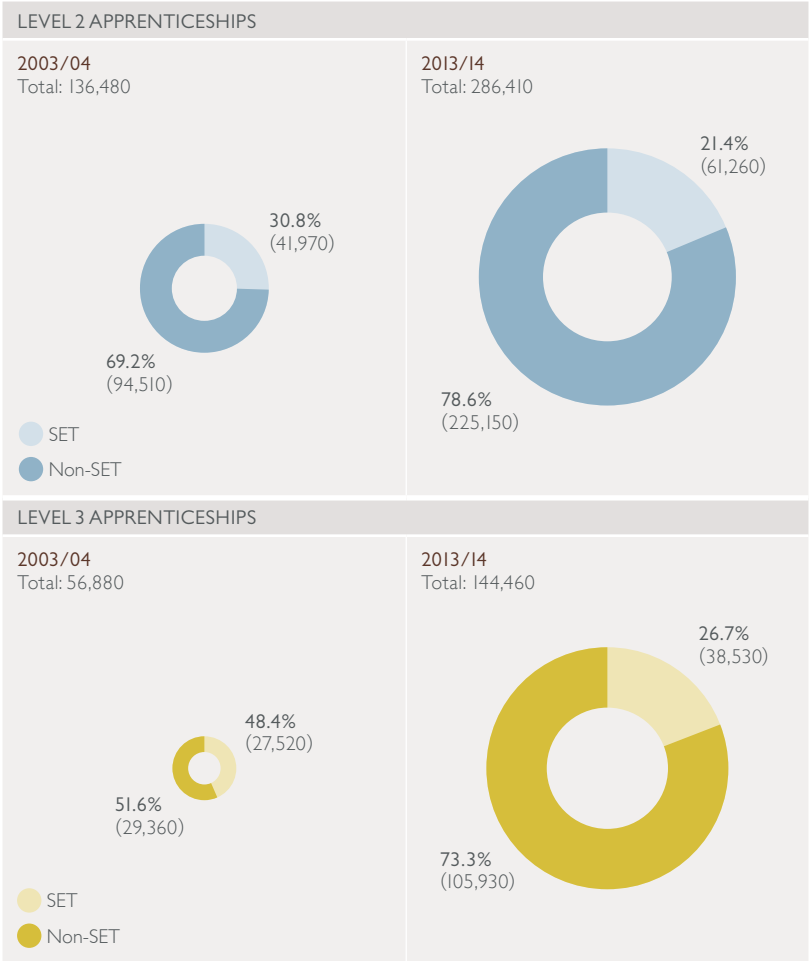

Chart 3: Growth in SET and non-SET apprenticeship numbers. Source: SFA/BIS

IN SET AREAS THE ACTUAL NUMBER OF STARTS HAS INCREASED BY OVER 10,000 AT LEVEL 3 SINCE 2003/04

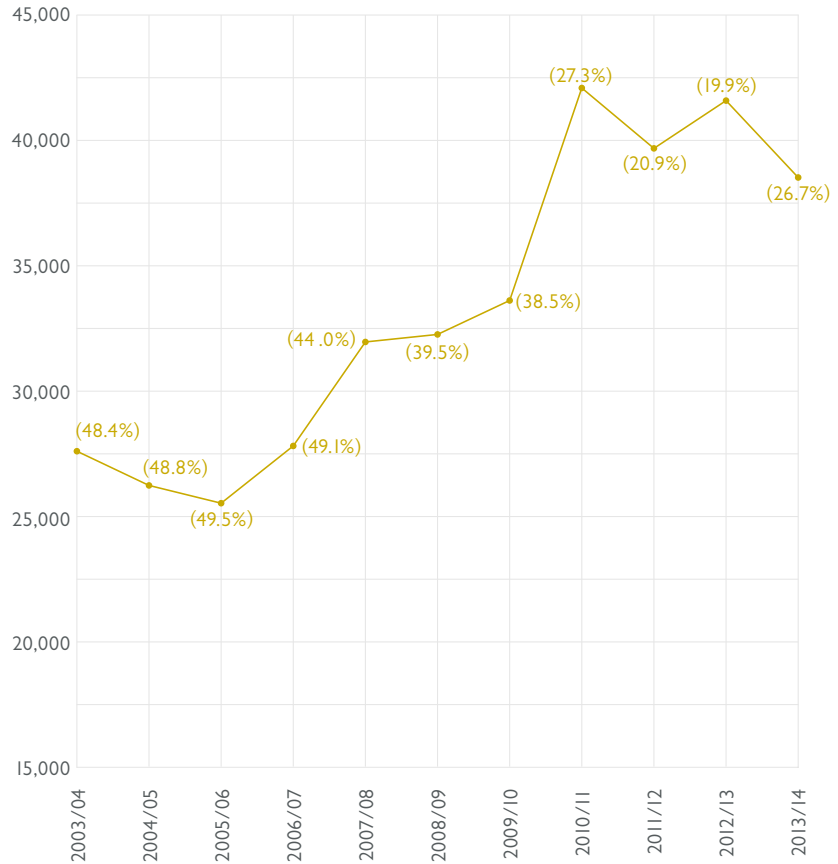

Chart 4: Level 3 apprenticeship starts in SET. Source: SFA/BIS

Notes

The figures in the brackets represent the proportion of Level 3 apprenticeship starts that were in SET areas.

WE BELIEVE THAT POLICYMAKERS, MEMBERS OF THE STEM EDUCATION COMMUNITY, EMPLOYER GROUPS AND OTHERS MUST MAKE USE OF KEY DATA WHEN DISCUSSING POLICY INTERVENTIONS IN THIS AREA.

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