# IN THE BALANCE

## The STEM human capital crunch

Nida Broughton

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## ABOUT THE AUTHOR

Nida Broughton is a Senior Economist at the Social Market Foundation, where her research has focused on public spending, public services and economic growth. She previously worked at the House of Commons, where she advised MPs and committees on a broad range of economic and financial issues. Nida also has in-depth expertise in microeconomics and competition policy, gained whilst working at Ofcom, the UK regulator and competition authority for communications markets. She has an MA (Cantab) in Economics from Cambridge University and an MSc in Economics from Birkbeck College, University of London.

## EXECUTIVE SUMMARY

UK economic output is flatlining, with GDP still below 2007–08 levels. In addition, projections of future growth look anaemic, raising questions as to where future growth is to come from. In the wake of the financial crisis and subsequent recession, the Government set out its aim to stimulate exports and 'rebalance' the economy away from financial services and the south east, towards other sectors and regions, including manufacturing, life sciences and green energy.

This path to growth is heavily reliant on building and sustaining the health of the science, technology, engineering and maths (STEM) industries. The success of this strategy will depend crucially on the available STEM skills base. With political pressure to reduce immigration, it has become vital to ensure that there will be sufficient home-grown talent to satisfy the employment requirements in this sector.

This paper examines the mismatch between projected employment requirements in the STEM industries and the likely domestic supply of individuals with the requisite STEM skills in the context of economic rebalancing. First, we analyse the current situation, looking at the policy and economic context of the debate and the shortages that already exist in the STEM sectors. We then look at the scale of the challenge ahead and illustrate the likely impact of targeted policies to increase the pipeline of STEM-qualified individuals. We conclude by exploring what policy changes may be required to meet anticipated demand for domestic STEM-qualified individuals.

On the current picture we find that:

- There are already shortages in the supply of UK-domiciled STEM-qualified labour.

- STEM-qualified individuals are in demand across the core STEM sectors, but also across the wider economy, meaning that the supply of STEM-qualified individuals actually has to be higher than the number of STEM jobs to ensure that demand from the STEM sector is met.
- The UK has a long-run home-grown STEM skills deficit, and has tended to rely on migration to make up the shortfall in domestic supply in several areas of STEM.

Projections of future employment requirements imply a large increase in demand for STEM-qualified workers, even without any policy action to foster growth in this sector. But while demand for skilled workers is rising rapidly, other policy pressures are pushing supply in the opposite direction. There is significant political pressure to reduce migration, with a Government target to reduce net migration levels to the 'tens of thousands' by the end of the parliament, and a number of measures introduced to reduce non-EU migration. There is also political pressure to reduce EU migration, and given the political debate over EU withdrawal, there is uncertainty for UK businesses as to whether EU workers will be able to fill employment demand in the future. This means that the real challenge ahead is to make sure that the UK can produce sufficient numbers of qualified home-grown individuals to satisfy demand in the UK STEM sector. This will also have the beneficial effect of ensuring that the UK's young people are equipped with the skills they need to take up high productivity jobs in the new economy.

On this challenge ahead we find that:

- Even before any rebalancing, the Royal Academy of Engineering and Big Innovation Centre estimate that demand for new workers will average 104,000 STEM graduates and 56,000 STEM technicians in each year between now and 2020.
- There were around 82,000 UK-domiciled graduates in STEM

in 2011–12, of which an estimated 18,000 will go into non-STEM occupations. Based on this, **we calculate that there remains an annual shortfall in domestic supply of around 40,000 STEM graduates.** To close this shortfall with domestic employees, the number of UK STEM graduates would have to increase by around a half. Again, this is without taking into account the policy aim to rebalance the economy.

- Engineering and IT are expected to see particularly high levels of demand. According to the same study, 80% of the future demand set out above for both STEM graduates and STEM technicians is expected to be in engineering and IT. This equates to a demand for new workers in these sectors of 128,000 qualified individuals each year.
- Looking at engineering specifically, another study by EngineeringUK and Warwick IER, which used a broader engineering footprint and included qualifications from Level 4 upwards, indicates even higher levels of demand for new workers in the years ahead. It is estimated that 87,000 engineers qualified at Level 4+ and 69,000 qualified at Level 3 will be needed in each year between now and 2020. In total, this equates to a demand for new workers of 156,000 each year – equivalent to almost one in five of UK 21-year-olds entering the engineering profession alone each year between now and 2020.

To achieve economic rebalancing on the scale set out by the Government will require us to go even further. Skills have a significant impact on economic growth, and skills shortages in STEM are likely to limit the STEM sector's ability to expand as our politicians would like it to. Insufficient focus on skills now means that the UK's young people will be ill-equipped to take advantage of the high productivity jobs that could be created from the rebalancing of the economy. If we are to fulfil the estimated employment requirements and make progress in economic rebalancing, **the UK will need to substantially increase the number of individuals taking STEM subjects at school.**

On increasing the pipeline of STEM qualified individuals we find that there are several points at which potential future STEM employees are lost to other subjects and sectors. Of those who achieve good science GCSEs two years earlier, only around one fifth go on to take science A-levels. Just under 60% of those who take science A-levels graduate in STEM subjects. And even of those who graduate in STEM, around 18–29% go on to work outside STEM occupations. One way to address the shortfall is for policymakers to focus on reducing the proportion of students lost to non-STEM subjects at each educational transition point.

There is some scope to increase A-level STEM take-up amongst those who do well at GCSE, and by reducing disparities in GCSE achievement between different groups of students. Raising the performance of all groups to the level of the best could help to make some inroads into the shortfall across STEM, as set out below.

- **Raising GCSE science achievement among boys and A-level science take-up among girls:** If boys did as well as girls at science GCSE and girls took up A-level science at the same rate as boys, the number of pupils doing A-level science in England and Wales in recent years would have been higher by an average of around 11,000 to 13,000 each year, or 14% to 16% higher per year.
- **Bringing take-up of science A-levels in England and Wales to Northern Ireland levels**: If the proportions of A-level students taking science in England and Wales had been as high as that in Northern Ireland in recent years, the number of pupils doing A-level science in England and Wales would have been higher by around 13,000 to 17,000 each year, or 16% to 22% higher per year.
- **Raising science GCSE achievement amongst those eligible for free school meals to the level of others**: If those on free school meals in England had done as well in GCSE science in recent years as the rest of their cohort, the number of pupils

doing A-level science in England would have been higher by an average of 3,000 to 4,000 each year, or 4% to 5% higher per year.

However, even these measures taken together will only do a modest amount to close the STEM skills gap. Even if there are no overlaps in the groups that these policies target, successful policies in these areas would have only added around 30,000 additional A-level science students per year in the last few years. On the current rate of progression onto STEM degrees, this could translate into an increase of around 18,000 STEM graduates per year. This is far below the shortfall of 40,000. In practice there are likely to be overlaps in the groups targeted by the different policies, and some of the additional STEM graduates may not go into STEM occupations, which means that the gain to domestic supply from removing disparities would be even lower.

This means that the real solution to the UK's huge STEM skills deficit lies in starting much earlier to boost GCSE STEM attainment across the board. At the moment, too few students achieve good GCSE grades: in 2011–12, **24% of pupils did not even attempt a science GCSE and only 49% achieved the science component of the EBacc.**

## So how can we meet the challenge ahead?

Teaching has a major impact on achievement, so expanding the supply of science and maths teachers is vital if we are to avoid a vicious cycle of self-perpetuating STEM skills shortages. To achieve this, we recommend the following policy interventions:

- Policymakers should explore methods to **make the profession more financially attractive** relative to the many other employment options that are open to science and maths graduates.
- The numbers of **STEM teachers on the Teach First programme** should be further expanded, building on support from the STEM industry.

- More radical measures could include **relaxing the initial eligibility criteria for teacher training** and encouraging more **international recruitment of science and maths teachers** in the short-term.

Measures to push up GCSE achievement will take time and require interventions at an earlier age. And encouraging more science and maths graduates to go into teaching will narrow the pool of labour for STEM industries in the short-term. This leads to two conclusions:

1. Given the home-grown STEM skills shortage, it is inconceivable that the Government's planned rebalancing can take place in the short-term without substantial levels of migration. But at the moment, the Government has a target to *reduce* net migration to 'tens of thousands' by the end of the parliament.
2. Any further delays to improving our home-grown supply of STEM skills will make these industries even more reliant on migration in the future, further undermining the Government's aim to reduce migration whilst rebalancing the economy.

The STEM sector has been identified as an area to drive the UK's future economic growth in the new rebalanced economy. But the long-standing home-grown skills deficit must be eliminated if this vision is to be a reality. If we cannot bolster our domestic STEM skills base, the STEM industries will be held back by a lack of the skills needed to boost productivity. Removing these shackles on the STEM industries will be crucial to the success of the Government's aim to rebalance the economy for future growth.

## CHAPTER 1: INTRODUCTION

UK economic output is flatlining, with GDP still below 2007–08 levels. The economy contracted in 2008 and 2009, and registered no growth in 2012. Future prospects are also looking anaemic: in December 2012, the OBR downgraded its forecast of economic growth over the years to 2017.[1] Sluggish economic growth in combination with falls in unemployment mean that labour productivity is falling – the UK is producing less output with more input. Given that productivity is what drives long-term prosperity, this is of great concern.

In the wake of the financial crisis and subsequent recession, the Government set out an aim to stimulate exports and 'rebalance' the economy away from financial services and the south east, towards other sectors and regions, including manufacturing in particular, highlighting sectors including advanced manufacturing, life sciences and green energy.[2] Recently, the LSE Growth Commission reported that both investment in human capital and investment in transport and energy were needed to keep up with demand.[3] The science, technology, engineering and maths (STEM) sector is being set up to play a substantial part in the UK's long-term economic growth. Recently, Lord Browne, former president of the Royal Academy of Engineering pointed to engineering in particular as the key to Britain's recovery in the context of the policy aim to rebalance and promote exports.[4]

But skills also have a big part to play in this. Research has found that around a fifth of economic growth in the late 1990s and early

1 Office for Budget Responsibility, *Economic and Fiscal Outlook*, December 2012 (London: HMSO,2012)

2 Vince Cable, speech on industrial strategy given at Imperial College, London, 11 September 2012, https://www.gov.uk/government/speeches/industrial-strategy-cable-outlines-vision-for-future-of-british-industry

3 LSE Growth Commission, *Investing for Prosperity* (London: LSE, 2013)

4 Angela Monaghan, "Engineers: the UK's Future", *The Telegraph*, 9 March 2013

2000s was due to changes in labour quality.[5] The 2006 Leitch Review recommended ambitious targets for upgrading the UK's skills and qualifications levels, estimating that achieving these could boost the productivity growth rate by 15% and the employment growth rate by 10%.[6] In contrast, shortages of skills can have severe impacts on the industries affected by them. Research has found that manufacturing firms that report skill gaps have lower levels of productivity,[7] and skills shortages can act as barriers for firms aiming to upgrade to high value-added products.[8]

Even before the financial crisis, there were concerns that the UK was not investing enough in the right sort of skills. A study in 2007 looking at the extent which workers' skills match the demands of their jobs found that the UK had the lowest rate of job matching in the EU – i.e. workers' skills were least likely to be at the right level for the jobs they held.[9] Surveys suggest that there are already skills shortages in some science, technology and engineering sectors, and projections of future employment requirements imply a large increase in demand for STEM-qualified workers, even without any policy action to foster growth in this sector.

At the same time, other policy pressures are pushing in the opposite direction. There is significant political pressure to reduce migration, with a Government target to reduce net migration levels to the 'tens of thousands' by the end of the parliament, and a number of measures introduced to reduce non-EU migration. There is also political pressure to reduce EU migration, and given the political debate over EU withdrawal, there is uncertainty for UK

5 Department for Business, Innovation and Skills, *Supporting analysis for 'Skills for growth: the national growth strategy'* (London: HMSO, 2010)

6 Leitch Review of Skills, *Prosperity for all in the global economy – world class skills* (London: HMSO, 2006)

7 Richard Harris, Qian Cher Li and Catherine Robinson, "The productivity impact of skills in English manufacturing, 2001: evidence from plant-level matched data", Business School Economics University of Glasgow Working Paper, 2006

8 Geoff Mason, *In search of high value added production: how important are skills?* (London: NIESR, 2005)

9 Stephen Bevan and Marc Cowling, *Job matching in the UK and Europe* (London: Work Foundation, 2007)

businesses as to whether EU workers will be able to fill employment demand in the future. This means that the real challenge ahead is to make sure that the UK can produce sufficient numbers of qualified home-grown individuals to satisfy demand in the UK STEM sector.

