Engineering UK 2016

The state of engineering

EngineeringUK

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Engineering UK
Forewords

EngineeringUK's annual report on the state of engineering is a hugely valuable aid to understanding the contribution engineering makes to our society and our economy. Its detailed analysis shows us that young people who choose a career in engineering can look forward to promising futures, with above average employment rates and salaries. In turn, they can help the engineering sectors support a more productive UK economy.

A healthy economy requires strong productivity and here the UK's engineering sectors continue to punch above their weight. As this report shows, in 2014 engineering contributed over £450 billion to the UK economy - around 27% of total UK GDP and more than the retail & wholesale and financial & insurance sectors combined. Engineering sectors also produce the majority of the nation's exports and play an essential role in supporting the UK's international competitiveness by investing in research and development. Furthermore, for every new engineering job another two new jobs are created for the wider economy. So it is good news that the 5.6% growth in the number of engineering enterprises during 2013/14 was the highest in six years.

However we must not be complacent. For the UK economy, productivity remains the challenge of our time and it is evident that for a productive economy we need a skilled workforce. One vital component of this is high-quality education and training, which is why I have instigated plans for reforms to technical and professional education (TPE) which will focus on simplifying the currently over-complex and confusing system. TPE routes will only enjoy high status if they are well understood and genuinely valued by employers. That is why our reforms will put employers and professional bodies at the heart of setting and maintaining standards, to ensure the new system provides the skills our economy needs for the 21st-century economy.

Alongside boosting productivity, education and training transforms the lives of individuals. Around 265,000 individuals in England completed an apprenticeship in the engineering and manufacturing technologies sectors between 2005/06 and 2013/14. The findings of this report and those published by the Government show substantial returns to individuals, employers and wider society from completing apprenticeships, particularly at level 3.

This is why the Government has committed to achieve 3 million apprenticeship starts in the five years to 2020, an increase of around 26%. The Prime Minister has also announced a package of up to £67 million to recruit 2,500 new maths and physics teachers and upskill 15,000 non-specialist teachers in these subjects.

Challenges remain however and, as this report highlights, employers continue to report significant skills shortages in the engineering sectors at both technician and graduate levels. These shortages are compounded by insufficient numbers of young people, especially girls, choosing a career in engineering. I am convinced we will only overcome these challenges if all those with an interest in UK engineering commit to greater collaboration and partnership. Engineering in this country enjoys something of an embarrassment of riches when it comes to the number of organisations seeking to support it. Across these dozens of organisations it must be possible to unlock the greater efficiency, focus, sustainability and impact that closer integration inevitably brings. I hope all those who read this excellent EngineeringUK report will reflect on its messages, rise to its challenges and redouble efforts to work more closely together to deliver the strongest possible future for UK engineering.

Nick Boles MP,
Minister of State
Department for Business, Innovation and Skills
and the Department for Education

I welcome the focus of the Engineering UK 2016 report on the skills needed for a 21st century economy and the productivity that engineering skills drive so effectively. This annual report turns a spotlight on the current status and points to the future direction needed.

UK engineering companies develop the skills and technology that contribute to economic prosperity in the markets they serve. Their programmes drive local supply chains and enable the transfer of technology and skills – BAE Systems in the UK has 7,000 suppliers, three quarters of which are based in the UK, including many SMEs. And, of course, engineering delivers great economic benefit to the UK, contributing more than a quarter of total UK GDP, the majority of exports and maintaining its position at the forefront of R&D and innovation.

What this report makes clear, is that if the UK is to retain and strengthen its reputation for world-leading engineering and technology, we have to continue to invest in developing skills and technologies for the future. BAE Systems has a talented and diverse workforce of approximately 83,000 people in 40 countries and we are particularly proud of our apprenticeship programme. This year alone, we have recruited a record intake of just over 1,000 apprentices and graduates in the UK.

If as a nation we are to meet the challenges highlighted in the report, however, and address the projected annual shortfall of 69,000 graduates and technicians, the engineering community needs to do more to invest in education and training for the next generation of highly-skilled engineers, alongside our existing workforces.

The report highlights the growth potential across the widest range of sectors. It's clear that if we wish to avoid a contest between engineering companies competing for a limited supply of talent, a joined-up and concerted effort is required by all involved to deepen the talent pool. Importantly, the efforts must be underpinned by the continued development of a highly-valued and highly-skilled teaching profession, with sufficient capacity and capability to inspire young people of both genders at all stages of their education.

The Engineering UK 2016 report provides industry with an essential annual reminder of the vital contribution made by engineering and of the direction we have to take to maintain a leadership position, developing the skills and technologies that deliver the economic benefits that mean so much to the UK.

Sir Roger Carr,
Chairman – BAE Systems plc

Engineering UK
About us

Our aim is to raise awareness of the vital contribution that engineers, engineering and technology make to our society and economy, and inspire people at all levels to pursue careers in engineering and technology.

Britain's economy needs a vibrant, innovative and successful engineering sector. Our vision is a society that understands and values the contribution of the engineering industry and the opportunities it provides.

Our goal is to improve the perception and the supply of engineers through interventions with learners and those who influence them: their parents, the media, education professionals and policy makers.

We work in partnership with business and industry, Government, education and skills providers, the professional engineering institutions, the Engineering Council, the Royal Academy of Engineering and the wider science, technology, engineering and mathematics (STEM) community.

Together, we pursue two strategic goals:

- to improve the perception of engineers, engineering and technology
- to improve the supply of engineers

All of our activities are underpinned by thorough research and evaluation. This evidence base has helped to establish the not-for-profit organisation as a trusted, authoritative voice for the engineering community with influencers, policy makers and the media. Engineering UK, our annual review of the state of UK engineering, is our flagship publication, providing the engineering and wider STEM sectors, policy makers and the media with a definitive source of information, analysis and evidence.

You can view *Engineering UK* by theme online at www.engineeringuk.com/research

We focus our activity on two core programmes:

The Big Bang

The Big Bang programme exists to show young people the range and number of exciting and rewarding opportunities available to them with the right experience and qualifications. A unique collaboration by Government, business and industry, education, professional bodies and the wider STEM community, The Big Bang brings to life the exciting possibilities that exist for young people with science, technology, engineering and mathematics backgrounds.

The programme comprises:

The Big Bang UK Young Scientists and Engineers Fair – the largest celebration of science, technology, engineering and mathematics for young people in the UK. Led by EngineeringUK and delivered in partnership with over 200 organisations, with the shared aim of inspiring the next generation of scientists and engineers, The Fair welcomed more than 70,000 people through its doors in 2015, with an equal number of boys and girls. The Fair also plays host to finals of the national competition to find the country's brightest and best young scientists and engineers.

The Big Bang Near Me programme enables more young people to experience a Big Bang Fair nearer to their homes and schools and includes regional fairs as well as smaller Big Bang @ School events. The reach of the Near Me events almost doubled in 2014/15, having grown from 41 events and 49,000 attendees to 90 events with over 96,600 attendees experiencing first hand the excitement of STEM careers.

We expect to welcome 28,000 11- to 14-year-olds amongst the 70,000+ visitors to The Big Bang Fair in 2016 and we will continue to grow the reach of the Big Bang Near Me events with 110,000 attendees expected in 2015/16. Our ultimate goal is that every child in the UK should know someone involved with The Big Bang.

Tomorrow's Engineers

Tomorrow's Engineers is a co-ordinated programme of schools outreach and careers inspiration, led by the engineering community. The programme aims to improve awareness about engineering and what engineers do; to enthuse young people about engineering and engineering careers and encourage young people to make the subject choices that would enable them to work in the industry.

This nationwide programme links schools with local employers, giving pupils the opportunity to learn more about the world of engineering work. It is designed to create the next generation of engineers, by doubling the number of young people choosing an engineering career through a co-ordinated approach that will reach one million school children annually within five years.

The Tomorrow's Engineers Programme consists of three layers:

- National impact
- Local employer co-ordination
- Quality engagement in schools

Local co-ordination, facilitated by our regional employer support managers, is delivering impact at a national level. This on-the-ground support for employers helps them to improve the reach, quality and impact of their schools engineering outreach and careers inspiration activity. The core features of the Tomorrow's Engineers programme, available to all participating employers, are:

- A searchable schools database to support more targeted schools engagement
- High quality careers resources
- An evaluation scheme that enables outreach impact benchmarking

Some of the programmes delivered as part of Tomorrow's Engineers are funded directly by employers, such as:

- Tomorrow's Engineers Energy Quest
- Tomorrow's Engineers EEP Robotics Challenge
- Tomorrow's Engineers Around the World

Careers information and resources are integral to our Big Bang and Tomorrow's Engineers programmes. We work with the professional engineering institutions to develop unified, consistent careers messaging across the community for young people and those who influence them.

Our communications strategy ensures that not only those involved in our programmes, but the wider population as a whole, understand that studying science and mathematics subjects at school, college and university can open up a whole range of exciting and rewarding careers opportunities.

At EngineeringUK we believe that working in partnership with stakeholders is the only way to fully embed the engineering agenda in UK society. If you feel the same way, please visit www.engineeringuk.com and follow us on Twitter @_EngineeringUK

Paul Jackson
Chief Executive
EngineeringUK

Engineering UK 2016
Synopsis, recommendations and calls for action

When it comes to boosting UK productivity, the engineering sector is in a very strong position. In 2014, engineering generated £455.6 billion GDP for the UK. It employed 5,529,000 people (two thirds of whom are practising engineers and technicians) and supported 14.5 million jobs in the UK. It is 68% more productive than the retail and wholesale sector. Every time a new job is created in engineering, two more jobs are created elsewhere in the UK. If engineering can meet the forecasted demand for new vacancies, it would generate an additional £27 billion GDP per year: the equivalent of building 1,800 new secondary schools or 110 new hospitals. In short, a rebalanced economy built on a growing engineering base will be a more productive economy.

The economy and productivity

Productivity is the challenge of our time. It is what makes nations stronger, and families richer. Growth comes either from more employment, or higher productivity.

Productivity is enormously important. A country's capacity to produce goods and services is dependent on the size of its workforce, the size of its capital stock, and total factor productivity (how efficiently it uses labour and capital). Increases in productivity are also essential if the budget deficit is to be eliminated during the current parliament. Yet productivity remains low. The UK 'productivity puzzle' is perhaps the biggest impediment to long-term growth. In 2013, the UK's labour productivity gap with other G7 countries was the widest since 1992 (17 percentage points), despite unemployment dropping to 5.7%. Economists suspect cheap labour/labour hoarding, economic uncertainty, mis-measurement, lack of investment, and sector-specific issues are common factors.

