KEY INDICATORS IN STEM EDUCATION

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 leaflet brings together key data relating to science, technology, engineering and mathematics (STEM) education. It focuses on the number of people studying STEM subjects at GCSE, A-Level and undergraduate degree levels and also includes data on apprenticeships. We hope it 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 spans 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 here 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 690,000 by 2014.

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).

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.

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.

Year	Triple Science			Double Science	Single Science	Core Science	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

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

The correlation is particularly striking in the case of physics, where A-Level numbers began to rise steeply from 2008 after falling for nearly two decades. However, examining the data for chemistry and biology suggests that, although a contributing factor, it was not Triple Science alone that led to the rise in A-Level science numbers. Chemistry and biology A-Level numbers began to rise before Triple Science was introduced in many schools, although one can observe a steepening in the rate of rise when Triple Science began to become widespread.

2014 saw a significant fall in the numbers taking Triple Science at GCSE. This has most likely been the result of a combination of factors, including a large reduction in the number of students entering GCSE a year early, and possibly 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. We will need to wait until 2015 to see the degree to which these changes represent a 'blip' or the start of a longer-term trend and what effect, if any, this has on A-Level science numbers.

A-LEVELS

Both maths and further maths have shown very significant increases in participation over the period shown. 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.

> THERE IS STILL A VERY SIGNIFICANT GENDER IMBALANCE IN PHYSICS AND FURTHER MATHS

It took until 2007 for maths A-Level numbers to return to 2000 levels. A-Level science numbers have been rising steadily over the last 8-10 years. These rises did however come after more than a decade of falling numbers. Chart 1, to the right, shows the trend since 1985.

In recent years more males and females have chosen to study science A-Levels but there is still a very significant gender imbalance in physics and further maths (where 79% and 72% of the entries were male in 2014 respectively) and, to a lesser degree, in maths (61% male) and biology (59% female). Chemistry is more balanced, with 48% of the 2014 cohort being female.

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

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

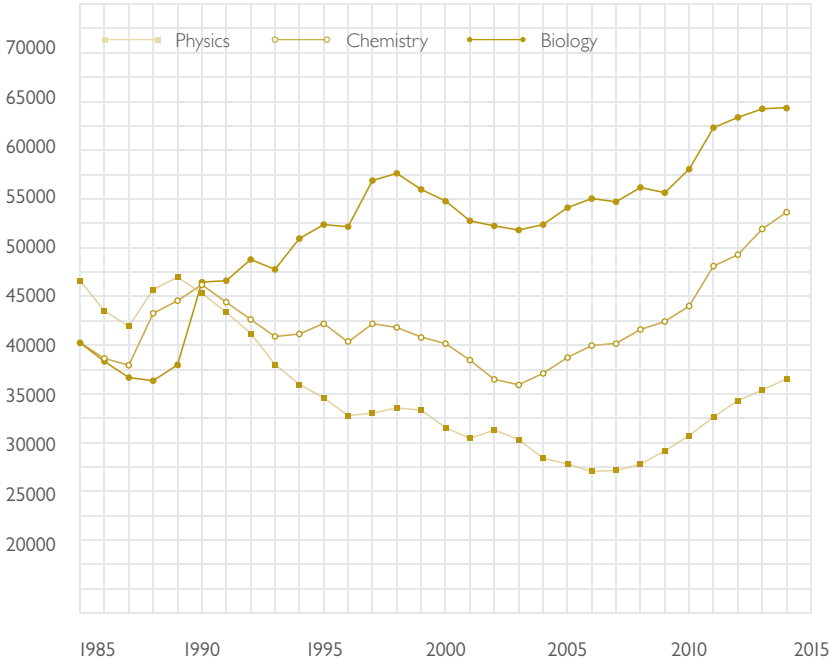

Chart 1: Entries to science A-Levels in the UK (all ages). Source: JCQ

UNDERGRADUATES

Table 4 to the right shows the growth in full-time undergraduate student numbers since 2003/04. STEM subjects account for around 45% 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 2003/04, 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 by 14% since 2003/04, while other EU and non-EU student numbers in STEM grew by 72% and 51% respectively.