The evidence suggests that without a significant expansion in the skills base, Government attempts to rebalance the economy are likely to fail, with a potential corresponding hit to our STEM industries, and our economic prospects. But the benefits of investing in skills go beyond economic growth. They are a route to greater employment for the UK's young people in the high value adding jobs that the Government is hoping to create, and provide a way of enhancing social mobility in the UK.

To its credit, the Government has recognised the need to expand the skills base. In a recent speech, Vince Cable outlined the need to formulate a long-term plan for UK industry, including the need to "build on our excellence in science". He went on to say that we need to get the skills system right, and highlighted the particular need for an adequate supply of engineering skills.[10]

The Government is launching, and has launched, a number of programmes focused on increasing the supply of STEM skills. These include expanding the apprenticeship programme, for example, to include supporting engineering apprenticeships that are equivalent to degree level.[11] It funds programmes designed to encourage interest in science subjects in schools.[12] In England, the inclusion of two science GCSEs at Grade C or above in the English Baccalaureate measure of GCSE performance is designed to

10 Vince Cable, speech given to the CBI Conference, 19 November 2012, http://news.bis.gov.uk/Press-Releases/Vince-Cable-Speech-CBI-conference-Grosvenor-House-London-19-November-2012-6838d.aspx

11 Vince Cable, speech given to the CBI Conference, 19 November 2012, http://news.bis.gov.uk/Press-Releases/Vince-Cable-Speech-CBI-conference-Grosvenor-House-London-19-November-2012-6838d.aspx

12 Department for Business, Innovation and Skills, "Engaging the public in science and engineering", https://www.gov.uk/government/policies/engaging-the-public-in-science-and-engineering--3/supporting-pages/inspiring-students-to-study-science-technology-engineering-and-mathematics

encourage higher levels of science GCSE achievement, among other aims.[13] Most recently, reforms to A-levels have been proposed, with the intention of better preparing students for university courses including STEM courses.[14]

But in the light of the huge expansion in STEM skills needed to sustain the STEM industry, and the even larger expansion needed to rebalance the UK's economy, there is an urgent need to invest now, and invest wisely, focusing on actions that are most likely to deliver the expansion we need. There are a range of different policies that could be employed to expand the UK's STEM skills base. But in which areas are skills shortages most acute? And where does policy need to focus to increase the proportion of students pursuing subjects that will help to ease those shortages?

This paper examines the mismatch between projected employment requirements in the STEM industries and the likely domestic supply of individuals with the requisite STEM skills in the context of economic rebalancing. First, we analyse the current situation, looking at the policy and economic context of the debate and the shortages that already exist in the STEM sectors. We then look at the scale of the challenge ahead and illustrate the likely impact of targeted policies to increase the pipeline of STEM-qualified individuals. We conclude by exploring what policy changes may be required to meet anticipated demand for domestic STEM-qualified individuals, and hence supply the economy with the human capital it needs to grow.

- Chapter 2 starts by setting out where there are already shortages in the supply of UK-domiciled STEM labour, based

13 Department for Education, "The English Baccalaureate", http://www.education.gov.uk/schools/teachingandlearning/qualifications/englishbac/a0075975/the-english-baccalaureate

14 Department for Education, "Michael Gove writes to Ofqual setting out changes to A-level", http://www.education.gov.uk/childrenandyoungpeople/youngpeople/qandlearning/alevels/a00220415/changes-a-levels

on employer surveys, evidence on wages and employment, and analysis by the Migration Advisory Committee.

- Chapter 3 sets out how demand for STEM skills is expected to evolve over the rest of the decade, and what this means for the jobs that are expected to arise in different STEM-related sectors.
- Chapter 4 maps out the supply of home-grown STEM skills, from graduate-level back to school. This chapter shows how different interventions targeted at increasing GCSE achievement and A-level take-up among some groups of pupils could widen the supply of individuals with the potential to work in the STEM sector.
- Finally, Chapter 5 concludes on where we need to focus policy to ensure we have sufficient home-grown talent to meet the expected employment requirements in the STEM sector, and provide the building blocks for the rebalanced economy.

# CHAPTER 2: SHORTAGES IN STEM SUPPLY: THE CURRENT PICTURE

A sufficient supply of individuals with the right skills is an essential requirement for the STEM industries to play their part in rebalancing the economy and in the UK's future economic growth. In the context of political pressure to reduce migration, this chapter explores how well current domestic supply is meeting demand for STEM skills in the UK.

It is difficult to separate out demand and supply factors for skills, as market indicators such as wages and employment will reflect both factors. For example, increasing wages in a sector could be an indication of falling numbers of individuals with the required qualifications. Or it could reflect higher levels of demand for employees, perhaps, due to increased demand for the types of products and services that firms in that sector produce. Or it could reflect increased demand for the same pool of potential employees from other sectors. But wages and employment indicators can show where demand is high relative to supply – at least in the short-term – and surveys of employers can provide evidence on sectors where employers experience recruitment difficulties.[15]

## Recruitment difficulties among STEM employers

Evidence suggests that STEM employers do experience difficulties in recruiting qualified individuals. STEM employers are more likely than other types of employers to report vacancies as hard to fill, and to report "skill shortage vacancies" – vacancies which are hard to fill because of a lack of applicants with the appropriate skills, qualifications or experience. In a study published in 2011, STEM employers reported that 26% of their vacancies were hard to fill,

15 In the longer-term, high wages and low supply could encourage firms to make structural changes, for example moving away from labour intensive to capital intensive processes.

compared to 22% among other employers. STEM employers also reported 21% of total vacancies as being "skill shortage vacancies", compared to 16% among other employers.[16]

Analysis by the Migration Advisory Committee (MAC), which informs which occupations should go on the "shortage occupation list", provides more specific information on STEM occupations that are seeing high demand relative to supply. Occupations are placed on the list if there are insufficient numbers of resident workers to fill the available jobs, allowing migrants – under certain conditions – to come to the UK to take up such roles. Currently, STEM-related occupations that appear on the list include engineers, physiologists, geologists, software developers, science and maths teachers, and a range of medical and healthcare professionals. Of the 34 occupation groups (grouped by standard occupational classification code) on the list, around three-fifths are related to specific STEM skills or are predominantly in a specific STEM-related sector.[17] In its most recent review, the MAC recommended further additions to the list of engineering roles, but the removal of some health sector roles.[18]

## STEM wages

Evidence shows that STEM graduates typically earn higher wages than non-STEM graduates, suggesting that demand for those with STEM skills is high compared to those without. As shown in the chart below, the top three subject areas in terms of median hourly wages for graduates were all in STEM subject and related areas. Previous research shows that this wage premium is mainly driven by graduates who work in STEM and financial occupations – the latter

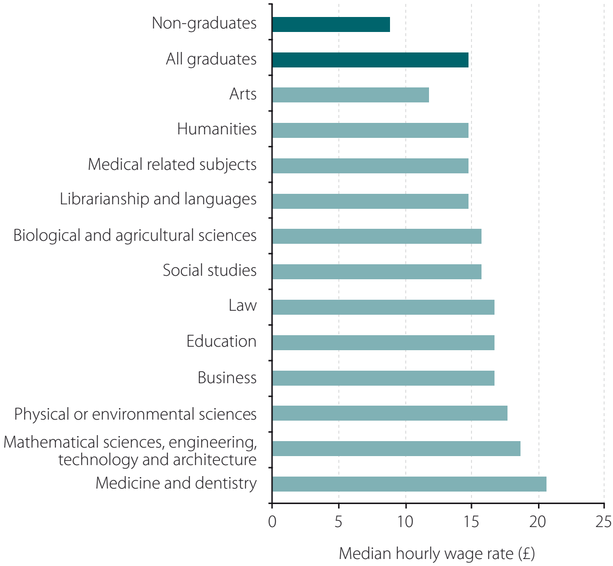
16 UK Commission for Employment and Skills, *The supply of and demand for high-level STEM skills* (UK Commission for Employment and Skills, 2011), http://www.ukces.org.uk/publications/the-supply-of-and-demand-for-high-level-stem-skills

17 UK Border Agency, *Tier 2 Shortage Occupation List (*UK Border Agency, 2011), http://www.ukba.homeoffice.gov.uk/sitecontent/documents/workingintheuk/shortageoccupationlistnov11.pdf

18 Migration Advisory Committee, *Skilled Shortage Sensible* (Migration Advisory Committee: 2013)

categorised by the Department for Business, Innovation and Skills (BIS) as an area related to STEM, but not a core STEM occupation.[19]

**Chart 2.1. Median hourly wage rate by degree subject studied (2011)**




Source: Office for National Statistics, "Graduates in the Labour Market- 2012" (ONS, 2012), http://www.ons.gov.uk/ons/rel/lmac/graduates-in-the-labour-market/2012/graduates-in-the-labour-market.html

This underlines the fact that while employers that are firmly within the STEM sector require employees with specific STEM qualifications, firms outside the core STEM sector also recruit STEM-qualified individuals. According to a Confederation of British Industry (CBI) survey, around a fifth of graduate-level jobs require a specific discipline, but in recruiting for other roles, around 50% of employers prefer graduates holding STEM degrees.[20]

19 Department for Business, Innovation and Skills, *STEM graduates in non-STEM jobs* (London: HMSO, 2011)

20 Confederation of British Industry, *Learning to grow: what employers need from education and skills* (London: CBI, 2012)

## Skills shortages outside "core STEM"

In a broader survey of employers across all sectors, 46% of employers with skill-shortage vacancies said there was a lack of "technical and practical" skills, 26% said that there was a lack of "numeracy skills", and 21% said that there was a lack of "advanced IT or software skills".[21]

So demand for those with STEM-related skills is wider than core STEM occupations and sectors. The types of skills that individuals with STEM qualifications hold – such as analytical and numerical skills – are often valuable to employers outside the core STEM sectors. Being able to complete a STEM qualification is a signal of having these skills, and the STEM qualification itself may well enhance these skills.

## Employment statistics

Employment statistics show a mixed picture. Although software developers are on the MAC shortage occupation list, graduates in computer science in 2010–11 not undertaking further study were less likely to be employed than graduates in some other subject areas as shown in Chart 2.2. Graduates in physical and mathematical sciences were also slightly less likely than average to be employed.[22] This could reflect the fact that it takes longer for those with specialist skills to find a job that is a good fit, or it could indicate that the courses currently being taken and offered may not be fulfilling employer demand. The latter is supported by employer surveys, which highlight concerns that employers have with weaknesses in core discipline knowledge and a lack of high-calibre applicants.[23] In the case of computer

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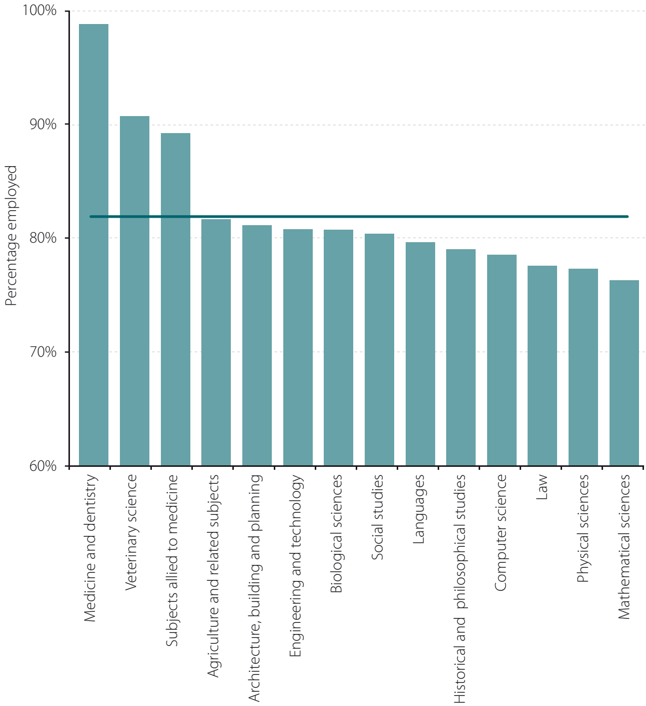
21 UK Commission for Employment and Skills, *UK Commission's Employer Skills Survey 2011: UK Results* (UK Commission for Employment and Skills, 2012), http://www.ukces.org.uk/publications/employer-skills-survey-2011

22 Higher Education Statistics Agency, "Destinations of leavers from higher education", http://www.hesa.ac.uk/index.php?option=com_content&task=view&id=1899&Itemid=706, Table 3. Individuals who obtained the qualification between January and July were surveyed the following January. Individuals who obtained the qualification between August and December were interviewed the following April.