However, the UK was the fastest growing G7 economy in 2014. From April to June 2015, GDP was estimated to have been 5.2% higher than pre-crisis peak in 2008, and engineering's output has rebounded back above its 2007 level. Indeed, the total number of all registered enterprises in the UK grew by 4.4% between 2013 and 2014, to 2,263,645, while registered engineering enterprises grew by 5.6% to 608,920. Of the engineering enterprises registered in the UK, 79.5% employed 0-4 people. Just 0.4% of all engineering enterprises employed more than 250 people yet, between them, these companies employed 42.4% of those working for an engineering enterprise.

Engineering sectors produce the majority of the nation's exports and play an essential role in supporting the UK's international competitiveness by investing in research & development and innovation – a vital part of sustaining the UK's long-term economic performance. Indeed, the gross value added of engineering businesses is larger than the retail and wholesale, and financial and insurance sectors combined, as well as being 68% more productive (GVA/person) than the retail and wholesale sector.

In the year ending March 2014, engineering enterprises in the UK generated turnover of £1.21 trillion, an increase of 3.4% on the previous year. Of all devolved nations, Scotland saw the greatest growth in engineering enterprise turnover since 2009, with the amount growing by 15.6% (after a decline of 3.9% between 2013 and 2014). In 2014, engineering enterprises in London fared better than any other region, with the highest revenue (£268.1 billion) and growth of £30 billion (13.0%) from 2013.

Recent analysis from the Institute for Public Policy Research (IPPR) supports the case for the creation of a rebalanced economy built on a growing engineering base. The research concluded that the key to restoring productivity growth is to shift job-creation towards higher-productivity sectors, while encouraging firms to invest more to boost the productivity of their existing workforces.

The government has also stepped in. Its plan for raising productivity focuses on encouraging long-term investment in boosting infrastructure, skills and knowledge and in promoting a dynamic economy that encourages innovation and helps resources flow to their most productive use.

The engineering sectors are well placed to boost UK productivity, contributing an estimated £455.6 billion to Gross Domestic Product (GDP) in 2014: 27.1% of the £1,683 billion total UK GDP. This contribution is expected to increase to £608.1 billion by 2022. In 2014, engineering employed 5,529,000 people, two thirds of whom (approximately 3.6 million) were practising engineers and technicians. A further 1,341,524 were working in the wider economy.

The engineering sectors are also estimated to have supported an aggregate 14.5 million jobs in 2014, representing 55% of UK employment. Furthermore, for every new engineering job, two additional jobs are created in the economy. Meeting the forecasted demand for new vacancies would generate an additional £27 billion per year: equivalent to the cost of building 1,800 secondary schools or 110 new hospitals.

For every £1 in Gross Value Added (GVA) generated in engineering sectors, £1.45 is generated elsewhere within the UK economy. The total GVA impact of engineering sectors in 2014 was an estimated £995.7 billion: equivalent to 66% of UK GVA and a GDP contribution of £1,116.8 billion. The total tax contribution made by engineering sectors is estimated at £117.8 billion for the 2013/14 tax year: equivalent to 24% of total HMRC receipts over the same period.

However, the engineering sectors depend on several things. They need a good supply of professionally-skilled people – in particular graduates and technicians – to meet forecasted demand. They need a robust science and engineering research base. Finally, they need a fiscal system that encourages existing businesses to flourish, new businesses to form and inward investment from overseas.

Education and training boosts productivity as well as transforming the lives of individuals. Discussion around skills shortages and productivity often centres on the supply of graduates. While this is still a major factor, our new research shows that the aggregate productive contribution to the UK economy from the 49,500 engineering, manufacturing and technology (EMT) apprentices that completed in 2013/14 amounted to £1.6 billion in 2014 prices. In actuality, the 10-year productive contribution of the 371,000 level 3 and 4 EMT apprentices that completed between 2005 and 2014 amounted to £12 billion (2014 prices), equivalent to 8% of UK GVA growth during the same period.

Furthermore, it was found that the net lifetime earnings premium associated with an EMT level 3 apprenticeship is approximately £111,900 (2014 prices): only 26% lower than the high net lifetime earnings premium associated with an engineering degree (£151,300). It appears that the long awaited apprenticeship renaissance in engineering at least has begun. This is reassuring now that government is intending to enshrine in law its commitment to create three million apprenticeships by 2020.

Skills demand and supply

Engineering ranked within the top five in-demand sectors for permanent placements for most of 2015. However, the UKCES Employer Skills survey showed that the science, research, engineering and technology professionals' category (SOC sub-major group 21) had the highest ratio of Skills Shortage Vacancies of any of the 25 occupational sub-major groups. At 43%, it is almost double the overall average of 23%. In a CBI survey, 44% of engineering, science and hi-tech firms reported difficulties in finding experienced recruits with the right STEM skills. In the last two decades, an hour glass effect has developed in the UK, with 2.3 million more high-skilled jobs, 1.8 million more low-skilled jobs and 1.2 million fewer middle-skilled jobs. At senior levels, female representation on UK boards has increased over the last year, so that now 18% of the directors on FTSE 250 boards are women. Most are non-executive directors.

The scale of the challenge is clear. Our extension to Working futures 2012-2022 shows that over this period, engineering companies will need to recruit 2.56 million people: with 257,000 of them being new vacancies. The largest proportion of job openings will occur in engineering enterprises within construction and the information and communications sectors (27.3% each).

Within this overall demand, 1.82 million of these workers will need engineering skills; pro rata, that is an average of 182,000 people per year. And within the engineering-related demand, 56,000 jobs per year are needed at level 3 (Advanced Apprenticeship) and 107,000 at level 4+ (HND/C, foundation degree, undergraduate or postgraduate and equivalent). Yet only 27,000 people are entering engineering occupations with level 3 Advanced Apprenticeships, and only 66,000 at level 4+. Our analysis of the supply data shows an annual shortfall of 29,000 people with level 3 skills and 40,000 with level 4+ skills.

Clearly, there are significant challenges in addressing this annual shortfall of 69,000. More positively, we know that practising engineers and technicians are very employable. New analysis shows that two thirds of employees in engineering enterprises are engineers and technicians, plus a quarter of all engineers and technicians are gainfully employed outside of engineering enterprises.

However, we remain concerned that the critical shortfall of specialist STEM teachers trained to a sufficient level remains a threat to meeting the forecasted demand for engineers and technicians.

Demographics and immigration

Population changes are having a significant effect on the numbers of people at key points in education and work. The number of teenagers will dip then grow. For example, the number of 16-year-olds has already fallen from 769,344 in 2012 to 698,330 in 2015. This will continue to a low of 744,771 in 2018, before recovering to 765,921 in 2022. The numbers of both 21- and 65-year-olds will reduce substantially over the short-to-medium term, with the number of 21-year-olds decreasing 14.0% from 875,604 in 2012 to 753,024 in 2022. Total population will steadily increase from 63.7 million in 2012 to 68.0 million in 2022 (a 6.7% increase).

Engineering has been highlighted as a priority by the Migration Advisory Committee (MAC). The newly added job titles on its shortage list relate to the aerospace, railway, electronics, mining, automotive manufacturing and design, and the civil nuclear industries. It is the MAC's view that this reflects increasing demand for specialist engineering skills continuing to outstrip potential supply: partly as a result of insufficiently joined-up activity in this sector on the part of employers and public bodies.

International student immigration was an issue that we covered in some detail in last year's report. One year on, it is still causing controversy and looks set to continue to do so. It is therefore worth restating the IPPR's viewpoint that, "the Government should abandon the net migration target as it is a bad measure for policy: it creates a perverse incentive for cutting international student numbers, and is incompatible with the growth of one of the UK's crucial export industries." Indeed, engineering sectors produce the majority of the nation's exports with manufacturing accounting for 44% of UK exports.

Secondary level education and training

Between 2002 and 2012, the number of individuals with level 4+ qualifications rose by over 5 million (an 11 percentage point rise), while those below level 2 fell by over 3 million (an 11 percentage point fall). These changes happened as the number of 19- to 64-year-olds increased by nearly 3 million. In the second quarter of 2015, there were 871,000 18- to 24-year-olds not in employment, education or training (NEET). The number of 16- to 17-year-old NEETs dropped to 53,000, influenced by the education participation age increase to 18.

Eligibility for free school meals (FSM) is an indicator of child poverty. Data from governmental sources shows that between October 2014 and March 2015, there were 550,000 secondary school students eligible for free school meals in the UK. The Social Mobility and Child Poverty Commission found that almost twice as many children eligible for FSM achieved good GCSEs in English and maths in 2013 than in 2005. Yet, they remained half as likely to progress to university. The Sutton Trust found that students from disadvantaged backgrounds who were in the top 10% at the end of primary education may typically attain, on average, half a grade lower than their advantaged peers at GCSE. Analysis in subject take-up by the Open Public Services Network shows that access to subjects such as triple science and language GCSEs varies enormously, with young people in poor neighbourhoods either denied access or strongly encouraged not to take up certain subjects. This may in part be due to the influence of school and college performance tables.

The secondary education system in the UK is undergoing exacting reform aimed at increasing the rigour and simplicity of qualifications at level 2. Since the reforms, entries to the more traditional – and challenging – science subjects have fallen. Entries to GCSE chemistry in England, Wales and Northern Ireland have fallen by 3.3%. Biology entries are 1.9% down. Significantly, physics entries have fallen by 2.6%, from 137,227 to 133,610 – and, when Scotland is included in the figures (GCSE and equivalent qualifications), that drop increases to 8% or 175,503 entries. In contrast, entries to GCSE mathematics increased by 3.4% in England, Wales and Northern Ireland, from 736,403 to 761,230. Furthermore, whilst the numbers are still relatively small, a greater number of pupils than ever are studying newer STEM subjects at GCSE, such as computing, engineering and further additional science.

The importance of Key Stage 4 qualifications is given additional significance by some very interesting research undertaken by The Centre for the Analysis of Youth Transitions (CAYT), who looked at the extent that schools have an effect on their pupils' HE decisions. The Centre concluded that the focus of 'widening participation' efforts on the basis of secondary school characteristics should be to ensure that pupils from all schools make the right choices over the subjects and qualifications they take at Key Stage 4, and that they maximise their chances of getting good grades at this level. This is because good grades in highly-regarded subjects and qualifications at Key Stage 4 are associated with a higher probability of staying in education beyond the age of 16 and doing well at Key Stage 5. In addition, they continue to be significantly associated with HE participation decisions and university outcomes, even after accounting for subsequent measures of attainment. The latter of these provides pupils with a curriculum equivalent to separate physics, chemistry and biology GCSEs.

Across all subjects, AS level entrants declined slightly in 2015. However, compared with 2014, entries to AS mathematics increased slightly by 2.2% (to 165,311), while AS further mathematics entries increased by 10.1% (to 27,034) and computing entries were up by 16.6% (to 13,510). Achievements improved in 2015 too, with the proportion of students achieving a grade A-C at AS level up for all subjects except physics, which dropped only slightly to 36,985 (down 0.6%).