	Domicile	2003/04	2006/07	2009/10	2012/13	Change since 2003/04
STEM subjects	UK	480,085	497,290	528,735	548,270	14.2%
	Other EU	16,955	21,125	26,190	29,180	72.1%
	Non-EU	33,630	35,240	43,390	50,760	50.9%
Non-STEM subjects	UK	541,170	574,260	632,120	632,610	16.9%
	Other EU	23,290	31,365	39,900	42,585	82.8%
	Non-EU	46,705	49,390	63,560	82,280	76.2%
All subjects	UK	1,021,255	1,071,550	1,160,855	1,180,880	15.6%
	Other EU	40,245	52,490	66,090	71,765	78.3%
	Non-EU	80,335	84,630	106,950	133,040	65.6%
Total	All	1,141,850	1,208,645	1,333,900	1,385,675	21.4%

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

	2003/04	2006/07	2009/10	2012/13	Change since 2003/04
Mathematical sciences	19,590	21,670	26,225	29,600	51.1%
Veterinary science	3,320	3,855	4,355	4,800	44.6%
Biological sciences	96,605	108,830	122,370	139,130	44.0%
Physical sciences	47,440	50,765	57,190	63,940	34.8%
Architecture, building & planning	22,655	29,695	34,645	29,235	29.0%
Engineering & technology	75,185	77,120	89,480	96,360	28.2%
Medicine & dentistry	36,270	42,950	45,455	46,230	27.5%
Agriculture & related subjects	9,935	9,785	11,135	11,690	17.7%
Subjects allied to medicine	138,345	149,870	148,770	147,615	6.7%
Computer science	81,340	59,090	58,680	59,600	-26.7%
Subtotal: STEM subject areas	530,685	553,630	598,305	628,200	18.4%
Education	36,915	46,000	57,060	55,970	51.6%
Social studies	98,070	107,275	122,050	131,890	34.5%
Creative arts & design	109,955	125,420	140,615	143,210	30.2%
Business & administrative studies	149,965	152,635	177,285	188,965	26.0%
Law	47,245	52,960	58,140	57,865	22.5%
Mass communications & documentation	32,565	34,540	38,790	38,595	18.5%
Historical & philosophical studies	49,880	52,385	54,255	54,785	9.8%
Languages	76,005	76,500	81,990	81,900	7.8%
Combined	10,570	7,295	5,420	4,290	-59.4%
Subtotal: Non-STEM subject areas	611,170	655,010	735,605	757,470	23.9%
Total: All subject areas	1,141,850	1,208,645	1,333,900	1,385,675	21.4%
STEM as a percentage of all subjects	46.5%	45.8%	44.9%	45.3%	

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

TEACHER RECRUITMENT

Table 5 to the right 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 during the last decade. 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 both of the last two years.

	Physics	Chemistry	Biology	General Science	Design & Technology	Computer Science	Mathematics
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	850	766		450	519	2,186
Gov't estimate for no. required in 2014/15	985	715	905		1,030	610	2,495

Table 5: Secondary school teachers recruited in STEM subjects in England, excluding Teach First route.

Notes

From 2013/14, general science recruits included within biology.

Data taken from NCTL census (first published version each year).

Teach First data excluded to allow consistent reporting across years. In 2014/15, Teach First recruited 230 maths teachers; and 231 science teachers including 18 physicists, 26 chemists and 130 biologists (the remainder were general science/other).

APPRENTICESHIPS

The government-funded apprenticeship system in England has three categories of apprenticeship: intermediate apprenticeships (Level 2); advanced apprenticeships (Level 3); and higher apprenticeships (Level 4 and above). In the last decade there has been a significant expansion in the number of government-funded apprenticeships but, as Chart 2 to the right shows, growth has largely been at Level 2 and in sectors not traditionally associated with apprenticeships, such as health, retail and business administration.

In 2012/13, 38,950 people started a Level 3 apprenticeship in science, engineering or technology (SET). A decade earlier, in 2002/03, this figure was 20,950. But this increase is dwarfed by the expansion of non-SET Level 3 apprenticeships, which have risen sixfold from 27,200 in 2002/03 to 167,600 in 2012/13.

Level 2 apprenticeships now dominate. This is a unique feature of the English system – we are the only country where Level 2 apprenticeships far outnumber those at Level 3, and in countries with world-renowned apprenticeship systems, such as Austria, Germany and Switzerland, almost all apprenticeships are Level 3.

Higher apprenticeships (Level 4 and above), while growing in number in recent years, still represent a tiny proportion of overall apprenticeship numbers. There were 9,800 people who started a higher apprenticeship in 2012/13 and just 700 of these were in SET-related areas. The most popular higher apprenticeships in 2012/13 were in care leadership and management (2,970 starts), management (2,540 starts) and accountancy (2,190 starts).