23 Department for Business, Innovation and Skills, *STEM graduates in non-STEM jobs* (London: HMSO, 2011)

science, some employer groups have argued that many courses categorised as "computer science" in fact contain little computer science content.[24]

**Chart 2.2. Employment rate as a proportion of 2010–11 graduates not undertaking study**




Note: Graduates taking further study or a combination of employment and study are excluded from the chart above. Individuals who obtained the qualification between January and July were surveyed the following January. Individuals who obtained the qualification between August and December were interviewed the following April.

Source: Higher Education Statistics Agency, "Destinations of leavers from higher education", http://www.hesa.ac.uk/index.php?option=com_content&task=view&id=1899&Itemid=706, Table 3

In summary, the overall current picture is one of high demand relative to supply for STEM-qualified individuals, with particularly severe shortages of UK-domiciled labour in some areas including engineers, physiologists, geologists, software developers, science

24 House of Lords Select Committee on Science and Technology, *Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects* (London: HMSO, 2012)

and maths teachers, and a range of medical and healthcare professionals. The evidence suggests that there are insufficient numbers of STEM-qualified individuals in some areas, and that in some cases, STEM qualifications may not provide the skills and knowledge that employers require.

The next chapter brings together projections that have been made of future employment trends, highlighting what this means for some specific STEM sectors over the rest of the decade.

**Key points**

- There are already shortages in the supply of UK-domiciled STEM-qualified labour, potentially limiting the ability of the STEM sector to grow.
- STEM-qualified individuals are in demand across the core STEM sector, but also across the wider economy.

# CHAPTER 3: FUTURE DEMAND FOR STEM: FORECASTS OF STEM EMPLOYMENT

There are already skill shortages in STEM sectors, which, as set out in Chapter 1, are likely to limit their ability to expand as our politicians would like it to, and consequently curtail the role the sectors can play in rebalancing the economy. This chapter explores how demand for skills is likely to shape up over the coming years and where employment requirements are likely to be especially high.

Consumer demand for different goods and services, changes in technology, and wider macroeconomic conditions will all drive the total numbers of individuals employed in different sectors in the future. The main source of forecasts on employment trends in the UK is the Working Futures series of research published by the UK Commission for Employment and Skills (UKCES). The most recent research covers projections over the period 2010–2020 and includes estimates of the number of jobs by sector and skill level.

**Box 3.1: Making employment projections[a]**

The Working Futures series of research models projected numbers of jobs across sectors and skill levels. The projected number of jobs is made up of replacement demands – jobs created by leavers (for example, retirement) – and more structural changes based on changes in a sector's size, and occupation and skill make-up. Overall, the UKCES numbers show that replacement demand – job openings created by people who leave the market, for example due to retirement – is projected to generate almost eight times as many openings as the number of additional, new jobs over the period to 2020.[b]

Projections of structural changes are based on a macroeconomic model. The macroeconomic model reflects expected demand for different goods and services as well as trends in productivity. Historical trends are analysed and trends are extrapolated over the forecast period.

These projections are described as "skills needs" and could be broadly interpreted as representing demand for skills based on current trends. But strictly speaking, they do reflect some supply factors as well. For example, historical trends in employment across some sectors will reflect previous supply constraints that employers have been faced with.

In addition, to some extent, apparent increased demand for higher skills could be a reflection of the fact that the population as a whole is upskilling – increasing the supply of high-skilled labour. Faced with this, employers may revise their qualification requirements upwards.

a For more details see UK Commission for Employment and Skills, *Working Futures 2010–2020: Main Report Evidence Report 41, August 2012*; UK Commission for Employment and Skills, *Working Futures 2010–2020: Technical Report*, January 2012

b UK Commission for Employment and Skills, *Working Futures 2010–2020: Main Report Evidence Report 41, August 2012* (UKCES, 2012)

## Employment requirements by qualifications

Working Futures includes projections of employment requirements (including requirements for replacement labour due to demographic shifts in the workforce) by sector and skill level. Sectors covered by UKCES, and which potentially relate to STEM include engineering, manufacturing, construction, information technology, professional services and health and social work. However, the UKCES projections do not cleanly map on to demand for qualifications in specific subject areas. For example, not all of those in health and social work will require a medical degree. The professional services category includes scientific research, veterinary activities, and engineering as well as management consultancy. Qualified engineers are required across several sectors, including engineering, manufacturing, construction and professional services.

Other studies have used the Working Futures data and additional analysis to map demand forecasts by sector onto requirements for qualifications in specific subject areas. These are the average number of job openings expected to be created in each year, both to replace those who leave the sector – such as retirees – and to fill new jobs driven by structural changes on current projections. Based on the UKCES figures and additional data from the Labour

Force Survey, the Royal Academy of Engineering and Big Innovation Centre, calculated that demand for new STEM graduates will be around **104,000 per year over the period 2012–2020.** These figures cover the range of STEM subjects, but exclude medicine-related subjects.[25] Estimated demand for new workers with vocational Level 3+ STEM qualifications is around 56,000 per year.

Engineering and IT are expected to see particularly high levels of demand: across both graduate and Level 3, around 80% of the estimated employment requirement set out above is expected to be in engineering and IT-related occupations.[26] This equates to a demand for new workers of 128,000 individuals qualified as graduates or technicians in this area.

Looking at engineering specifically, another study indicates even higher levels of demand in the years ahead. According to Warwick Institute for Employment Research (IER) data provided for EngineeringUK's 2013 report, which used a broader engineering footprint and included qualifications from Level 4 upwards, demand for new engineers qualified at Level 4 and above will come to an average of approximately **87,000 per year between now and 2020**.[27] For Level 3 workers, the figures are an average demand for new workers of **69,000 per year between now and 2020**.[28] In total, this equates to a demand for new workers of 156,000 each year – equivalent to **almost one in five of UK 21-year-olds entering the engineering profession alone each year between now and 2020**.[29]

25 Specifically, it includes engineering and technology, physical sciences, computer science, mathematical sciences and biological sciences.

26 Royal Academy of Engineering, *Jobs and growth: the importance of engineering skills to the UK economy* (London: Royal Academy of Engineering, 2012)

27 EngineeringUK, *EngineeringUK 2013, The state of engineering* (EngineeringUK, 2012)

28 Whilst there are other qualifiers at Level 3, the apprenticeship route is the main one within the sector, especially within advanced manufacturing. See, for example, UK Commission for Employment and Skills, *Sector Skills Insights: Advanced Manufacturing, Evidence Report 48*, July 2012 (UKCES, 2012)

29 Based on population projections from Office for National Statistics, "2010-based national population projections" (ONS, 2011)

Table 3.1: Comparisons of estimates of demand for new qualifiers per year

| **STEM**<br><br>*Royal Academy of Engineering/Big Innovation Centre estimate* | **Engineering**<br><br>*EngineeringUK/Warwick IER estimate* |
|---|---|
| 56,000 with Level 3+ vocational qualifications<br><br>**plus**<br><br>104,000 graduates<br><br>= 160,000 qualified workers<br><br>Of which 80%, or 128,000 is expected to be in engineering and IT | 69,000 with Level 3 qualifications<br><br>**plus**<br><br>87,000 with Level 4+ qualifications<br><br>= 156,000 qualified workers |

## Box 3.2: Qualification levels

The table below sets out how different types of qualifications discussed in this report map on to specific levels, according to the National Qualifications Framework (NQF).

Level 4+ refers to higher education qualifications. Of the higher education levels, postgraduate and doctorate courses are considered to be levels 7–8, whilst bachelor degrees are level 6. Level 3 encompasses A-levels and equivalent vocational qualifications.

| | | |
|---|---|---|
| **Level 1** | GCSE grades G-D | |
| **Level 2** | GCSE grades A*-C | Intermediate apprenticeships |
| **Level 3** | A-levels | Advanced apprenticeships |
| **Level 4** | Certificate of higher education | Higher apprenticeships |
| **Level 5** | Diplomas of higher education, foundation degrees and HNDs | |
| **Level 6** | Bachelor degrees | |
| **Level 7** | Master degrees and postgraduate certificates | |
| **Level 8** | Doctorates | |

Source: Ofqual, "Comparing qualifications levels", http://www.ofqual.gov.uk/help-and-advice/comparing-qualifications/

Within health and social work – an area not covered by the Royal Academy of Engineering and Big Innovation Centre estimate of STEM demand – UKCES estimates that demand and supply broadly match, with a lower percentage of hard-to-fill vacancies than other sectors of the economy. However, there are shortages in some areas, including specific health professionals, and for carers. There is some uncertainty around future employment growth: whilst there are underlying factors that could increase the demand for labour – such as the ageing population – pressure on public sector finances may limit the extent to which more people can be recruited, and place more focus on trying to increase productivity. Most of the growth in employment in this sector is expected to be in care.[30]

But at the same time, the health and social care sector is heavily reliant on immigration. In 2008–09, around 18% of health professionals and 11% of the care sector workforce were born outside the UK.[31] This also applies to other areas of the STEM sector such as IT, where 19% of the workforce was non-UK born in 2008, compared to 13% across the economy as a whole.[32] So any future restrictions on migration in this sector could increase demand for UK-born labour in STEM-related sectors.

## Are these numbers enough to rebalance the economy?

As set out in the introduction to this report, Government is aiming to rebalance the economy away from financial services and the south east, towards other sectors and regions, including manufacturing in particular. But despite these policy aims, the projections by Working Futures are based on an expectation of little actual

30 UK Commission for Employment and Skills, *Sector Skills Insights: Health and Social Care, Evidence Report 52, July 2012* (UKCES, 2012)

31 UK Commission for Employment and Skills, *Sector Skills Insights: Health and Social Care, Evidence Report 52, July 2012* (UKCES, 2012)

32 UK Commission for Employment and Skills, *Sector Skills Insights: Digital and Creative, Evidence Report 49, July 2012* (UKCES, 2012)

rebalancing of the economy by 2015, with manufacturing's share of value-added in 2015 in fact projected to be a little lower than it was in 2007. Over the period 2015–20, it expects growth in finance and insurance, information technology, media, accommodation and food to be stronger than manufacturing. Overall, this leads to a projection of little change in manufacturing's share of total output over the decade.[33]

So the requirements set out above are minimums. If the Government wishes to rebalance the economy towards a greater reliance on sectors such as manufacturing, life sciences and green energy, it will need to go further than even these numbers suggest. Moreover, an increased supply of people with STEM skills alone will not necessarily be enough to successfully rebalance: other factors such as general macroeconomic conditions, and trends in both domestic and international demand for goods and services will influence the structure of the UK economy. But an enlarged skill base is an important pre-requisite: a necessary, if not sufficient, condition for successful rebalancing and to allow the STEM sectors to help drive the UK's long-term economic growth.

The next chapter maps out the supply of individuals with STEM skills, with reference to whether the labour requirements set out above are likely to be met on current trends. It shows how take-up changes through school and onto further and higher education, and demonstrates how different types of policies could influence the numbers of students who progress from one stage to another.

33 UK Commission for Employment and Skills, *Working Futures 2010–2020: Main Report Evidence Report 41, August 2012* (UKCES, 2012)

## Key points

- Across all sectors of the economy including STEM, replacement of the current supply of labour alone will drive substantial employment requirements over the rest of the decade.
- The Royal Academy of Engineering and Big Innovation Centre calculated that demand for new STEM graduates will be around 104,000 per year over the period 2012–2020. The equivalent figure for those with Level 3+ vocational STEM qualifications is 56,000 per year. 80% of these jobs are expected to be in engineering and IT. This equates to a demand for new workers of 128,000 qualified individuals each year.
- EngineeringUK, using Working Futures data commissioned from Warwick IER, which used a broader engineering footprint and included qualifications from level 4 upwards, calculated that demand for new engineers qualified at Level 4+ will average around 87,000 per year over the period to 2020. The equivalent figure for Level 3 qualified engineers is 69,000 per year. This equates to a demand for new workers of 156,000 each year – equivalent to almost one in five of UK 21-year olds entering the engineering profession alone each year between now and 2020.
- These requirements are minimums. To rebalance the economy towards high productivity STEM sectors, even greater numbers of STEM qualified employees would be required.