At A level, entrant numbers to STEM subjects increased slightly in 2015, to 850,749. Most of the increase was in mathematics, which attracted an extra 4,000 students (92,711 in total). Physics entrants, however, decreased

very slightly to 36,287. Computing, further mathematics and mathematics were in the top 10 most popular of all A level subjects. For all STEM subjects, just over three quarters of the candidates achieved A*-C grades.

It should be noted that A levels and other qualifications at level 3 are an important bridge connecting compulsory and tertiary education. It is at this point that the first of several leaks in the supply of future female engineers arises. Whilst 48.8% (65,221) of those studying physics at GCSE are female, this figure drops to 23.6% (15,192) at AS level and only 21.5% (7,801) at A level. This decline occurs despite higher female attainment, which means some of the best and brightest students are being lost at this early stage.

Finally, whilst it is still too early to see the results, it should also be noted that AS and A levels will be decoupled. This means that AS results will no longer count towards an A level in the way they do now. AS and A levels will be assessed at the end of the course and courses will no longer be divided into modules

The numbers of students completing engineering and related BTEC courses and vocational qualifications offered by OCR at level 2 decreased markedly in the last year, down 37.3% to 160,305. There has, however, been growth at level 3 for BTECs in STEM subjects, with 359,340 completions in 2015 (an increase of 3.5%).

In Scotland in 2015, the A-D achievement rate for physics, biology and chemistry in new National 5 qualifications increased. Students in Scotland also took the new Higher qualifications in 2015: compared to the old Highers, entries increased slightly to 23,348 in 2015. The proportion of those achieving grades A-C increased slightly for chemistry and biology and decreased slightly for physics.

Higher education

In 2013/14, 6.9% of all higher education students (159,010) were on engineering and technology courses. The number of engineering and technology students has increased slightly (by 1.3%), while the total number of university students declined by 7.8% during the preceding five years. Provision of engineering course places is concentrated, with ten universities accounting for a quarter of total acceptances.

Students are taking more diverse routes into HE. For example, 18-year-olds in England are 20% more likely to enter HE with a BTEC this year than last. The numbers of female applicants for engineering courses increased by over a quarter on 2013/14, from 8,940 to 11,330 (26.7%). However, it still attracted the lowest proportion of female applicants after computer sciences.

There has been a shift in the popularity of engineering sub-disciplines, from electronic and electrical engineering, production and manufacturing engineering, and civil engineering, to chemical, process and energy engineering (17.5% increase to 6,235 in the last year) and general engineering (28.8% increase to 11,060 in the last year).

Of HE qualifications awarded in engineering and technology in 2013/14, 43.8% were awarded to international students – a number significantly higher than the average of 26.1% for all subjects. This represents a significant potential leak in the pipeline of future engineers in the UK economy, as international students are much less likely to progress to employment in the UK after graduation.

The numbers of qualifications obtained in engineering and technology has remained relatively steady, with 50,185 in 2013/14 – a 0.3% decline from 2012/13. Engineering and technology first degree achievements are at an all-time high, with 25,870 first degrees awarded in 2013/14. However, only 15% of engineering and technology first degrees were awarded to females. This proportion increased to 23.9% for postgraduate degrees and 24.4% for doctorates.

In 2013/14, there were 8,540 students enrolled on HND programs, around a quarter of whom were studying engineering and technology subjects. 10,205 students were entered into HNC programmes accounted for 10,205 of these, with 54.2% studying an HNC in engineering and technology. Engineering and technology was the second most popular of all STEM subjects for foundation degrees, with 3,015 entrants in 2013/14. While entrants to HNDs and foundation degrees have declined over the last six years, those to HNCs have increased. For HNDs and foundation degrees, most student entrants were full time. For HNCs, most were part time. In 2013/14, there were 6,795 completions for engineering level 4 and 5 BTEC HNCs and HNDs, an increase of 10% on the previous year.

The non-continuation rate for engineering and technology in higher education was 5.6% and was slightly higher for males (5.9%) than females (4%). Not having mathematics or physics A levels doubled the likelihood of a student not continuing compared with those who had both, with the non-continuation rate increasing from 3.3% to 7.2%.

Engineering and technology accounts for the lowest proportion of female staff members of any higher education cost centre, at 17.3% in 2013/14. This may negatively affect female perceptions of both the subject and sector in general.

Despite demand for HE engineering courses (against the context of higher education fees), the pool of those with level 4+ engineering qualifications (66,391), is still well below the annual projected shortage of 107,000. It is also substantially lower than the figure of 82,000 reported in last year's report. Closer analysis reveals that this precipitous decline was predominantly driven by a reduction of those graduating from other subjects who went on to work in engineering occupations. For example, the supply of graduates from tier two subjects fell by 30.4% from 26,663 in 2012/13 to 18,547 in 2013/14. Likewise, the tier three supply number fell by 45% from 15,194 in 2012/13 to 8,349 in 2013/14. This decline was largely driven by a fall in the number of those studying part time, which fell by 19,580 between 2012/13 and 2013/14.

Engineering and technology graduates enjoyed a full time employment rate in 2013/14 of 65.0%, higher than the level for all subjects (57.8%). Overall, 65.5% of UK engineering and technology graduates were working in an engineering occupation. However, only just over half of female graduates went into engineering occupations, compared with two thirds of their male colleagues. Within six months of graduating, those with a degree in engineering and technology enjoyed the second highest average starting salaries of all subjects. At £27,079, they were just behind medicine and dentistry, but well above the average starting salary for UK-domiciled graduates in all subjects (£22,205) and almost equal to the UK national average salary (£27,271). At a time when student debt is increasing, the earnings premium associated with a degree in engineering and technology cannot be overstated. However, females still earn less than their male counterparts (£25,959 vs £27,260).

Notably, it is not only those with a degree in engineering who contribute to the supply of future engineers. Our analysis shows that over 70% of graduates in architecture, building and planning were working in an engineering related role in 2013/14, as well as the majority of those graduating from computer science (54.1%).

Apprenticeships and further education

In 2013/14, around 3.9 million learners were engaged in government-funded education or training in the FE and skills sector. An estimated 850,000 were apprentices and 10,500 learners were on traineeships (pre-apprenticeship programmes). Around 28% were in STEM subjects. Within these, the numbers of NVQ/SVQs and VRQs declined, as this qualification been retired and replaced by QCF qualifications. In England, while overall achievements at all levels for engineering-related qualifications declined by 1.3% this year to 53,110, achievements at level 3 increased by 5.4% to 21,140.

The government has ambitious plans to boost the quantity of apprenticeships and, in contrast to recent years, the number of young people starting an apprenticeships is again on the rise.

However, with a projected shortfall of over 28,000 level 3 engineering technicians, the recorded number of 27,195 apprenticeship achievements at level 3, needs to more than double to meet demand

While the total number of apprenticeship starts in England fell by 13.7% between 2012/13 and 2013/14, starts in apprenticeships related to engineering subjects remained stable at 93,780. This represents 21.3% of all apprenticeship starts. Of these engineering-related apprenticeships, Higher Apprenticeship starts increased 42.9% to 1,000, while level 3 Advanced Apprenticeship starts declined by 14.4% to 33,340. Across all subject areas and for all engineering-related sector subject areas (where data is available), success rates were slightly lower in 2013/14 than in 2011/12.

In Scotland, the number of engineering-related framework starts fell slightly between 2012/13 and 2013/14, to 7,887. Within this, however, the number of female starts fell considerably, from 783 to 282. Starts at level 2 declined, while those at levels 3 and 4 increased. Over all, the number of engineering-related achievements fell from 6,534 to 5,729.

In Wales, the Pathways to Apprenticeships (PtA) programme finished in 2013/14. In 2012/13, 1,075 learners completed the programme and 16% of those progressed onto an apprenticeship. Science, engineering and manufacturing technologies had the highest rate of progression at 38%, however, this was a slight decrease from the 40% progression rate reported in 2011/12. In 2013/14, 1,570 apprentices completed an engineering-related apprenticeship at level 3, a slight increase on the previous year.

In Northern Ireland, the number of apprenticeship starts fell considerably between 2012/13 and 2013/14 to 5,409. (Much of this came from the drop in those aged 25 or older as a result in funding changes). In 2014, there were 1,170 on an engineering-related framework at level 3, an increase from the previous year.

Teacher quantity and quality

The education of the future workforce needs to be underpinned by a highly valued and highly skilled teaching profession. The current reality, however, does not reflect this need.

In 2014 in England, there were 229,000 teachers of STEM subjects serving Key Stages 3 to 4. The number of those teaching physics (6,400) is significantly lower than the headcount for chemistry (7,500) and biology (8,800) and mathematics (33,400). While it is estimated that 1,000 new physics teachers are required each year, only 200 were recruited in 2014. Wales and Scotland also reported fewer physics teachers than chemistry or biology teachers.

There are also too few teachers with specialist subject knowledge at all stages of education. More than 20% of mathematics and chemistry teachers, a third of physics teachers and more than half of computing teachers in state-funded schools in England have no relevant post-A-level qualification in the subject they are teaching. A £67m package to increase the number of mathematics and physics teachers by 2,500 has been launched by the UK government.

Research highlights the difference that high quality teachers make. For example, research from the Sutton Trust showed that for poor students, the difference between a good teacher and a bad teacher is the equivalent to a whole year's learning. Research from UCL (based on data from around 10,000 students) shows that females are less confident in their answers in physics than males and that teacher encouragement is associated with higher self-concept. It indicates that high-aspiring females are less likely to receive teacher encouragement than high-aspiring males.

UK industries strengths and opportunities

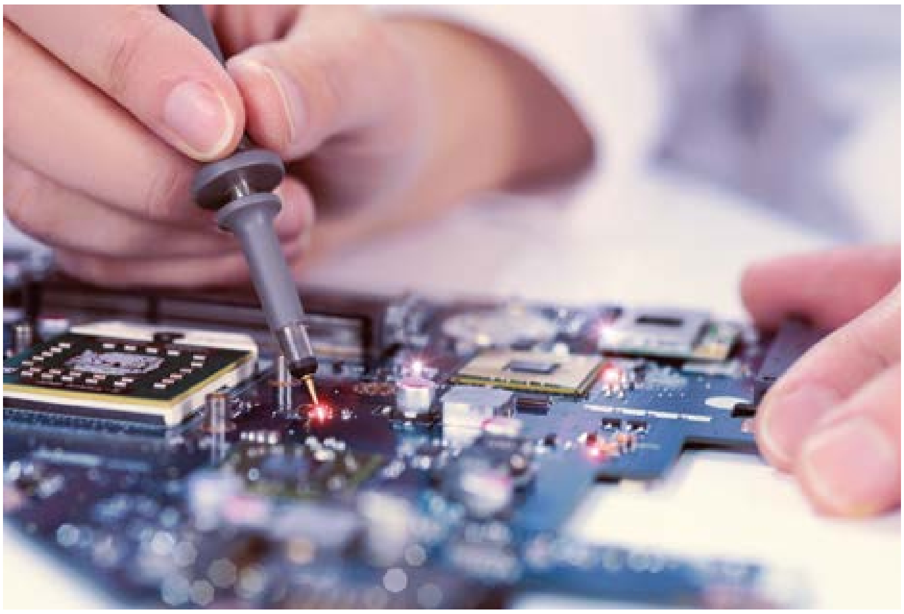
In a number of engineering sub-sectors – nascent or well established – the UK is strong, and could use that strength to boost UK productivity.