> WE ARE THE ONLY COUNTRY WHERE LEVEL 2 APPRENTICESHIPS FAR OUTNUMBER THOSE AT LEVEL 3

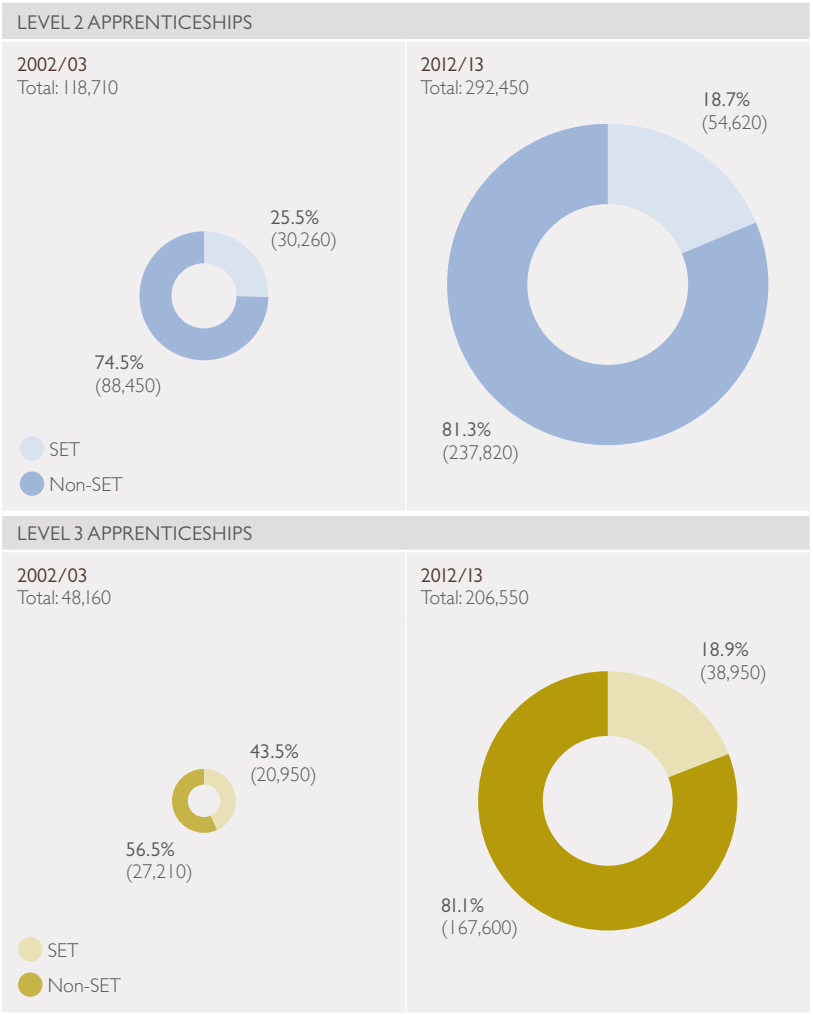

Chart 2: Growth in SET and non-SET apprenticeship numbers. Source: SFA/BIS

STEM ENHANCEMENT AND ENRICHMENT ACTIVITIES

There are several national initiatives which seek to enhance and enrich the science and engineering taught in schools and colleges. Three of the most significant are:

STEM AMBASSADORS PROGRAMME

The STEM Ambassadors programme brings volunteers working in STEM sectors into the classroom to enthuse young people about STEM subjects and careers. There are currently 28,000 registered Ambassadors across the UK taking part in around 10,000 activities each year. Over 40% of Ambassadors are female and 65% are under 35 years old. A recent evaluation found that pupils are 90% more likely to be interested in continuing to study STEM subjects after engaging with STEM Ambassadors.

STEM CLUB

STEM Clubs act as a focus for teachers to engage in STEM activity which takes pupils beyond the curriculum. Around 60% of UK secondary schools (2,400 schools) currently have a STEM Club, with a target to increase this figure to 80% by 2015/16. Teachers regularly report that STEM Clubs have led to an increase in pupils' attainment in STEM subjects, and pupils who participate in STEM Clubs are more likely to want a job in STEM.

THE BIG BANG

The Big Bang is the largest celebration of STEM for young people in the UK. Through a four day national event – The Big Bang Fair – every March, and a series of regional and local events, the Big Bang aims to show pupils aged 7-19 the wide range of exciting and rewarding opportunities that exist in STEM occupations. 5,500 people attended the first Big Bang Fair in 2009. By 2014, this number had risen to 75,000.

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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