## CHAPTER 4: THE SUPPLY OF STEM SKILLS

There are already shortages in STEM sectors, and demand is set to increase substantially over the coming years. Given political pressure to reduce migration, the health of the STEM industries is vitally dependent on the UK's investment in its skills base. This chapter looks at trends in the supply of STEM skills in the UK, starting with graduate and Level 4+ skills. It also illustrates how different parts of the STEM skills "pipeline" could be widened to help meet future requirements. Meeting these requirements will be vital to the long-term growth prospects of the STEM industries, and to the success of the Government's plan to rebalance the economy.

### Graduates in STEM

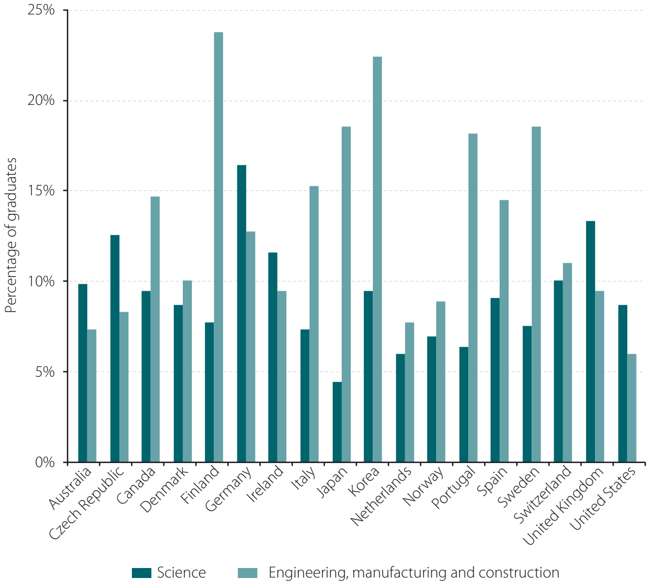
The UK does well compared to other countries in terms of the percentage of young people who go to university.[34] In addition, a high proportion of the cohort graduate from its higher education institutions in science and science-related subjects. According to the OECD, around 23% of graduates in 2010 were in this field, compared to only 15% in the US. But as shown in Chart 4.1, the UK's graduates in this field are skewed towards science,[35] rather than engineering, manufacturing and construction. At 14%, the UK is among the highest in terms of proportions of graduates in science. Only around 10% graduate in engineering, manufacturing and construction, a lower percentage than many other OECD countries.[36] This indicates some scope to increase take-up in this subject area, particularly given that most of the future demand for STEM skills is projected to arise within the engineering and IT sector.

34 OECD, *Country Note. Education at a glance: OECD Indicators 2012 United Kingdom* (Paris: OECD, 2012)

35 Here, "science" includes life sciences, physical sciences, mathematics and statistics, and computing.

36 OECD, "Graduates by field of education, 2010" (Paris: OECD, 2010)

Chart 4.1. Graduates by field of education, 2010



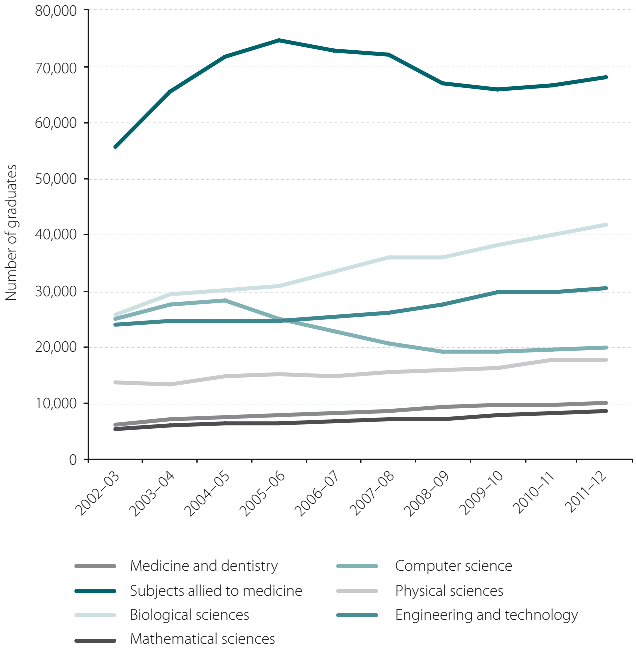

Note: "Science" includes life sciences, physical sciences, mathematics and statistics, and computing. "Engineering, Manufacturing and Construction" includes engineering and engineering trades, manufacturing and processing, and architecture and building

Source: OECD, "Graduates by field of education, 2010", (Paris: OECD, 2010)

As shown in Chart 4.2, there has been a positive trend in the numbers of STEM graduates from UK universities in the last few years.[37] The exception is computer science, where total qualifications have fallen by 20% over the last ten years.

37 We focus on annual first degree and undergraduate qualifications as a measure of annual supply. This is to avoid double-counting individuals who take undergraduate qualifications, followed by a post-graduate qualification in subsequent years

Chart 4.2. First degrees and other undergraduate qualifications, 2002–03 to 2011–12 – all domiciles



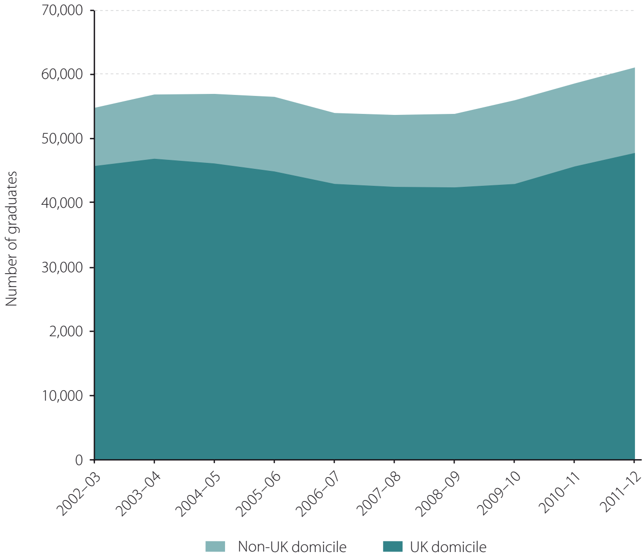

Source: Higher Education Statistics Agency, "Students and qualifiers data tables", http://www.hesa.ac.uk/index.php/content/view/1973/239/

But for some STEM subjects, in particular at first degree level, a significant proportion of the increase in qualifications has been driven by increases in non-UK domicile students. The chart below shows the growth in first degree qualifications, broken down by domicile, in physical, mathematical and computer sciences, and engineering and technology.

In some specific subjects the difference is starker. While the total growth in first degree qualifications for engineering and technology stood at 21% from 2002–03 to 2011–12, the figure for UK domiciled students only was 13%. So a large proportion of growth in qualifications may not translate into an increase in the size of the

STEM-skilled workforce, especially in an environment of increased visa restrictions.[38]

**Chart 4.3. Growth in first degree qualifications: physical, mathematical and computer sciences, and engineering and technology**




Source: Higher Education Statistics Agency data request; House of Lords Select Committee on Science and Technology, *Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects, (London: HMSO, 2012), Appendix 6*

## Current supply compared to requirements

As set out earlier, the Royal Academy of Engineering and Big Innovation Centre calculated that demand for new STEM graduates (excluding medicine) will be around 104,000 per year over the years to 2020, compared to a supply of around 89,000 first degree STEM

38 Whilst some UK domiciled individuals may take qualifications abroad, these "outflows" are relatively small compared to international student "inflow". In addition, many students who study internationally expect to work abroad for at least a few years. As an approximation, we therefore exclude them from our calculations of supply and shortfalls in this chapter. See, for example, Department for Business, Innovation and Skills, *Motivations and experiences of UK students studying abroad* (London: HMSO, 2010)

graduates in 2009–10.[39] In 2011–12, the numbers qualifying in these subjects in UK higher education institutions rose to over 97,000.[40] But this includes many international students: the number of UK-domiciled STEM first degrees in the same year was around 82,000. In addition, many STEM graduates do not go into STEM occupations – around 18–29% depending on the subject according to previous research.[41]

Based on this previous research, we estimate that around 18,000 of the 82,000 UK domiciled STEM graduates will go into non-STEM occupations. This means that the Royal Academy of Engineering and Big Innovation Centre estimate of demand is unlikely to be met from domestic supply. On current figures, the annual shortfall of UK graduates is projected to be around 40,000. To close this shortfall, a 49% increase in STEM graduates would be required if employment requirements are to be met from domestic supply. This is before taking into account the policy aim to rebalance the economy.

As set out earlier, future demand is likely to be especially high in some specific areas of STEM. Looking at engineering, EngineeringUK and Warwick IER estimate an average demand for new workers of 87,000 individuals qualified at Level 4+ a year from now until 2020, compared to a current supply of 46,000 individuals qualified at Level 4+ each year – just over 50% of projected demand.[42] But this level of supply includes international students qualifying in the UK, and many of the 46,000 may well go on to work in other sectors.

39 For the purposes of this comparison, the Royal Academy of Engineering looked at the number of first degree graduates in 2009–10 in engineering and technology, and physical, computer, mathematical and biological sciences. See Royal Academy of Engineering, *Jobs and growth: the importance of engineering skills to the UK economy* (London: Royal Academy of Engineering, 2012)

40 Source: Higher Education Statistics Agency, "Students and qualifiers data tables", http://www.hesa.ac.uk/index.php/content/view/1973/239/

41 UK Commission for Employment and Skills, *The supply of and demand for high-level STEM skills* (London: HMSO, 2011)

42 EngineeringUK, *EngineeringUK 2013, The state of engineering* (EngineeringUK, 2012)

One option to ease pressures in particular areas of STEM is to steer students who are already planning to do STEM towards STEM qualifications that are most in demand. But given the significant domestic shortfall at the level of STEM as a whole, this is likely to make only a marginal impact, and risks creating recruitment difficulties in other areas of STEM.

This points towards the need to focus on what is happening earlier on in the education system, with a view to widening the pool of potential university students. The next sections explore routes to higher education through AS, A-levels and GCSEs (and their equivalent qualifications in Scotland). Although this is considered the traditional mainstream route into higher education, there are other routes, for example, through vocational qualifications, which are explored later on in this chapter.

The following sections set out the current trends in GCSE and A-level take-up and the proportions of students progressing from one level on another. We also analyse the potential effectiveness of focusing policy in different areas of the education system, through illustrative examples. These examples are intended to provide an indication of the magnitude of change in take-up, and ultimately the change in the size of the UK skills base, that different types of policy could give rise to.

## The A-level to university transition

The most common route to higher education in STEM is through taking A-levels (in England, Wales and Northern Ireland) and taking Highers or Advanced Highers (in Scotland).[43] Measuring the pool of potential students across the UK as a whole is difficult, due to the different education system in Scotland, and because education statistics vary across the devolved regions. However, a previous

43 The Royal Society, *Preparing for the transfer from school and college science and mathematics education to UK STEM higher education* (London: The Royal Society, 2011)

study by the Royal Society found that in 2008–09 there were 137,731 UK students achieving qualifications in science (at A-level or Highers) that could allow them to study science subjects at university.[44]

In comparison, as set out earlier, there were around 82,000 UK domiciled individuals graduating from UK universities in STEM degrees in 2011–12,[45] equating to around 59% of the number of students available to take science at university three years earlier. In addition to the 82,000 who graduated in degree subjects within the STEM category defined by the Royal Academy of Engineering and Big Innovation Centre, an additional 43,000 graduated in medicine and dentistry and subjects allied to medicine, many of which also require science A-levels to enter the course. This suggests that a high proportion of those who study A-level science are likely to go on to do related subjects at university.[46] In other words, the A-level to university transition is unlikely to be a significant source of "leakage" of potential STEM qualifiers.