Some have already made a big contribution to the economy. In 2014 Agricultural science and technology made an estimated contribution of £96 billion or 7% of gross value added and employed 3.8 million people. The UK retail sector employed 2.8 million people – about 10 % of all UK employment – across almost 300,000 establishments. It contributed 10% to overall UK GVA, approximately 5% of GDP, and had a turnover of £1,211 billion. Construction contributed £83.0 billion in economic output – 6% of the total – and employed 2.15 million people in 2013. If you include construction-related services and products and materials, the industry contributed nearly 7% of GVA and over 9% of employment. The digital and creative sector has grown rapidly in recent years, and contributed £134 billion in GVA to the UK economy – almost 9% of total UK GVA – in 2014. It employed 2.1 million people in 2012.

Making a slightly smaller but still very substantial contribution to the UK economy, from 2000-2013 the automotive sector accounted for an average of 0.7% of UK GVA and 5.9% of UK manufacturing jobs. The automotive sector employed 731,000 people and invested £1.7 billion in R&D in 2013. As a whole, low carbon renewables supported over 460,000 jobs and had a 2013 turnover of £122 billion. Universities contributed £39.9 billion, equivalent to 2.8% of GDP, in 2011 and directly employed 378,250 people. Oil and gas UK estimates the total number of employees involved in the UK upstream oil and gas supply chain to be 450,000, including 200,000 employees directly involved. It generated over £35 billion of turnover in 2012. Aerospace employed around 230,000 people within the supply chain, with annual revenues over £24 billion. Life sciences employed 176,000 people with an estimated £51 billion UK turnover.

Other sub-sectors are worth noting for their rate of growth or expected growth potential. They include automotive, which bucked EU growth trends, and aerospace, thanks to demand for aircraft being at record levels globally. Despite its size, agri-tech is one of the world's fastest growing markets. The digital and creative sector has grown rapidly and is expected to need 1.2 million new workers between 2012 and 2022. Life sciences is forecast to grow by 36.4% between 2011 and 2016.

There are also sectors with large investments such as in nuclear power, which between 2010 and 2014 invested around £2.5 billion. There are development plans for at least 12 nuclear reactors on five different sites by 2030. Overall,



almost £37 billion has been invested in renewable energy since 2010. The 2013 capital investment of £14.4 billion in the UK's oil and gas reserves was the highest it has been for 30 years.

Some nascent industries could also make a big contribution to the UK economy. The Institute of Directors (IoD) claims that shale gas production could satisfy one third of the UK's annual gas demand at peak output by 2030 and could create 74,000 jobs. The Centre for Economics and Business Research (CEBR) estimates that the big data marketplace could create 58,000 new jobs in the UK between 2012 and 2017. A recent report from Deloitte estimates that the direct value of public sector information alone to the UK economy is around £1.8 billion per annum, with wider social and economic benefits bringing this up to around £6.8 billion. Geographically, 61% of UK growth is generated by city regions. If the UK's top 15 metros were to realise their potential, it is estimated they would generate an additional £79 billion growth.

Innovate UK has identified several high-potential emerging technologies worthy of support. These are: energy-efficient computing; energy harvesting; non-animal technologies for drug and chemical development; emerging imaging technologies; graphene; quantum technologies; and synthetic biology.

Manufacturing

Manufacturing makes up 10% of UK GVA and 54% of UK exports, and directly employs more than 2.5 million people. While productivity has not returned to pre-2008 levels, it continues to compare favourably to that in the services industry and the economy as a whole. Despite a projected decline in overall employment, GVA is expected to increase from £138 billion in 2012 to £160 billion in 2022, with the manufacturing share of the UK GVA remaining relatively constant.

There are approximately 1.3 million people employed in the advanced manufacturing industries in the UK. Advanced manufacturing is often reported as an area of significant potential growth for the UK economy. A high proportion (44%) of the advanced manufacturing workforce holds high-level qualifications (qualifications at level 4 and above). This is a much higher proportion than for manufacturing as a whole (31%) and slightly higher than for the economy as a whole (41%).

The trend of reshoring manufacturing has strengthened. Over the past two years, reshoring has added £600 million to the UK economy and created approximately 10,000 new jobs.

Research and development

Scientific, engineering and technological research and development will play a critical dual role on the global stage. Economically, they will help countries boost their productivity and competitiveness. And ethically, they are vital in addressing the on-going global challenges of climate change and creating a low carbon economy: ensuring access to clean water, providing adequate food supply and preparing for the growing and ageing population.

The UK still punches above its weight in research. With just 0.9% of global population, the UK represents 3.2% of R&D expenditure, 4.1% of researchers and 15.9% of the world's most highly-cited articles. Through the Science and Innovation Strategy, the government has committed £5.9 billion capital spend to support UK scientific excellence to 2021. However, the UK lags behind international competitors when it comes to spending on research and development. Businesses, universities and the government together spend around 1.6% of GDP on R&D – much less than the 2.8% spent in the US and Germany, 2.2% in France, and the agreed European target of 3%.

The first UK Research Excellence Framework (REF) was undertaken by the four UK higher education funding bodies, to determine the distribution of research funding from 2015/16 onwards. Overall, quality was judged, across all 1,911 submissions, to be 30% world-leading (4*), 46% internationally excellent (3*), 20% internationally recognised (2*) and 3% nationally recognised (1*). Following this, Technopolis examined in detail the engineering Units of Assessment within the REF2014, finding that 70% of all engineering-related research outputs were classified as world-leading (4*) or internationally-excellent (3*).

Perceptions of engineering careers and engagement

Young people's perceptions of engineering careers form a crucial front in the battle for ensuring an adequate supply of engineers and technicians. And they are improving across a range of metrics. In 2015, 43% of 11- to 14-year-olds believe that a career in engineering is desirable, while 49% of 15- to 16-year-olds say that they would consider a career in engineering. Just five years ago, the corresponding figures were 27% for desirability and 37% for consideration of a career.

This improvement has, in part, been the result of the STEM community influencing the influencers. Perceptions of desirability among educators remained relatively steady from 2012-2014, before increasing dramatically in 2015 from 57% to 79%. Also, when asked which one engineering development of the last 50 years has had the greatest impact on them, around three in five (61%) adults could do so, compared with 38% in 2010. This is despite the fact that respondents would have been using a computer, smartphone or tablet to complete the survey online.

The improvement in perceptions of engineering has coincided with an unprecedented expansion in school engagement activities among the STEM community. Almost all of these activities are predicated on several underlying theories which have formed a relatively unified strategy; that is, a focus on improving enjoyment of STEM – especially among 11- to 14-year-olds – as well as effective contextual careers guidance linked to the curriculum.

The focus on enjoyment is informed by a large evidence base that has shown it to be as significant as attainment in a pupil's likelihood to pursue that subject further. Research commissioned by the Department for Business, Innovation and Skills suggested that "enjoying a subject is key to taking it further". EngineeringUK's own research has looked at student subject decision-making at age 14 and 16, and identified that 89% of those asked said that enjoyment of a subject influenced their decision to select it at GCSE or A level.

There is much research to suggest that the 11- to 14-year-old age group is both the most likely point at which young people can lose interest in STEM and at which interventions can have the greatest effect. The *ASPIRES* study showed that enjoyment decreases year-on-year among Year 6 to Year 9 students (10- to 14-year-olds). Qualitative data suggest that the significant drop-off in Year 9 is due largely to an increasing focus on exams and written work, at the expense of practical activities – particularly in the run-up to GCSEs.

Alongside enjoyment of subjects, aspiration is likely to be a reliable indicator of a young person's future career, and there is a large body of evidence to show that interest in science is formed by the age of 14. Students who had an expectation of science-related careers at that age were 3.4 times more likely to earn a physical science and engineering degree than students without this expectation.

At a top-line level, the engagement strategy can be summarised as an attempt to encourage young people in three ways:

1. Inspiration (from employer role models and educators in STEM)
2. Aspiration (to pursue STEM subjects and careers)
3. Application (to STEM qualifications and careers)

This year, results from the annual Engineers and Engineering Brand Monitor have suggested a key specific addendum to this strategy: focus on pay. The top three responses given by all pupil ages when asked which factors were most important to them when deciding a career were "something I'm interested in", "pay" and "enjoyment". Girls in the 17- to 19-year-old group were most likely to rate pay as an important factor, with three quarters (75%) doing so. Despite this, when asked what they believe to be the average starting salary of a graduate engineer, 17- to 19-year-olds underestimated the real figure (£27,079) by around 27% (a mean of £19,744) and females by around 30% (a mean of £18,995). Parents and teachers were also likely to underestimate the average salary of a professional engineer significantly, meaning that both young people and their influencers require more accurate information.

The current knowledge of engineering careers among STEM teachers is particularly concerning: the EEBM has revealed that while three in five (58%) of those who teach 14- to 19-year-olds have been asked for careers advice about a job in engineering in the last year, just two in five of all STEM teachers (37%) felt confident giving advice on engineering careers, while 34% said that they were not confident.

In relation to career guidance itself, it's vitally important to make the links between education and work clear. The University of Warwick has shown that students don't make these links between the curriculum and future careers and that students don't know that triple science is either desirable or essential for some STEM careers.

This is supported by young people themselves. An Institution of Engineering and Technology (IET) survey showed that the most popular potential ways to promote engineering among young people were "school trips to see what engineers do" (67%) and "visits to school from engineers" (56%). The importance of this type of engagement cannot be overstated. A 2012 survey for the Education and Employers Taskforce showed that "the 7% of young adults surveyed who recalled four or more [employer engagement] activities while at school were five times less likely to be NEET and earned, on average, 16% more than peers who recalled no such activities."

Employers surveyed in the CBI/Pearson survey felt that the biggest barrier to engagement was a lack of guidance and support on how to make work experience worthwhile (28%). A lack of interest among educational institutions (25%), educational institutions interested but unsure how employers can help (22%), not enough employee interest in working with educational institutions (16%), and not being sure how to make contact with educational institutions (11%) were also mentioned. Tomorrow's Engineers is designed to address these concerns, providing guidance, on a regional basis, for employers in carrying out their engagement activities and ensuring that employers and educational institutions are communicating effectively.