Mathematics at A-level is often also required, or is recommended, to take on further science-related study at university. But the numbers of students taking Maths post-16 is very low compared to other countries.[47] Universities have argued that this has led to a gap in maths ability for students entering higher education.[48] However, there is a positive trend in A-level entries for both Maths and Further

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44 The Royal Society, *Preparing for the transfer from school and college science and mathematics education to UK STEM higher education* (London: The Royal Society, 2011)

45 As set out previously, this is across engineering and technology, physical sciences, computer science, mathematical sciences and biological sciences – the areas for which demand for new workers is expected to be at 104,000 a year according to the Royal Academy of Engineering/Big Innovation Centre.

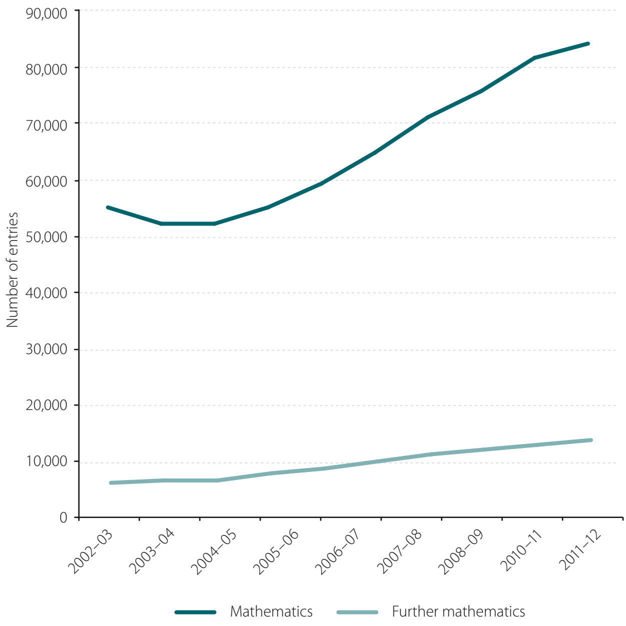
46 Note that some UK domiciled students may take up degrees in other countries, but this percentage is likely to be small. See, for example, Department for Business, Innovation and Skills, *Motivations and experiences of UK students studying abroad* (London: HMSO, 2010)

47 House of Lords Select Committee on Science and Technology, *Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects* (London: HMSO, 2012)

48 Ibid.

Maths,[49] with strong growth over the past decade, as shown in Chart 4.4. At the same time, the proportion gaining top grades is relatively high: in 2012, 82% of students who entered obtained a grade A* to C in A-level Maths. Scotland has also seen growth in the number of Maths entries at Higher and Advanced Higher levels, by 7% from 2005 to 2012 at Higher level, and by 40% from 2005 to 2012 at Advanced Higher level.[50]

**Chart 4.4. A-level entries in Maths - England, Wales and Northern Ireland**




Source: Joint Council for Qualifications, A-level examination results, http://www.jcq.org.uk/examination-results/a-levels

49 Joint Council for Qualifications, A-level examination results, http://www.jcq.org.uk/examination-results/a-levels

50 EngineeringUK, *EngineeringUK 2013, The state of engineering* (EngineeringUK, 2012)

Although this report primarily focuses on STEM specific qualifications, and the supply "pipeline" of those studying STEM subjects, it is important to point out that the types of skills that are learnt on STEM A-level courses – particularly mathematics – may be required or useful for other higher education study of subjects outside traditional STEM categories. For example, statistical skills can be an important part of research within the social sciences.[51] So the need for high levels of maths take-up at A-level is driven by both STEM and non-STEM subjects.

## What makes up the A-level pipeline?

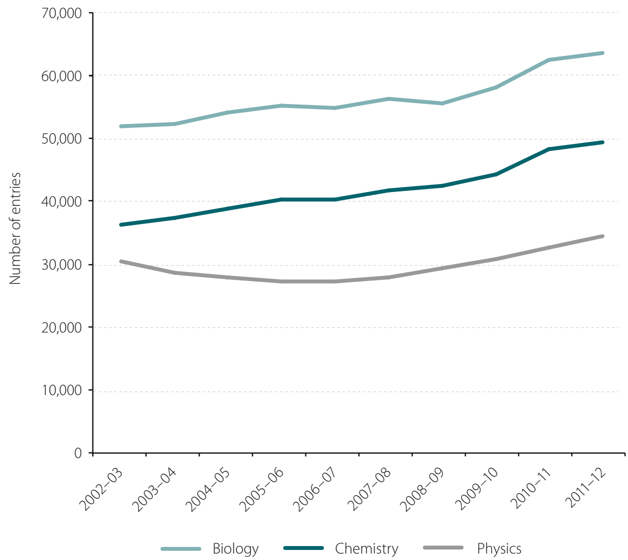
Given the fact that a large proportion of those who take science subjects at A-level go on to do so at university, the size of the A-level pipeline – and its ability to be widened – is of vital importance.

The chart below shows trends in A-level entries in biology, chemistry and physics in the UK over the past few years. Entries across all the subjects have risen, but growth in physics – already relatively low compared to the other sciences – has been weaker. In contrast, entries in Scotland are much more evenly balanced across the three sciences.[52] The low physics uptake in England, Wales and Northern Ireland is a concern, as it is a requirement for many engineering-related courses at university, and the engineering sector is an area of STEM that is likely to see a particularly large shortfall between demand and supply in the future.

51 British Academy, *Society Counts* (London: British Academy, 2012)

52 Scottish Government, "SQA pre-appeal exam results 2010/11", http://www.scotland.gov.uk/Topics/Statistics/Browse/School-Education/preappexam2011

Chart 4.5. A-level entries in science in England, Wales and Northern Ireland




Source: Joint Council for Qualifications, A-level examination results, http://www.jcq.org.uk/examination-results/a-levels

Scotland also outperforms the rest of the UK at a broader level, with a higher proportion of students taking at least one science subject post 16. Around 50% of final year students in Scotland take a science subject, compared to only around 30% in England.[53] This is likely to be partly due to the different structure of Scottish qualifications – whilst students in Scotland are expected to take three to five Highers and many go on to take two to three Advanced Highers,[54] students in the rest of the UK usually take four AS-levels and three A-levels.

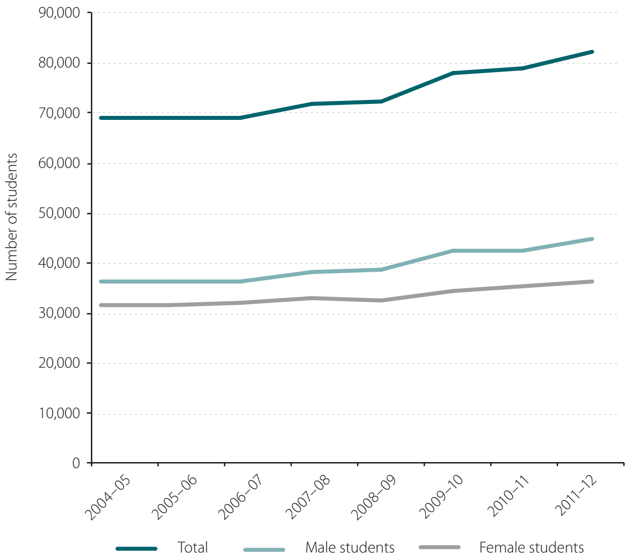
Performance in England has been getting better as shown in Chart 4.6: the numbers of students taking at least one A-level in science in England has increased by just under 14% between 2007–08 and 2011–12.

53 Calculation based on data requests from the Scottish Government and the Department for Education, Scottish Government "Pupil Census", http://www.scotland.gov.uk/Topics/Statistics/Browse/School-Education/Datasets

54 UCAS, "Scottish Qualifications", http://www.ucas.co.uk/students/ucas_tariff/factsheet/sqa

As these students move on to university, we should see a similar sized jump in university qualifications in the next three to four years.[55]

**Chart 4.6. Students taking at least one science A-level, England**




Source: Department for Education data request

But A-level science take-up in England and Wales is still below that of Northern Ireland. Taking further action to close the gap between England, Wales and Northern Ireland could make some inroads in the STEM graduate shortfall as set out in the box below.

### Box 4.1: What if England matched Northern Ireland in A-level science take-up?

The number of students taking at least one A-level science in Northern Ireland has stood at around 35% over the period 2008–09 to 2010–11. Over the same years, science A-level take-up in England averaged around 29%, and in Wales 28%. The higher percentage of students taking science in

55 Assuming a similar proportion of STEM A-level students go on to take STEM at university.

Northern Ireland suggests that there may be scope to further increase the number of A-level science students in England and Wales.

If the proportions of A-level students taking science in England and Wales had been the same level as that in Northern Ireland in the years 2008–09 to 2010–11, the additional number of pupils doing A-level science in England and Wales would have averaged 17,000 – or an additional 22%.

In recent years, the gap between Northern Ireland and England and Wales appears to have slightly narrowed. In 2010–11 specifically, the most recent year for which data from Northern Ireland is available, just under 35% of A-level students took at least one science subject. The equivalent figures for England were 30% and the figure for Wales was 29%.

If the proportions of A-level students taking science in England and Wales had been the same level as that in Northern Ireland in 2010–11, the size of the potential pool of applicants to do science at university would have been just under 13,000, or 16%, higher.

If around 59%[a] of these additional A-level science qualifiers went on to take STEM degrees, this would result in an increase of around 7,000 to 10,000 graduates. So action in this area could make a modest in-road into the size of the 40,000 STEM graduate shortfall.

a As set out earlier, 59% is the percentage of UK graduates in 2012 as a proportion of the number of UK A-level and Higher science qualifiers three years earlier.

Sources: Office for National Statistics, "2010-based National Population Projections"; Department of Education Northern Ireland data request; Department for Education data request; Statistics for Wales data request

## The AS-level to A-level transition

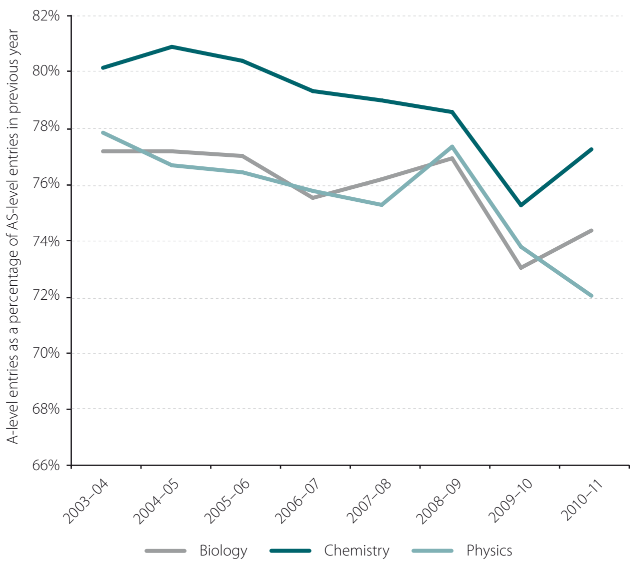
AS-level entries in the sciences have also risen, and risen faster than A-level entries. Whilst this is a beneficial development for STEM take-up, this change suggests that there may be an opportunity to expand the STEM A-level pipeline to university by increasing the proportion of students who continue taking science at A-level. If recent proposals to move to linear A-levels and stand-alone AS-levels go ahead, this could become a question of how to ensure that sufficient numbers of students take the qualifications required – whether A-levels or AS-levels – for university entrance on to STEM courses.[56]

56 Department for Education, "Michael Gove writes to Ofqual setting out changes to A-level", http://www.education.gov.uk/childrenandyoungpeople/youngpeople/qandlearning/alevels/a00220415/changes-a-levels

Of the three sciences, AS-level to A-level physics has the lowest progression rate – 72%, compared to 74% for biology and 77% for chemistry as shown in Chart 4.7. Added to this, physics has a lower number of total AS-level entries – around 58,000 in 2011 compared to around 80,000 for chemistry and around 103,000 for biology. This is of concern, as engineering and IT is expected to make up a large proportion of new job openings in STEM, and physics is a requirement for many engineering and related courses.

The box below explores the potential for increasing the AS-level to A-level progression rate in physics, but concludes that such a policy is unlikely to lead to substantial increases in supply of skills. Rather, we need to look at the decisions taken by students earlier in their school careers.

**Chart 4.7. A-level entries as a proportion of AS-level entries in the previous year**




Source: Joint Council for Qualifications, A-level examination results, http://www.jcq.org.uk/examination-results/a-levels

### Box 4.2: Increasing the progression rate from AS-level to A-level physics

Although the number of physics AS-levels has increased, it has not risen by as much as the other sciences, and it also has a relatively low progression rate. This is a particular concern, as physics is a requirement for many engineering and technology courses – and this is the area where employer demand is likely to be concentrated in the next few years. The number of physics AS-level entries increased by 23.3% from 2002–03 to 2009–10, but the number of physics A-level entries increased by 14.5% from 2003–04 to 2010–11.

If, instead, the growth in physics A-levels had kept pace with the growth in physics AS-levels (i.e. if it had also grown at 23.3%), the number of A-level entries in 2010–11 would have only been around 2,500, or 8% higher. In this scenario, around 78% of AS-level physics students would progress onto A-levels.

Even if the progression rate for physics stood at 86% – the progression rate for history, among the highest of progression rates among A-level subjects – the number of A-level entries in physics would have only been around 6,250 or 19% higher.[a]

The increase in size of the university pool for physics-related subjects would be even smaller than the above figures suggest, as not all of the increased take-up would result in the required numbers of A* to C grades. In addition, increasing the progression of physics AS-level to A-level could come at the expense of other science subjects.

Given the size of the expected shortfall in STEM as a whole, actions to increase the progression rate in physics from AS-level to A-level are unlikely to have a significant impact, and could negatively impact other STEM areas.

a Source for A-level data: Joint Council for Qualifications, A-level examination results, http://www.jcq.org.uk/examination-results/a-levels

## The GCSE to A-level transition

Previous research shows that there is a strong link between performance at GCSE and uptake at AS and A-level. However, the link varies across subjects. For example, among those taking GCSEs in 2008, 54% of those who received an A* at GCSE chemistry went on to take the subject at A-level, compared to 38% for physics and 47% for biology.[57]

In England, the main measure of performance at GCSE level is the English Baccalaureate (EBacc), which reflects the achievement of a C grade or better across a core of academic subjects – English, mathematics, history or geography, the sciences and a language.[58] This measure has been published from 2010 onwards. Before then, the main measurement of performance at GCSE level science was the achievement of at least two science A* to C grades in GCSEs or equivalents. The EBacc measure differs as it does not count achievements in vocational qualifications equivalent to GCSE level.

The number of students taking at least one science A-level as a proportion of the number of students obtaining two A* to C science GCSEs or equivalent two years previously has remained fairly constant in England, ranging from 21% to 23% since 2009.[59] In Northern Ireland, the proportion is higher – around 43% in 2010–11, but the proportions achieving good science GCSEs is lower.[60]

Theoretically, due its use as a performance measure, the EBacc may encourage greater take-up of academic subjects – including science – at GCSE level. This could in turn increase subsequent take-up of science at A-level and university. However, evidence so far suggests that take-up of triple science and double science has not increased significantly. This could be because the main influence affecting subject choices continues to be ability and enjoyment.

57 Department for Education, *Student Progression from GCSE to AS level and continuation to A level*, (London: HMSO, 2012). The report looked at the cohort taking GCSEs in 2008.

58 http://www.education.gov.uk/researchandstatistics/statistics/allstatistics/a00214981/gcse-national-curriculum-teacher-assessment-ks3-england

59 Calculation based on Department for Education data request

60 Calculation based on Department for Education Northern Ireland data request

In addition, many schools do not offer the option of taking EBacc subjects to pupils with low attainment.[61]

Is there anything else that can be done to increase overall progression rates from GCSE to A-level science? Potential areas for focus include the gap between boys and girls, GCSE subject provision and inequalities in GCSE achievement. These are explored in more detail in the rest of this section.

There is a gap in science subject uptake between boys and girls. Despite the fact that a higher percentage of girls achieve two grades A* to C in GCSE science, a lower percentage of them go on to take at least one science at A-level. As explored in the box below, reducing gender disparities here could make an impact on the shortfall across STEM as a whole.

**Box 4.3: What if disparities between girls and boys were eliminated?**

In England and Wales, girls are more likely than boys to get good grades in GCSE sciences, but less likely to then go on to do A-level science. In contrast, in Northern Ireland, there is little gap between the proportions of girls and boys who progress onto A-level science after achieving good GCSE grades.

Over the four years 2008–09 to 2011–12, the numbers of boys in England taking at least one science A-level averaged 25% of the number that achieved at least two A* to C GCSE science grades or equivalent two years previously. The equivalent figure for girls was only 20%. If the progression rate for girls had matched that for boys over the same years, the number of pupils doing at least one A-level science would have been higher by an average of 10% in each year over the period 2008–09 to 2011–12, or 7,800 higher in each year. Similarly in Wales, if girls progressed at the same rate as boys, the number of pupils

61 Department for Education, *The effects of the English Baccalaureate* by Helen Greevy, Anastasia Knox, Fay Nunney & Julia Pye (London: HMSO, 2012)

doing A-level science would have been around 260 or 8% higher per year over the period 2009–10 to 2011–12.[a]

So encouraging girls who do well in GCSE science in England and Wales to continue the subject at A-level could expand the STEM skills pipeline. But even further gains might be made if boys did as well as girls at GCSE science: in England, over the same period as the analysis above, the proportion of girls achieving grades A* to C in two GCSE sciences was around three percentage points higher than the proportion of boys, with a similar-sized gap for Wales.

If, instead, boys had done as well as girls at GCSE, and all pupils had progressed on to science A-levels at the rate displayed by boys, the additional number of pupils doing at least one A-level science in England would have been higher by an average of 14% a year, or 11,100 higher in each year over the period 2008–09 to 2011–12. The figure for Wales would have been an increase of 340, or 11% over the period 2009–10 to 2011–12.

For the most recent year in our analysis, the larger gap in GCSE science achievement across gender means that the gains would have been even greater. If boys had done as well as girls at GCSE in 2009–10, and all pupils had progressed on to science A-levels at the rate displayed by boys, the additional number of pupils doing at least one A-level science in England in 2011–12 would have been higher by just under 13,000 pupils, or 16%. The figure for Wales would have been an increase of 346 pupils, or 11%.

If around 59%[b] of these additional numbers of A-level science qualifiers went on to take STEM degrees, this would result in an increase of around 7,000 to 8,000 graduates per year. So reducing gender disparities could make some modest in-roads into the 40,000 gap between UK STEM graduate supply and projected requirements.

a The relevant data for 2008–09 for Wales was unavailable.

b As set out earlier, 59% is the percentage of UK graduates in 2012 as a proportion of the pool of UK A-level and Higher science qualifiers three years earlier.

Note: The figures above are based on achievements of GCSEs or equivalent, for which gender breakdowns are available over a longer period of time, rather than the EBacc measure.

Sources for calculations: Department for Education data request; Statistics for Wales data request.

There is a link between taking triple science at GCSE level and results at A-level – which therefore goes on to affect the supply of potential university students. In particular, boys who take triple science are more likely to do A-level physics and chemistry, with a higher impact for those from a deprived background.[62] 93% of schools now offer triple science,[63] suggesting that the gains from increasing triple science availability further are likely to be limited. However, there may be scope to increase triple science take-up from its current level of 34%.[64]

Those from deprived backgrounds, as measured by eligibility for free school meals, are less likely to take up science and maths at A-level – but this is primarily explained by their lower attainment at Key Stage 4.[65] The box below explores the impact of this on total A-level entries.

**Box 4.4: What if pupils on free school meals performed as well as their peers?**

Over the period 2006–07 to 2009–10, the percentage of pupils eligible for free school meals in England who achieved two or more A* to C grades in science GCSE averaged around 33%. This compares to around 57% of those who were not eligible for free school meals.[a] If, over the same period, those eligible for free school meals had done as well as their peers, an average of 18,000 additional pupils a year would have achieved two or more A* to C grades in science. Assuming that 22%[a] of these progressed onto A-level science over that period, this would have meant an average of 4,000 additional pupils per year doing at least one A-level science over the period – an increase of 5%.

However, there has been some narrowing of the gap in more recent years. In 2009–10, 45% of pupils eligible for free school meals in England achieved two or more A* to C grades in science, compared to 64% of the

62 Stiijn Broeke, "Does offering more science at school increase the supply of scientists? The impact of offering triples science at GCSE on subsequent educational choices and outcomes", Working Paper, Royal Holloway University of London (2010)

63 Department for Education, *The effects of the English Baccalaureate* by Helen Greevy, Anastasia Knox, Fay Nunney & Julia Pye (London: HMSO, 2012)

64 Ibid.

65 Department for Education, *Maths and science education: the supply of high achievers at A-level* (London: HMSO, 2011)

pupils not eligible. In 2009–10 specifically, if those eligible for free school meals had the same science achievement rates as those not eligible, an additional 14,800 pupils would have achieved two good science grades in that year. Assuming again that 22% of these progressed onto A-level science over that period, this would have meant an additional 3,300 pupils doing at least one A-level science in 2011–12 – an increase of 4%.

If around 59%[b] of these additional A-level science qualifiers went on to take STEM degrees, this would result in an increase of around 2,000 to 2,300 graduates. These are relatively small numbers, compared to the size of the shortfall in STEM graduates. But eligibility for free school meals is a fairly blunt measure of variations in pupil background. Broader measures to increase the achievement levels of those from less well-off backgrounds could have a larger effect.

Source: Department for Education, "GCSE and Equivalent Attainment by Pupil Characteristics in England, 2009/10", http://www.education.gov.uk/rsgateway/DB/SFR/s000977/index.shtml

a 22% is the proportion who did at least one science A-level as a percentage of the number of two science GCSEs at grades A*-C two years previously, averaged over the period 2009–2012.

b As set out earlier, 59% is the percentage of UK graduates in 2012 as a proportion of the number of UK A-level and Higher science qualifiers three years earlier.

The three main policies which this chapter has analysed and which could make some inroads into the 40,000 graduate shortfall include levelling up A-level science take-up across nations of the UK, levelling up GCSE science achievement and A-level science take-up across gender, and levelling up GCSE science achievement for those eligible for free school meals. There are likely to be overlaps in the groups targeted by these policies. But even if there were no overlaps in the groups targeted, the analysis suggests that successful policies in these areas would have only added around 30,000 additional A-level science students per year in the last few years. Assuming around 59% of these additional numbers went on to do STEM degrees, this would translate into an increase of around 18,000 STEM graduates per year. This is far below the shortfall of 40,000. In practice there are likely to be overlaps in the groups targeted by the different policies, and some of the additional STEM graduates may not go into STEM occupations, which means that the gain to domestic supply would be even lower.

This means that these types of policies, even if successful, are unlikely to be enough to close the gap in the domestic supply in STEM graduates. And they may well present best-case scenarios. If the policies only resulted in increases in grades of B and C at GCSE level science, this may not be sufficient to dramatically increase subsequent progression onto further STEM study. Previous research has shown that only 5% to 7% of A-level students across the sciences progress from grades B or lower at GCSE to achieve an A or B at A-level.[66]

This points to the need for broader measures to increase science achievement before, and at, GCSE level. As a percentage of total pupils at the end of Key Stage 4, the proportion who achieved the science component of the EBacc was 49% in 2011–12. In the same year, 36% of pupils at the end of Key Stage 4 were not even entered for the science component. In terms of numbers, just over 315,000 pupils did not achieve the science component of the EBacc in 2011–12.[67] The only way to substantially increase the number of STEM graduates is to drastically improve achievement in science at this level. But given that pupils with low attainment prior to GCSE are often not even entered for the EBacc subjects,[68] policy will need to focus even earlier on in the education pipeline.

The next section outlines vocational routes into STEM, with particular reference to fulfilling employment requirements at Level 3.

## Vocational Routes

As well as the "academic" route to a STEM career set out above, there are also vocational routes. Given that A-levels are the mainstream

66 Department for Education, *Maths and science education: the supply of high achievers at A-level* (London: HMSO, 2011)

67 Department for Education, "GCSE and equivalent results in England 2011/12 (provisional)", http://www.education.gov.uk/researchandstatistics/statistics/allstatistics/a00214981/gcse-national-curriculum-teacher-assessment-ks3-england

68 Department for Education, *The effects of the English Baccalaureate* by Helen Greevy, Anastasia Knox, Fay Nunney & Julia Pye (London: HMSO, 2012)

route into university, vocational qualifications are likely to be particularly important in fulfilling requirements for Level 3 qualifiers. This section explores some potential shortfalls in specific STEM areas at Level 3 and vocational qualifications.