Career information is a crucial part of The Big Bang Fair and Tomorrow's Engineers. Only 23% of girls aged 11-14 and 25% of those aged 15-16 surveyed in the EEBM knew what to do next in order to become an engineer. However, figures for Big Bang Fair attendees were more than double that, at 49% and 51%. Females aged 11-14 who attended The Big Bang Fair 2015 were around three times more likely to know what people working in engineering do (46% vs 16%) and twice as likely as those responding to the EEBM to view a career in engineering as desirable (52% vs 26%). Key Stage 3 students who attended the in-school aspiration programme, Tomorrow's Engineers, were also much more likely to be knowledgeable about what engineers do than their EEBM counterparts (50% vs 25%). This included a large increase among Key Stage 3 female students (43% vs 16%). More than half (51%) of 15- and 16-year-olds said that The Big Bang Fair had motivated them to choose physics as an option when they had the choice, including 38% of female students. Currently, just 2% of 18-year-old female students in England, Wales and Northern Ireland enter A level physics exams. There was also a positive impact on influencers, with attending teachers (82%) who were 44% more likely than their counterparts surveyed in the EEBM 2014 (57%) to believe that a career in engineering is desirable. They were also much more likely to be confident in giving advice about science, engineering and technology careers.

There are three overriding messages from the report. Firstly, that engineering and skilled engineers make a significant contribution to the UK economy and its productivity as well as working towards mitigating the grand global challenges of climate change, ageing populations, food, clean water and energy. Secondly, that the UK at all levels of education does not have the current capacity or the required rate of growth needed to meet the forecast demand for skilled engineers and technicians by 2022. Thirdly, through concerted and co-ordinated action, the engineering community and employers in particular can make a demonstrable difference by working with schools and colleges to inspiring future generations to pursue relevant qualifications and go on to careers in engineering.

Recommendations and calls for action

Increasing the supply: recommendations 1, 2 and 3

1. A doubling of the number of engineering and technology and other related STEM and non-STEM graduates who are known to enter engineering occupations. This is vital to meet the demand for future engineering graduates and to meet the additional shortfall in physics teachers and engineering lecturers needed to inspire future generations of talented engineers.
2. A doubling of the number of young people studying GCSE physics as part of triple sciences or further additional science or equivalent and a growth in the number of students studying physics A level (or equivalent) to equal that of maths. This must have a particular focus on increasing the take-up and progression by girls.
3. A two-fold increase in the number of Advanced Apprenticeship achievements in engineering and manufacturing technology, construction planning and the built environment, and information and communications technologies – with particular emphasis on 18- to 24-year-olds.

Provision of high quality, engineering engagement interventions and coordinated careers inspiration and information: recommendations 4 and 5

4. Provision of high quality, engineering engagement interventions and careers inspiration for all 11- to 14-year-olds. This should include opportunities for every child between 11 and 14 years old to have at least one engineering experience with an employer. This inspiration must highlight the value placed on STEM skills, promote the diversity of engineering careers available and provide real life engineering context.
5. Support for teachers and careers advisors delivering careers information so that they understand the range of modern scientific, technological and engineering career paths, including vocational/technician roles. It is vital that our education system recognises the employer value placed on STEM subjects and that young people have the opportunity to experience a 21st century engineering workplace for themselves.

Calls for action:

It is imperative that no talent is wasted. Governments in each of the devolved nations need to ensure joined-up education policies that deliver easy-to-follow academic and vocational pathways for our young people within schools and colleges. This will ensure maximum throughput in STEM subjects and into engineering careers.

We need a coordinated approach led by government and supported by the engineering community, business and the education sector to make sure that the vital need for more trained specialist physics and mathematics teachers is met.

The engineering community must recognise and address the fact that, despite numerous campaigning initiatives over the past 30 years, there has been no significant advance in the diversity or make-up of the sector. In particular, the gender participation of women into engineering must change.

Focussed action towards the co-ordination, quality, reach and impact of engineering engagement interventions by the whole engineering community and business and industry which is supported by government is essential. Building and consolidating of existing programmes is necessary to positively influence the perceptions and subject choices of young people and get more of them interested in a career in engineering. Programmes such as Tomorrow's Engineers have made it evident that this is best achieved through ensuring coordinated support and partnerships via local, regional and national STEM employers.

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Part 1 – Engineering in Context
1.0 Productivity and capability

When it comes to boosting UK productivity, the engineering sector is in a very strong position. In 2014, engineering generated £455.6 billion GDP for the UK. It employed 5,529,000 people (two thirds of whom are practising engineers and technicians) and supported 14.5 million jobs in the UK. It is 68% more productive than the retail and wholesale sector. Every time a new job is created in engineering, two more jobs are created elsewhere in the UK. If engineering were to meet the forecasted demand for new vacancies, it would generate an additional £27 billion GDP per year: the equivalent of building 1,800 new secondary schools or 110 new hospitals. In short, a rebalanced economy built on a growing engineering base will be a more productive economy.

Productivity, productivity, productivity. We may not yet agree on how to measure it. We may not agree on why the UK seems to be experiencing a 'productivity puzzle'. And we may not know how we are going to achieve the rates of growth our government requires to achieve its ambition of eliminating the deficit and returning to surplus in 2019/20. However, we do know that the potential for significant sustained productivity growth is huge – particularly from the engineering sector.

Engineering is vital to the UK's economy. It contributed an estimated £455.6 billion to Gross Domestic Product (GDP) in 2014 – 27.1% of the £1,683 billion total UK GDP[1] – and this contribution is expected to increase to £608.1 billion by 2022.

Engineering sectors produce the majority of the nation's exports and play an essential role in supporting the UK's international competitiveness by investing in research & development and innovation – a vital part of sustaining the UK's long-term economic performance. Indeed, the gross value added of engineering businesses is larger than the retail and wholesale, and financial and insurance sectors combined as well as being 68% more productive (GVA/person) than the retail and wholesale sector.

Every £1 in GVA that engineering contributes to the UK economy (its Gross Value Added) goes on to generate £1.45 elsewhere in the economy: a total GVA multiplier of 2.45. This put engineering's estimated GVA for 2014 at £995.7 billion: equivalent to 66% of total UK GVA. In GDP terms, this represents a contribution of £1,116.8 billion. Engineering is also estimated to have supported an aggregate 14.5 million jobs in 2014: an impressive 55% of UK employment.[2]

However, this success is underpinned by several factors which we have it in our power to influence: a good supply of professionally-skilled people to meet forecasted demand (in particular, graduates and technicians); a robust science and engineering research base; and a fiscal system that encourages existing businesses to flourish, new businesses to form and inward investment from overseas. We do however, remain concerned that a threat to meeting the forecasted demand for engineers and technicians is the critical shortfall in the quantity of specialist STEM teachers trained to a sufficient level.

The scale of the challenge is clear. Our extension to *Working Futures 2012-2022* shows that over this period engineering companies will need to recruit 2.56 million people: 257,000 of whom will be needed to fill new vacancies. Of these 2.56 million, 1.82 million will need engineering skills: that's an average of 182,000 people per year. Within this engineering-related demand, 56,000 jobs per year will be needed at level 3 (Advanced Apprenticeship) and 107,000 at level 4+ (HND/C, foundation degree, undergraduate or postgraduate and equivalent). Yet our latest figures show that only 29,000 people are entering engineering occupations with level 3 Advanced Apprenticeships, and only 66,000 at level 4+. Clearly, there are significant challenges in addressing this annual shortfall of 69,000. More positively, we know that practising engineers and technicians are very employable. New analysis[3] shows that two thirds of employees in engineering enterprises are engineers and technicians, plus a quarter of all engineers and technicians are gainfully employed outside of engineering enterprises.

Putting pure economic gain to one side, UK engineering enterprises are working tirelessly towards mitigating the biggest challenges facing the world today: tackling climate change by working towards a low-carbon economy, ensuring access to clean water, preparing for a growing and ageing population, feeding the world's population and addressing global security threats.

Discussion around skills shortages often centres on the supply of graduates. While this is still a major factor, we would highlight findings from new research[4] that show that the aggregate productive contribution to the UK economy from the 49,500 engineering, manufacturing and technology (EMT) apprentices that completed in 2013/14 amounted to £1.6 billion in 2014 prices. In actuality, the 10 year productive contribution of the 371,000 level 3 and 4 EMT apprentices that completed during 2005 and 2014 amounted to £12 billion (2014 prices), equivalent to 8% of UK GVA growth during the period 2005 and 2014.

Furthermore, it was found that the net lifetime earnings premium associated with an EMT level 3 apprenticeship is approximately £111,900 (2014 prices), bringing them only 26% lower than the high net lifetime earnings premium associated with an engineering degree (£151,300). This is reassuring now that government is intending to enshrine in law its commitment to create three million apprenticeships by 2020.[5]

Finally, despite the disappointing rate of UK growth post-recession, we should be reminded that the UK is still expected by the IMF to be among the fastest growing advanced economies in the world over the next few years, outstripped only by the US.[6]

1.1 The issues and challenges of productivity

"Productivity is the challenge of our time. It is what makes nations stronger, and families richer. Growth comes either from more employment, or higher productivity."[7]

Productivity is enormously important. A country's capacity to produce goods and services is dependent on the size of its workforce, the size of its capital stock, and total factor productivity (how efficiently it uses labour and capital).[8] Increases in productivity are also essential if the budget deficit is to be eliminated during the current parliament.[9]

1 The contribution of engineering to the UK economy, Cebr, October 2014 http://www.engineeringuk.com/_resources/documents/Oct%202014%20Cebr%20-%20The%20contribution%20of%20engineering%20to%20the%20UK%20economy.pdf **2** The contribution of engineering to the UK economy – the multiplier impacts, Cebr, January 2015 http://www.engineeringuk.com/_resources/documents/Jan%202015%20Cebr%20-%20The%20contribution%20of%20engineering%20to%20the%20UK%20economy%20-%20the%20multiplier%20impacts.pdf **3** Section 4.3.1 **4** Productivity and lifetime earnings impacts of engineering education & training, Cebr, September 2015 **5** https://www.gov.uk/government/news/government-kick-starts-plans-to-reach-3-million-apprenticeships **6** World Economic Outlook, April 2015, p14 http://www.imf.org/external/pubs/ft/weo/2015/01/pdf/text.pdf **7** Fixing the foundations: Creating a more prosperous nation, HM Treasury, July 2015, p3 **8** The Missing Pieces Solving Britain's Productivity Puzzle, IPPR, 10 August 2015, p5 http://www.ippr.org/files/publications/pdf/missing-pieces-britains-productivity-puzzle_Aug2015.pdf?noredirect=1 **9** *Ibid*, p8