In England, according to the National Careers Service, apprenticeships are the "gold standard for work-based learning".[69] There are three levels of apprenticeship – Intermediate, which corresponds to Level 2; Advanced, which corresponds to Level 3; and Higher, which corresponds to Level 4. Apprenticeships will usually involve taking technical and competency-based qualifications such as NVQs.[70]

Previous research suggests that apprenticeships offer significant benefits over and above simply taking vocational qualifications on their own, due to their combination of on-the-job and off-the-job training.[71] Analysis by London Economics for BIS also found that "apprenticeships have some of the largest long term impacts on learners."[72] A City and Guilds-commissioned report on the Million Extra campaign, which aims to see one million starts by apprentices between 2011 and 2013, found that an individual completing a Level 3 apprenticeship could expect an average annual increase in earnings of £1,634 compared to individuals who complete other forms of Level 3 training, although some of this premium may reflect the fact that competition for apprenticeship places mean that they are likely to go to the most capable applicants.[73] Along with the general growth in apprenticeships, the number of apprenticeship achievements in STEM related areas at Level 2 and 3 has been growing in recent years as shown in Chart 4.8.

69 National Careers Service, "Earn while you learn with an apprenticeship", https://nationalcareersservice.direct.gov.uk/advice/courses/typesoflearning/Pages/apprenticeships.aspx

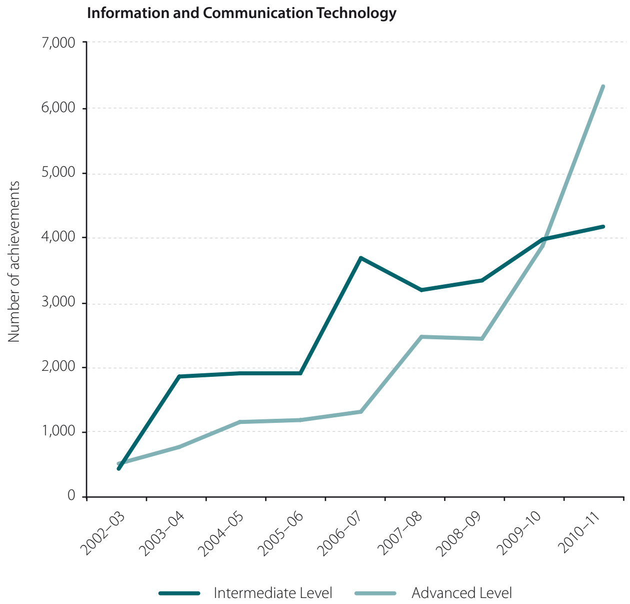
70 National Apprenticeship Services, "The Basics", http://www.apprenticeships.org.uk/Be-An-Apprentice/The-Basics.aspx

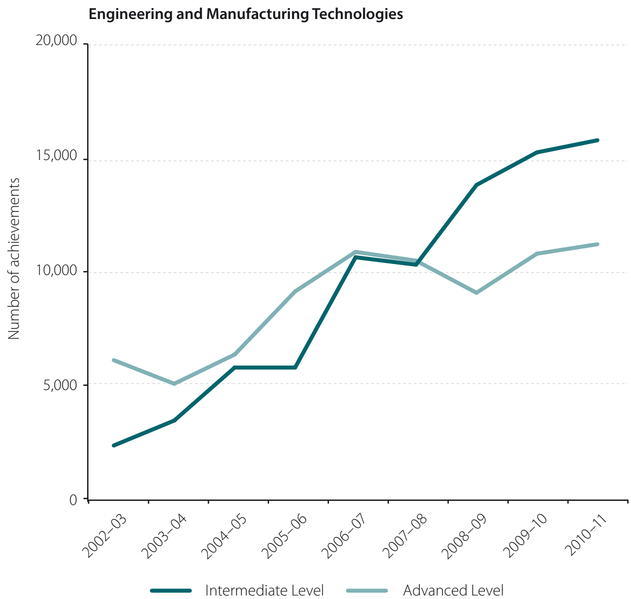
71 Richard Garrett, Mike Campbell and Geoff Mason, *The value of skills: an evidence review* (UKCES, 2010)

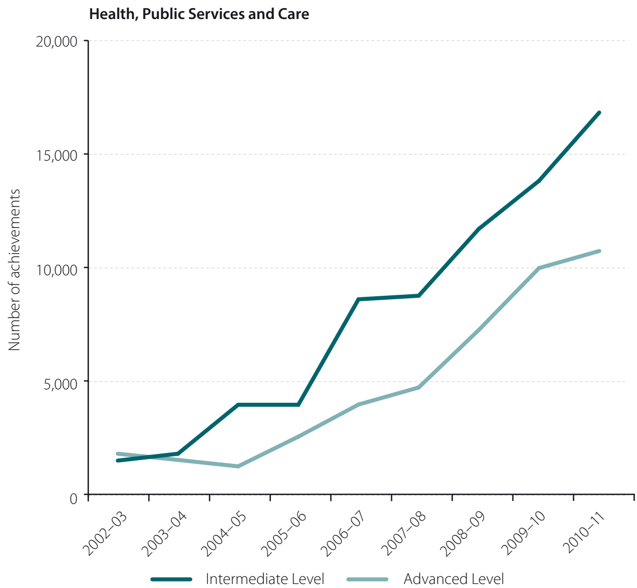
72 Department for Business, Innovation and Skills, *The long term effect of vocational qualifications on labour market outcomes* (London: HMSO, 2011)

73 City & Guilds, *The Economic Value of Apprenticeships* (City & Guilds, 2012)

Chart 4.8. Apprenticeship achievements, England






Source: The Data Service, "Apprenticeships", http://www.thedataservice.org.uk/statisticsNEW/fe_data_library/Apprenticeships/

The level of engineering Level 3 Advanced apprenticeship qualifiers stood at 11,200 in 2010–11. The fact that the number of apprenticeship starts in 2010–11 stood at 32,120 at Intermediate level (a 30% increase on the previous year), indicates potential for growth in the future. But even these numbers are low compared to the EngineeringUK and Warwick IER estimated demand for new workers of around 69,000 individuals qualified at Level 3 a year, across the UK.

Looking more broadly at NVQs and SVQs (Scottish Vocational Qualifications) across the UK, in 2010–11, there were 29,300 qualifications at Level 3 in Engineering and Manufacturing Technologies, and 85,900 at Level 2.[74] Increased progression from

74 The Data Service, "Vocational Qualifications", http://www.thedataservice.org.uk/statisticsNEW/fe_data_library/vocational_qualifications Note that number of achievements may not necessarily equal number of people qualified.

Level 2 to Level 3 will therefore be needed to meet projected employment requirements. Depending on progression from Level 2 NVQs onwards, there is potential here for demand to be met, although not solely from apprenticeships.

Analysis by other organisations such as the Royal Academy of Engineering comes to similar conclusions in its STEM-wide analysis. It estimates a requirement for an additional 56,000 individuals with at least Level 3 STEM qualifications per year to work as technicians. Analysis of STEM qualification numbers led it to conclude that the requirement may be met by the further education and skills sector, although not solely from apprenticeships unless there is a significant uplift in take-up.[75]

**Key points**

- There has been progress towards narrowing the skills gap in recent years across the STEM sector as a whole. But reflecting the fact that STEM graduates are in demand and employed across the wider economy, we estimate that on current projections there remains a shortfall in domestic supply of 40,000 STEM graduates per year.
- To close this shortfall, a 49% increase in STEM graduates would be required if employment requirements are to be met domestically. The policy aim to rebalance the economy would require even further increases.
- The shortfall could be even larger in some specific areas of STEM such as engineering and IT, where 80% of future STEM demand is expected to arise.
- Once students are doing science A-levels, there is a fairly high progression rate onto university.
- Reducing disparities in GCSE performance and subsequent take-up could help to close the shortfall at the level of STEM as a whole. These include: policies targeted at levelling up A-level science

75 Royal Academy of Engineering, *Jobs and growth: the importance of engineering skills to the UK economy* (London: Royal Academy of Engineering, 2012)

take-up across nations of the UK; levelling up GCSE science achievement and A-level science take-up across gender; and levelling up GCSE science achievement for those eligible for free school meals. But these outcomes, even if they could be achieved, would not be enough to close the shortfall in STEM graduates, even under optimistic assumptions.

- This points to a need for broader measures to increase science achievement before, and at GCSE level, where half of students do not achieve the science component of the EBacc.
- The numbers of vocational qualifications is generally in line with employment requirements, but in some specific areas such as engineering, increased progression from Level 2 to Level 3 courses is required.

# CHAPTER 5: WHERE DOES THE MAIN FOCUS FOR POLICY NEED TO BE?

The analysis presented above suggests that there are already shortfalls across the STEM sector. Without action, these are likely to continue, with serious repercussions for the UK's STEM industries, on which the Government is placing its faith in its attempt to rebalance the economy for long-term growth. Graduate-level shortfalls are particularly large – we estimate a shortfall in domestic supply of around 40,000 graduates per year, even before taking into account the policy aim to rebalance the economy. Shortfalls are likely to be higher within some specific STEM areas such as engineering and IT. There are likely to be shortfalls in vocational qualifications as well, unless more students progress from Level 2 to Level 3 qualifications. But whilst demand for STEM workers is increasing, other policy pressures are pushing in the opposite direction, with significant political pressure to reduce migration. In this context, it is vital that we develop more home-grown talent to fill the STEM sector skills gap.

## What's constraining the pipeline?

A critical point in the system, where many potential STEM students are being lost is at GCSE level. There are some opportunities for increasing progression after GCSEs – for example among girls who do well in science GCSEs, and by bringing boys' GCSE science achievement levels up to the level of girls'. It may be helpful to explore why A-level science take-up is higher in Northern Ireland, and whether lessons can be applied to England and Wales. The Scottish model, which allows more subjects to be taken post-16, resulting in higher science take-up at those ages, may also provide some useful insights. There are also opportunities for policies to level up the achievement of those eligible for free school meals to match the performance of their peers.

Taken together, these measures could contribute to making up some of the shortfall in STEM graduates. But, even on optimistic assumptions, they would not be sufficient to close a gap of the size we are faced with. To make up this size of shortfall, policy has to focus on substantially raising GCSE science achievement across the board, and on improving progress on the way to GCSEs. Enjoyment and confidence in one's own ability are important factors in A-level science take-up,[76] but the main constraint at the moment is simply the low levels of GCSE achievement. In 2011–12, only 49% of pupils achieved the science component of the EBacc, with even fewer achieving triple science GCSEs. In the same year, 36% of pupils in England at the end of Key Stage 4 were not even entered for the science component of the EBacc, and 24% of pupils did not attempt any science GCSE.[77]

Students' educational achievement is driven by a number of factors, including parental education levels, home environment and school quality. In terms of school quality, access to laboratory space and equipment are important for science subjects.[78] But in general, evidence shows that the quality of teaching is the main driver of school quality: the impacts of other factors are modest in comparison with the benefits that could be realised by improving the quality of teaching.[79] For example, one study of GCSE achievement in England found that being taught by a high quality teacher rather than a low quality one added 0.46 of a GCSE grade per subject per pupil, and found that high quality teaching could make up a significant part of the gap in achievement between poor and better-off students.[80]

But there is already a shortage of maths and science secondary school teachers, and both are currently on the MAC shortage

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76 Department for Education, *Maths and science education: the supply of high achievers at A-level* (London: HMSO, 2011)

77 Department for Education, 2011/12 GCSE exam results, Table 9

78 The Royal Society, *Preparing for the transfer from school and college science and mathematics education to UK STEM higher education* (London: The Royal Society, 2011)

79 LSE Growth Commission, *Investing for Prosperity*, (London: LSE, 2013)

80 H Slater, N Davies and S Burgess, "Do teachers matter? Measuring the variation in teacher effectiveness in England", Bristol Centre for Market and Public Organisation Working Paper no. 09/212 (2009)

occupation list.[81] This creates the danger of self-perpetuating shortages, with insufficient teachers to educate the next generation. So a key area for policy action is to attract more high quality teachers into the profession.