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The 'productivity puzzle' is perhaps the single most challenging issue that the UK economy will have to resolve to unlock its long-term growth.[10] In 2013, there was a 17 percentage point gap between the UK's labour productivity and the other G7 countries – the widest gap since 1992.[11] Analysis by the Institute for Fiscal Studies (IFS) shows that real output per worker was 3.2% lower than in Q1 2008, and 12.3% below its pre-recession trend.[12] The IFS attributed part of the fall to an increase in part-time work and the resulting reduction in average hours. However, it has also shown that output per hour has fallen – by 2.6% between Q1 2008 and Q3 2012 – and is 12.8% below its pre-recession level.[13]

The following sub-sections highlight several key barriers that need to be addressed to support the UK government's ambition of unlocking long-term growth, eliminating the deficit and returning to surplus in 2019/20.[14]

1.1.1 The productivity puzzle

There is a lot of talk in the media and among policymakers about Britain's poor productivity record. It is a vital subject.[15] Productivity, or increased efficiency of production, is the biggest driver of human welfare. As Paul Krugman, the Nobel laureate and New York Times columnist famously said, *"Productivity isn't everything but in the long run it is almost everything."*

The current economic recovery has been unusual in at least two respects. First, it has been weak by historical standards. Real GDP at the end of 2014 was only 4% higher than in the final quarter of 2007. Second, it has relied wholly on increases in employment. Productivity fell in the recession, recovered a little in the first years of recovery but has fallen back again over the last three years.[16]

This pattern of recovery cannot be sustained for much longer. The employment rate is at a record level and, while there are benefits to be gained from pushing it even higher (both for the economy in aggregate and specifically for those people brought into work), further substantial increases will be hard to achieve. Unemployment is already down to 5.7% and it has rarely been below 5% since the early 1970s. Moving the employment rate higher will increasingly require getting people who are not active in the labour market into work. This will be tough.

If growth is to be sustained, there needs to be a revival of productivity growth. Unfortunately, economists do not know why productivity has stopped increasing. Indeed, they are so confused that they have dubbed recent developments the 'productivity puzzle'.[17] Most, though, accept that the weakness of productivity is probably due to a combination of cyclical, demand-driven factors and structural, supply-side problems.

That said, trying to summarise the myriad of reports, articles and speeches over the past year that elucidate, postulate, speculate or conflate the reasons for the UK's productivity paradox is like finding a needle in a haystack. Most commentators accept that the weakness in UK productivity is probably due to a combination of cyclical, demand-driven factors and structural, supply-side problems. They cite cheap labour, labour hoarding, economic uncertainty, mis-measurement, lack of investment, and sector specific issues as the common underpinning factors.

Table 1.1 offers a very condensed view of the commonly published reasons, extracted from four different reports.

10 The Economic Role of UK Universities, UniversitiesUK, June 2013, p7 **11** Office for National Statistics (2015) International Comparisons of Productivity – Final Estimates, 2013 **12** IFS (2013) "The IFS Green Budget 2013. Chapter 3: The productivity puzzles" Available online at: http://www.ifs.org.uk/docs/34598THZZ12.pdf **13** The IFS Green Budget: February 2013, The productivity puzzles, Richard Disney, Wenchao Jin and Helen Miller, IFS, February 2013, p53 **14** Summer Budget 2015, HM Treasury, July 2015 **15** http://www.fxstreet.com/analysis/monday-briefing/2015/06/08/ **16** http://www.huffingtonpost.co.uk/tony-dolphin/sajid-javid-uk-economy_b_7284422.html **17** http://www.bbc.co.uk/news/business-31602582

Table 1.1: The productivity puzzle – selected explanations

[18]The financial crisis has resulted in **impaired resource allocation across the economy**, preventing capital and labour from finding their most productive uses and weighing on productivity growth.[19] It is likely that **some sector-specific factors are also at play**. Five sectors – financial services, ICT, professional services, wholesale and retail and transportation and storage – represent around 40% of the economy but have accounted for around 65% of the productivity shortfall. [20, 21] The **relatively low cost of labour** since the crisis may have led firms to substitute away from investment, reducing the effective amount of capital workers can use and thus reducing productivity.[22] It is likely that **'labour hoarding'** by firms may have reduced productivity in the initial phase following the financial crisis, as firms sought to hold on to labour despite falling demand for their output.[23] **However**, this cannot explain developments in more recent years, as employment and hiring have grown very strongly. **Measurement issues**: although there have been some recent statistical improvements,[24] the changing nature of economic activity in the modern economy poses measurement challenges. Capturing fully the increasing quality of new goods and services for example, along with financial services measurement, forms a distinct part of the puzzle.[25]	**[26]Mis-measurement:** as the economy has become more service based and business investment has switched from physical investment to investment in 'knowledge', it makes it difficult to measure productivity accurately and we may therefore be understating the rate of productivity growth in this recovery. **Sector specific factors:** exceptionally large falls in output in the oil and gas sectors and the financial services industry have pushed output lower than employment for a period. **Too many zombie firms:** financial institutions have held back from closing firms that owed them money, and banks may be excessively cautious in making loans to new and expanding businesses, so that the normal reallocation of resources from lower productivity activities to higher productivity activities has been inhibited. **Innovation slowdown:** the pace at which innovation enhances productivity is slowing as we have completed all the easy wins from the previous big leaps in technology, leaving only incremental innovation in well-established areas. **Economic uncertainty:** the financial crash saw a simultaneous downturn across the Organisation for Economic Co-operation and Development (OECD). Faced with unprecedented insecurity, firms have held back productivity enhancing investment programmes. **Labour is cheap and plentiful:** with real wages falling labour has become much cheaper than in previous recoveries, so firms have invested in more people rather than new technologies and new plant and offices. **Labour hoarding:** In the top half of the labour market, firms are reluctant to let skilled labour go even though their output growth sits poorly with staffing levels.	[27]Unemployment rose, but is nowhere near as high as it was in the milder recessions of the early 1980s and early 1990s. **The flip side of Britain's productivity problem is that more people have stayed in work** through the biggest downturn since the 1930s. In terms of human welfare, this is surely preferable to sustaining productivity by pushing hundreds of thousands into unemployment. The 'productivity crisis' and Britain's success in preserving and growing employment are two sides of the same coin. **Keeping people in work through the downturn has helped maintain skills**, experience and contact with the world of work. Indeed, this was this reason that many employers avoided mass lay-offs during the recession. In this way, at least, the standstill in productivity of the last few years may actually contribute to future growth in productivity. **Weak productivity during the downturn had a silver lining, in terms of job preservation**. But the downturn has long since ended and productivity growth remains weak. This is a global phenomenon, but the UK has done especially poorly. According to analysis carried out by the Financial Times, around **three quarters of the fall in productivity is due to four previously high productivity sectors** – the professions, telecommunications, manufacturing and banking.	**[28]There are now more people in employment in the UK than before the recession. But output remains below pre-recession levels**. At the same point after the recessions of the early 1980s and 1990s, the reverse was the case: employment levels were still lower than before the recessions, but output had more than recovered its pre-recession level. The result is a fall in labour productivity since 2008 that is much larger and more persistent than in previous recessions. Real wages have fallen since 2008. Labour supply appears to have been more robust, and the labour market more flexible than was the case during previous recessions. This may have **contributed to lower real wages, which in turn allow firms to retain more workers than they otherwise would** during periods of falling demand – thereby to lowering labour productivity. In contrast to previous recessions, there has been **no surge in levels of economic inactivity** – i.e. in the numbers of people of working age neither in employment nor looking for employment. **The evidence in favour of continued 'labour hoarding' is weak:** flows into employment have remained strong and we would expect the majority of firms to have adjusted their labour inputs by now. Business investment has fallen significantly during the recession to the extent that this has reduced either the level or quality (or both) of available capital. We expect **low investment to have contributed to lower labour productivity**. The **movement of capital to high-productivity projects may have been inhibited** by a combination of bank forbearance and financing constraints that reduce the exit of low-productivity firms and restrict the entry of new firms.

Source: OECD

18 Fixing the foundations: Creating a more prosperous nation, HM Treasury, July 2015, p78 **19** OECD Economic Surveys: United Kingdom, OECD, February 2015. **20** HMT calculations using ONS GDP low level aggregates, Quarterly National Accounts and Workforce Jobs. **21** ONS Quarterly National Accounts, GDP low level aggregates **22** The UK Productivity and Jobs Puzzle; Does the answer lie in Labour market flexibility? Pessoa and Van Reenen. **23** The productivity puzzle: a firm-level investigation into employment behaviour and resource allocation over the crisis, Bank of England Working Paper No. 495, April 2014. **24** Such as the UK implementation of the ESA10- the European System of National and Regional Accounts **25** The UK productivity puzzle, Bank of England Quarterly Bulletin, Q2 2014. **26** Employment Relations Comment, The productivity challenge – and what the next government should do about it, ACAS, February 2015, p2-3 **27** http://www.fxstreet.com/analysis/monday-briefing/2015/06/08 **28** The IFS Green Budget: February 2013, The productivity puzzles, Richard Disney, Wenchao Jin and Helen Miller, IFS, February 2013, p53

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Unfortunately, as the Institute for Public Policy Research (IPPR) has pointed out, post-recession, the productivity puzzle is still alive and well. The Institute highlights that there is plenty of scope for the UK to make productivity gains, although closing the gap between it and other European countries will take many years.[29]

This is highlighted by data from the OECD which shows that one hour's work in the UK generated US $50.5 of output in 2014, ranking it 18th out of 34 OECD countries in terms of GDP per hour worked. GDP per hour worked was US $62 or more in Belgium, the Netherlands, France and Germany (and more than $67 in the US). Productivity in those four European countries is between 23% and 32% higher than in the UK[30] (Table 1.2).

1.1.1.1 What can be done about it?

Recognising the need for concerted action to boost productivity, the government has launched a Productivity Plan for the next decade.[33] As further proof of need, they quote that matching the productivity of the US would raise GDP by 31%, equating to around £21,000 per annum for every household in the UK.[34]

The government's framework for raising productivity is to be built around two pillars:[35]

- encouraging long-term investment in economic capital, including infrastructure, skills and knowledge
- promoting a dynamic economy that encourages innovation and helps resources flow to their most productive use

These high-level drivers of productivity are based on widely agreed and relatively well-understood academic analysis.

The fifteen-point Productivity Plan is illustrated in Figure 1.1.

The IPPR has analysed historical and international records to try to get to the bottom of the productivity puzzle. These suggest that, over the last seven years, there were two distinct phases of productivity weakness.[36]

In the first phase, they found that poor productivity during the recession was wholly within sectors; productivity was relatively poor in manufacturing, wholesaling and retailing, transport, accommodation and food services, as a result of labour-hoarding and a shift in the capital to labour ratio, facilitated by a fall in real wages.

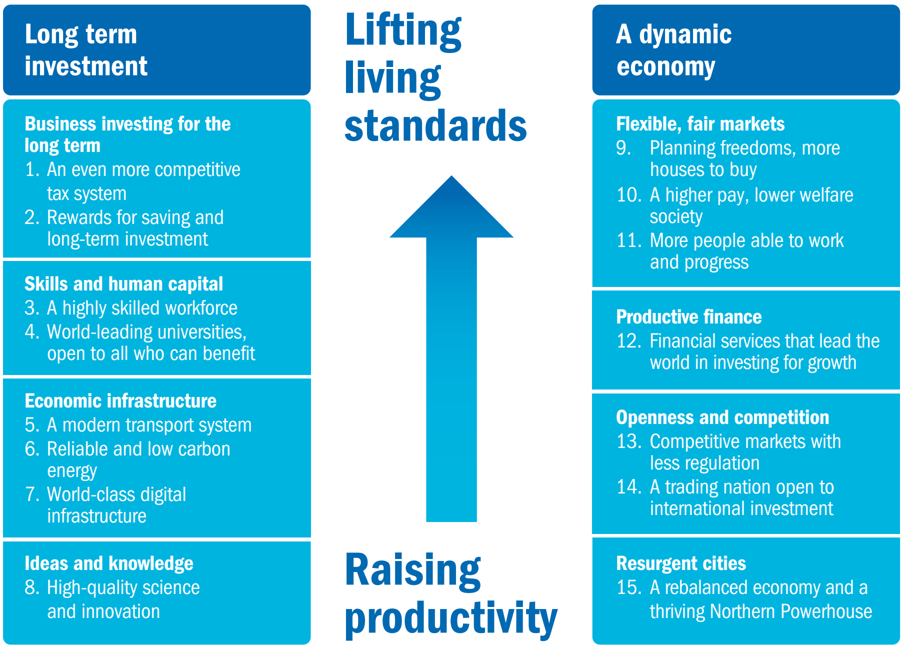
The second phase resulted in an unfavourable shift in the structure of the economy. A larger proportion of the labour force was working in

Table 1.2: Productivity (GDP[31] per hour worked) in OECD countries (2014)

Rank	Country	Productivity (GDP per hour, in US$)	Relative to the UK	Rank	Country	Productivity (GDP per hour, in US$)	Relative to the UK
1	Luxembourg	$96.9	90%	**19**	Iceland	$48.0	-5%
2	Norway	$88.0	74%	**20**	Slovenia	$42.8	-15%
3	US	$67.4	33%	**21**	Japan	$41.5	-18%
4	Belgium	$66.5	32%	**22**	New Zealand	$39.9	-21%
5	Ireland	$64.7	28%	**23**	Slovak Republic	$38.1	-25%
6	Netherlands	$64.3	27%	**24**	Israel	$37.3	-26%
7	Denmark	$63.3	25%	**25**	Greece	$36.2	-28%
8	France	$62.7	24%	**26**	Portugal	$35.3	-30%
9	Germany	$62.3	23%	**27**	Czech Republic	$34.8	-31%
10	Switzerland	$61.1	21%	**28**	Korea	$32.8	-35%
11	Sweden	$58.3	15%	**29**	Hungary	$31.6	-37%
12	Austria	$55.6	10%	**30**	Estonia	$31.4	-38%
13	Australia	$55.2	9%	**31**	Turkey	$31.4	-38%
14	Finland	$53.6	6%	**32**	Poland	$29.7	-41%
15	Spain	$51.4	2%	**33**	Chile	$25.9	-49%
16	Italy	$50.8	1%	**34**	Mexico	$19.5	-61%
17	Canada	$50.7	0%				
18	**UK**	**$50.5**					

Source: OECD[32]

Figure 1.1: A framework for raising productivity



Source: HM Treasury

29 The Missing Pieces Solving Britain's Productivity Puzzle, IPPR, 10 August 2015, p10 http://www.ippr.org/files/publications/pdf/missing-pieces-britains-productivity-puzzle_Aug2015.pdf?noredirect=1
30 Organisation for Economic Cooperation and Development, 2015 'National Accounts' theme, OECD stat database. http://stats.oecd.org/index.aspx **31** GDP is measured in current prices and converted to US dollars using purchasing power parities. **32** Organisation for Economic Cooperation and Development, 2015 'National Accounts' theme, OECD stat database. http://stats.oecd.org/index.aspx Using the main aggregate '1. Gross domestic product (GDP)' **33** https://www.gov.uk/government/publications/fixing-the-foundations-creating-a-more-prosperous-nation **34** HMT calculation: 2014 nominal GDP (YBHA) divided by 2014 ONS household estimates; Quarterly National Accounts, ONS, June 2015 and Families and Households, ONS, January 2015. **35** Fixing the foundations: Creating a more prosperous nation, HM Treasury, July 2015,p7 **36** The Missing Pieces Solving Britain's Productivity Puzzle, IPPR, 10 August 2015, p3 http://www.ippr.org/files/publications/pdf/missing-pieces-britains-productivity-puzzle_Aug2015.pdf?noredirect=1

relatively low-productivity sectors – particularly the accommodation and food sector – and a smaller proportion were working in high-productivity jobs in finance and manufacturing.

The IPPR concluded that the key to restoring productivity growth is, therefore, to shift job creation towards higher productivity sectors, while encouraging firms to invest more in boosting the productivity of their existing workforces. It stressed that putting in place an active industrial strategy would be the best way to tackle these problems and help deliver productivity growth. Measures to improve the UK's historically poor record of spending on innovation and investment should be at the heart of this strategy. Among other things, this will require better access to finance for firms. The Institute adds that more also needs to be done to improve vocational education and training – including the retraining of older workers – so that firms can find workers with skills they need.[37]

The view that inherent flaws in the current methodology for measuring productivity are leading to an understating of actual productivity (see box) is also gaining agreement. There are calls to create a more appropriate formula of measurement: one that reflects the modern business and financial world. Amongst other things, this should include investment in intangibles such as R&D and software.[38 39]

Measuring productivity[40]

In some parts of the economy, it is relatively easy to measure productivity. Across much of the manufacturing industry, for example, the output of a factory or plant can be measured fairly accurately, as can the number of hours of work that went into producing that output. Even here, though, problems can arise when trying to measure changes in productivity. It is relatively easy to do so when a plant increases the quantity of its output, without any change in quality. However, an increase in quality, with no change in quantity, also represents an improvement in productivity, but this is harder to measure.

The problems get worse in parts of the service sector. Areas such as retailing are relatively straightforward: the output of a supermarket is not much harder to measure than the output of a manufacturing plant. But how do you measure output and productivity in the health service or the caring professions? Or in the finance sector, in which incomes and profits may depend on conditions in the financial markets?

If we get all our 'actions' right, there are potentially huge economic gains. This belief is endorsed by a study from Oxford Economics, who predict a dramatic turnaround in both productivity and disposable income growth from 2015 to 2020.[41]

It predicts that productivity will rise by a total of 10.7% over the period, pushing real personal disposable incomes up by 12.4%. Over the last five years, productivity growth was 3.2% in total – around 0.6% per year – and disposable income grew by just 2.7% in total – or 0.5% per year.

The study also revealed:

- 530,000 new 'knowledge economy' jobs are forecast be created over the next five years: 330,000 in professional services and 200,000 in digital & creative.
- Watford will see the biggest growth in jobs by 2020 – rising by almost 9%.
- Manufacturing productivity will rise by 15.5% over the next 5 years.
- Rising productivity will boost the UK's international competitiveness, particularly in manufacturing, which will see the value of its exports rise by 35%.
- Wages will grow nationally but fastest in the South East, with Wokingham in Berkshire expected to see a 12.1% rise by 2020.
- Britain's second cities including Manchester (3.8%), Birmingham (2.5%), and Liverpool (2.6%) will experience faster employment growth than Paris (1.7%), Berlin (1%) and Tokyo (-0.2%) over the next five years.

Furthermore when considering actions, we should not overlook the contribution of small and medium sized enterprises (SMEs).

SMEs employ 15.2 million, or 60%, of the private sector workforce, and generate £1.6 trillion, or 33%, of UK turnover. In view of the sheer size of their economic contribution, improving the productivity levels of small businesses is certain to have a beneficial impact on the overall productivity growth of the UK economy.[42]

Finally, as the rest of this report will show, if we rebalance the economy towards engineering we will be engineering a more productive economy:

- Engineering sectors produce the majority of the nation's exports and play an essential role in supporting the UK's international competitiveness by investing in research & development and innovation – a vital part of sustaining the UK's long-term economic performance. Indeed, the gross value added of engineering businesses is larger than the retail & wholesale, and financial and insurance sectors combined.
- Engineering sectors are vital to the UK's economy, contributing an estimated £455.6 billion to GDP in 2014: 27.1% of the £1,683 billion total UK GDP. By 2022, this contribution is expected to increase to £608.1 billion.
- For every £1 in GVA generated in engineering sectors, a further £1.45 is generated elsewhere in the UK economy. This creates a GVA multiplier of 2.45 providing an estimated total GVA of engineering sectors in 2014 of £995.7 billion. This is equivalent to 66% of UK GVA and represents a GDP contribution of approximately £1,116.8 billion.
- Between 2013 and 2014, the number of registered engineering enterprises grew by 5.6% in the UK to 608,920 (Table 2.4); the highest growth in over six years. This reflects the increasingly buoyant nature of the sector over the last couple of years.
- For every new engineering job another two new jobs will be created for the UK economy.

1.1.2 Economic

We live in a world that's shrinking due to communication and technology, yet growing in terms of economic opportunities and competitors. As one of the oldest economies in the world, foreign trade has always been important to us. Happily, we are maintaining our strong record.