## Increasing the quality of teaching

Given the shortages of maths and science teachers, improving the quality of teaching in these subjects has to start by encouraging more individuals into the profession. Many teachers go into the profession for intrinsic reasons such as the enjoyment and satisfaction of teaching. But if we want to expand the number of high quality teachers with strong backgrounds in the subjects they teach, we need to understand the main influences on those who consider other job choices. Evidence suggests that employment opportunities and salaries in other sectors are an important influence on the decision to become a teacher and to remain a teacher. Consistent with this, periods of strong economic growth, when other sectors are likely to be buoyant, tend to coincide with fewer individuals deciding to become teachers.[82] The problem is likely to be especially acute for STEM graduates, who can earn relatively high wages in the STEM and financial sector.

Therefore, efforts to increase the relative attractiveness of science and maths teaching are vital. In the past, one-off financial incentives for science and maths teachers – "golden hellos" – have been used to encourage individuals into the profession. But such short-term incentives are unlikely to be enough to keep science and maths qualified individuals in the teaching profession: individuals with good employment options are more likely to leave the profession, especially in the early years of their careers.[83]

81 UK Border Agency, *Tier 2 Shortage Occupation List* (UK Border Agency, 2011), http://www.ukba.homeoffice.gov.uk/sitecontent/documents/workingintheuk/shortageoccupationlistnov11.pdf

*82 OECD, Teachers matter – attracting, developing and retaining effective teachers* (Paris: OECD, 2005)

83 P. Santiago, "Teacher Demand and Supply: Improving Teaching Quality and Addressing Teacher Shortages", *OECD Education Working Papers, No. 1* (Paris: OECD, 2002)

This points to the need for incentives that operate over the longer-term career cycle, such as wages rather than one-off payments and training bursaries. Evidence shows that flat national wages for teachers reduce school performance by keeping wages too low in areas where other, higher paying job options are available.[84] Allowing more schools increased flexibility to pay wages that reflect local labour market conditions can only help. In this regard, Government's acceptance of recommendations by the School Teachers' Review Body – including increased flexibility for schools in the use of recruitment and retention payments – is a welcome development.[85]

Given the attractiveness of other employment options open to STEM graduates, the Teach First programme, which allows top graduates to start off their careers in a teaching role whilst keeping other career options open has the potential to be especially effective. As suggested by Lord Adonis, expanding the scheme could be hugely beneficial.[86] Focusing any future expansion of the programme on STEM could bring even greater benefits. Strides have already been made in this area: in 2011–12, 50% of new Teach First secondary school teachers were teaching STEM subjects.[87] But with the support of employers in the STEM sector, the programme could be expanded even further.

If these measures are not successful in increasing the supply of science and maths teachers, other, more radical measures could be considered. These could include relaxing the initial eligibility criteria for teacher training, based on the fact that high qualifications are not necessarily an indicator of high teaching quality, as suggested by

84 Carol Propper and Jack Britton, "Does wage regulation harm kids? Evidence from English schools", Centre for Market and Public Organisation Working Paper No. 12/293 (2012)

85 School Teachers' Review Body, *Twenty-First Report* (London: HMSO, 2012)

86 Andrew Adonis, "A manifesto for change: Transforming education, the next steps", Policy Network, 2012 http://www.policy-network.net/pno_detail.aspx?ID=4252&title=A-manifesto-for-change-Transforming-education-the-next-steps

87 Teach First, *Education Matters, Annual Review September 2011 – August 2012* (Teach First, 2012)

the LSE Growth Commission.[88] Another option to boost the supply in the short-term is to actively encourage greater recruitment of science and maths teachers from outside the UK – although this could make it harder to hit the Government's net migration targets.

## The short and long term

The measures set out above will help build the strength of the UK's STEM industries, and ensure that UK's young people are equipped with the skills and ability to take on high-productivity jobs. This will have dual benefits of encouraging economic growth and social mobility. But they are long-term solutions. Improving GCSE achievement is a long-term process, likely to require intervention much earlier on in the education system. Analysis by the Department for Education shows that attainment prior to GCSE, at Key Stages 1–3, can have a strong impact on GCSE and A-level outcomes. For example, the odds of entering science A-levels are three to four times higher for those with high attainment in science at Key Stage 1.[89]

And getting more science and maths graduates to choose teaching over other occupations risks further narrowing the pool of labour for the UK's STEM industries in the next few years, potentially further exacerbating shortages in the short-term. In this context, it is inevitable that a substantial proportion of the employment requirement will have to continue to be filled from migration over the next few years if our STEM industries are not to suffer.

When the current Government came into power, it set out an aim to reduce net migration to the "tens of thousands" by the end of the parliament – a target which included foreign students.[90] It also closed the visa route whereby international students were able to stay and work in the UK for two years after finishing their

88 LSE Growth Commission, *Investing for Prosperity* (London: LSE, 2013)

89 Department for Education, *Maths and science education: the supply of high achievers at A-level* (London: HMSO, 2011)

90 Migration Advisory Committee, *Limits on migration* (MAC, 2010)

studies without a sponsoring employer.[91] In addition, the number of occupations on the MAC shortage list was narrowed. Recently, amidst growing criticism, the Government has been at pains to stress that the UK is open to international students,[92] saying that there is no specific cap on student visas, and announcing plans to expand opportunities for international students to work in the UK after completing their studies.[93] But given the Government's overall net migration target, it appears unlikely that pressures on migration will ease.

Already there have been falls in the number of international students coming to the UK: in the year to September 2012, there was a 26% fall in the number of visas issued for study in the UK.[94] There have also been falls in the numbers of students coming to study STEM courses in the UK. For example, the number of non-EU students accepted onto engineering first degree courses fell by 17% from 2010 to 2012.[95] Whilst it is possible to obtain visas to work in specific shortage occupations, including engineering, the data suggests that there are signs of a downward trend in international students coming to the UK: and these are students who could potentially have gone on to fill our STEM skill gaps in the short-term.

This leads to two inevitable conclusions. Firstly, we need to ensure that UK migration policy does not derail the long-term plan to rebalance the economy by reducing the supply of skilled STEM workers to industry and teaching professions just when we need

91 UK Border Agency, "Tier 1 (Post-study work) applications will not be accepted after 5 April 2012" http://www.ukba.homeoffice.gov.uk/sitecontent/newsarticles/2012/april/16-tier1-psw-route-closing

92 Speech by David Cameron at business event in Mumbai, 18 February 2013 http://www.number10.gov.uk/news/david-cameron-speech-at-business-event-in-mumbai/

93 Home Office, *The Government response to the fourth report from the Business, Innovation and Skills Committee Session 2012–13 HC 425, Overseas students and net migration* (London: HMSO, 2013)

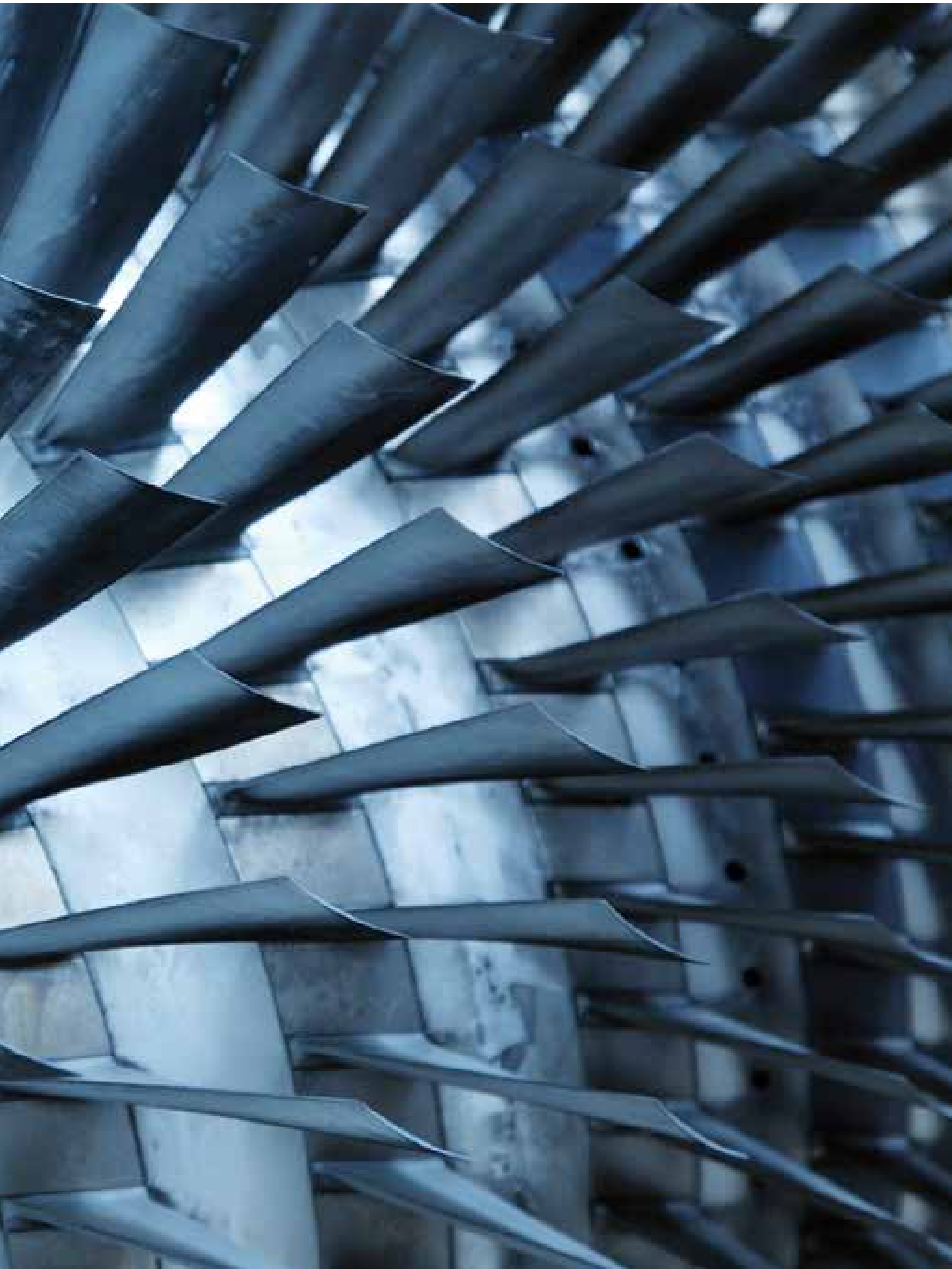
94 Office for National Statistics, "Migration Statistics Quarterly Report, November 2012", http://www.ons.gov.uk/ons/rel/migration1/migration-statistics-quarterly-report/november-2012/msqr.html

95 UCAS "Statistics Online", 2002–2011, http://www.ucas.ac.uk/about_us/stat_services/stats_online/

them most. Overly restrictive migration policy in the short-term will only leave our STEM industries even more reliant on migration in the long-term.

But secondly, in the face of on-going pressure to reduce migration, it is important that we act now to ensure that the UK's young people have access to high-productivity jobs in the future, and are able to build the long-term health of the UK's STEM industries and their contribution to economic growth. This means greater focus on teaching to raise GCSE achievement, and measures to expand the numbers of science and maths teachers.

The STEM sector has been identified as an area to drive the UK's future economic growth in the new rebalanced economy. But the long-standing home-grown skills deficit must be eliminated if this vision is to be a reality. If we cannot bolster our STEM skills base, the STEM industries will be held back by a lack of the skills needed to boost productivity. Removing these long and short term shackles on the STEM industries will be crucial to the success of the Government's aim to rebalance the economy for future growth.



The science, technology, engineering and maths (STEM) sector is at the heart of the Government's aim to rebalance the economy for future growth. But the sector is already suffering skills shortages, severely limiting its ability to grow.

This report quantifies the mismatch between future employment requirements and the supply of domestic skills in these industries, in the context of political pressure to reduce migration. It finds that a huge increase in take-up of science subjects in Britain's schools is needed to foster an adequate supply of home-grown STEM skills and proposes policy solutions to avoid the looming human capital crunch in the STEM sector.

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