Foreign direct investment continues to strengthen UK competitiveness across key industries and sectors. In 2014, the UK attracted the highest number of foreign direct investment (FDI) projects and received the largest value of FDI net inflows in Europe.[43] During 2014/15, UK Trade & Investment (UKTI) recorded 1,988 FDI projects – 12% more than in the previous year (Table 1.3) – with UK inward FDI Stock, the amount of foreign direct investment in the UK, surpassing £1 trillion. Preliminary estimates from the OECD are that the UK has achieved a 50% increase in FDI inflows in a year when the global value of FDI flows fell by 11%. Foreign investments bring with them a significant number of new and safeguarded jobs, across the UK and in all sectors of the economy. It is estimated that almost 85,000 new jobs were created by inward investment projects, 27% more than in the previous year and the highest since records began in the early 1980s. Foreign investment has also helped to secure many existing jobs in

37 Tony Dolphin, Senior Economist and Associate Director for Economic Policy, IPPR Article in Huffington Post, http://www.huffingtonpost.co.uk/tony-dolphin/sajid-javid-uk-economy_b_7284422.html 38 Peter Goodridge, Jonathan Haskel, Gavin Wallis, Can Intangible Investment Explain the UK Productivity Puzzle? February 2013,p2 http://www.ceriba.org.uk/pub/CERIBA/IntanUKProdPuzzle/Intangibles_and_Growth_Puzzle_7Feb13a.pdf 39 The UK productivity puzzle, Bank of England, Quarterly Bulletin 2014 Q2, p118 http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/2014/qb14q201.pdf 40 The Missing Pieces Solving Britain's Productivity Puzzle, IPPR, 10 August 2015, p12 http://www.ippr.org/files/publications/pdf/missing-pieces-britains-productivity-puzzle_Aug2015.pdf?noredirect=1 41 Beyond the City: Britain's economic hotspots, A forecast of the UK's economic performance across productivity, employment and wages, June 2015, p3 42 Building Productivity in the UK, ACAS, June 2015, p35 http://www.acas.org.uk/media/pdf/7/9/Building-productivity-in-the-uk.pdf 43 Inward Investment Report 2014/15, UK Trade & Investment (UKTI), 17 June 2015, p1 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/435646/UKTI-Inward-Investment-Report-2014-to-2015.pdf

the UK. Last year, the number of safeguarded jobs associated with FDI projects was just over 23,000. Overall, FDI projects are estimated to have brought with them almost 108,000 new and safeguarded jobs over the last year.[44]

Table 1.3: Projects and total jobs by industry group (2014/15)[45]

Industry group	Projects	Total jobs
Advanced manufacturing	468	33,288
Energy and infrastructure	241	14,738
Financial and professional services	515	34,921
Creative industries and ICT	486	13,590
Life sciences	168	6,583
Electronics and telecoms	110	4,538
Grand total	**1,988**	**107,658**

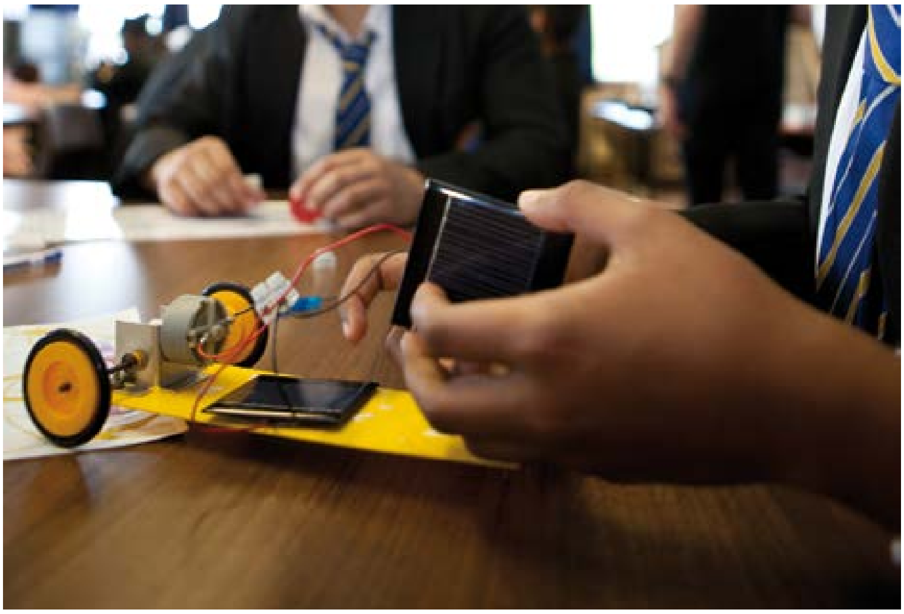
Source: UKTI

Table 1.4 shows the top 10 countries investing in the UK, along with the associated number of new and safeguarded UK jobs. Interestingly, just the US, India and China account for almost half of the UK's new and safeguarded jobs.

Table 1.4: The top 10 countries investing in the UK (2014)

Countries	Projects	Total jobs (new and safeguarded)
United States	564	36,778
France	124	8,198
India	122	9,350
China (inc. HK)	112	5,927
Japan	107	3,873
Germany	97	9,727
Italy	91	2,193
Australia	81	4,012
Canada	72	3,762
Spain	59	3,646

Source: UKTI



On the flip side, we have seen an increase in exports to key target markets. Significantly, increases in emerging economies such as China (3.4%), India (1.6%), Russia (1.5%) and Brazil (0.8%) account for a small, but growing, share of UK exports. Exports to the established BRICs increased by 55% in nominal terms between 2010 and 2013, and exports to China saw the fastest growth between 2010 and 2013 (83%), followed by Russia (60%), Brazil (29%) and India (23%).[46]

At sector level, engineering is vital to the UK's economy. In its own right, it contributed an estimated £455.6 billion to GDP in 2014: 27.1% of the £1,683 billion total UK GDP.[47] The sector also has a positive multiplier effect on the rest of the UK; for every new engineering vacancy filled, 1.7 new jobs can be expected to be created throughout the UK economy.[48 49]

Figure 1.2 breaks the UK economy down in terms of the respective contribution of each sector to UK GVA and share of employment. It shows that the services sector accounts for 77% of UK GVA, of which professional services (12%) is the largest subsector.[50] The remainder is accounted for by knowledge services (35%), manufacturing (10%), construction (7%), other production (5%) and agriculture (1%).

Services also dominate UK employment, accounting for 83% of jobs. Manufacturing (8%) and construction (6%) are the next two largest sectors by employment. Health and social work (13%) is the largest sub-sector within services.

The figures are a snapshot. Those who wish to keep a regular eye on the state of the UK will find what they need in the growth dashboard and the web link provided in the footnote below. [51]

44 Inward Investment Report 2014/15, UK Trade & Investment (UKTI), 17 June 2015, p9 **45** *Ibid*, p15 **46** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/396740/bis-15-4-growth-dashboard.pdf slide 23 **47** The contribution of engineering to the UK economy – A report for EngineeringUK, CEBR, October 2014 http://www.engineeringuk.com/Research/ **48** The contribution of engineering to the UK economy – the multiplier impacts– A report for EngineeringUK, CEBR, January 2015 http://www.engineeringuk.com/Research/ **49** See section 2.0 Engineering in the UK for a full review **50** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/396742/growth-dashboard-growth-and-sector-performance-data.xlsx Figure 13.1 **51** https://www.gov.uk/government/publications/growth-dashboard

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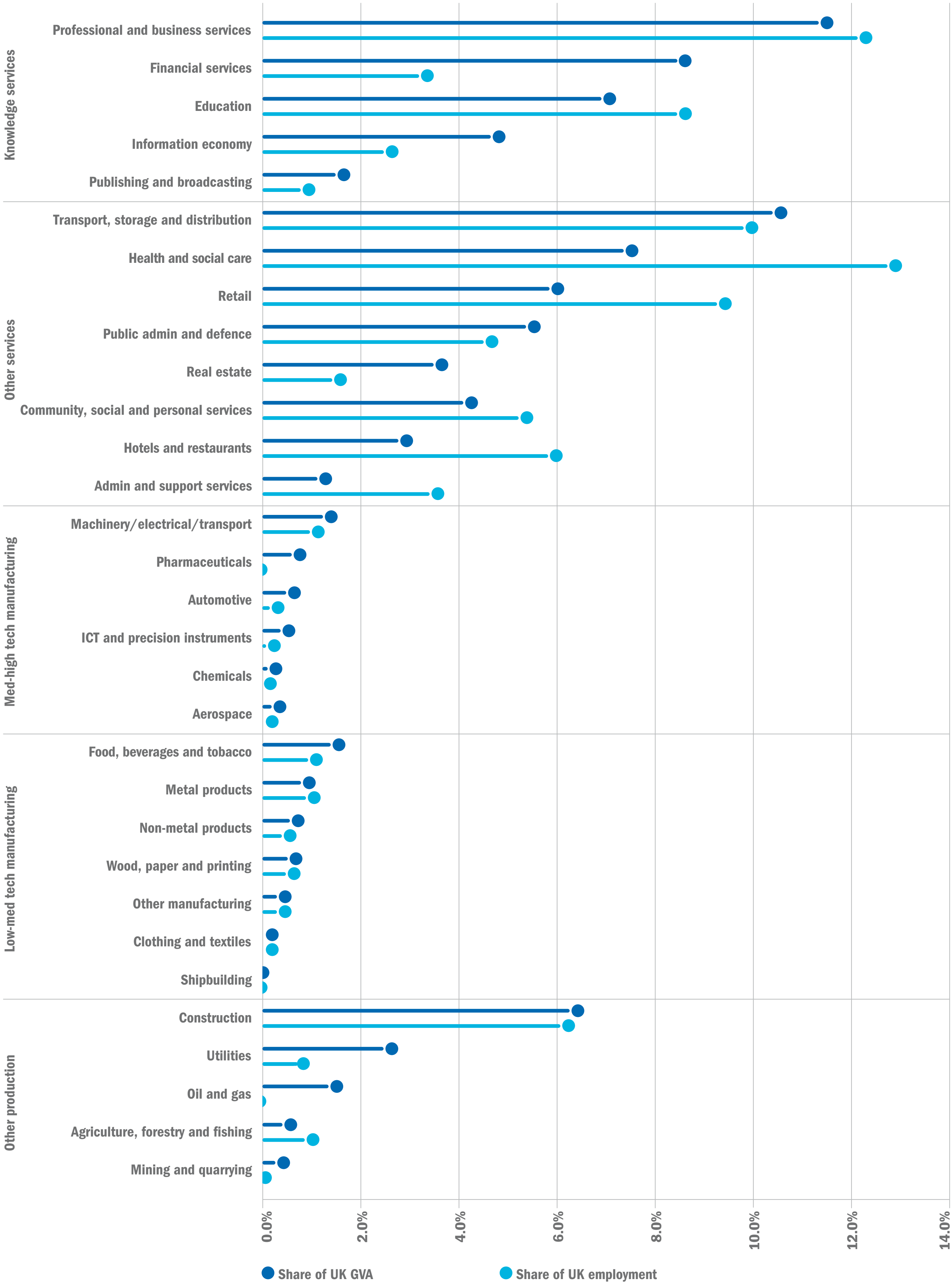
Figure 1.2: Structure of UK economy (2014)



Source: Structure of the UK economy, BIS analysis of ONS – GDP (O) low level aggregates

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1.1.3 Skills

"The world economy no longer pays you for what you know, but for what you can do with what you know."
Andreas Schleicher, OECD

The ability of a country, region, or business to develop and harness skills directly relates to their future economic, social and competitive wellbeing.

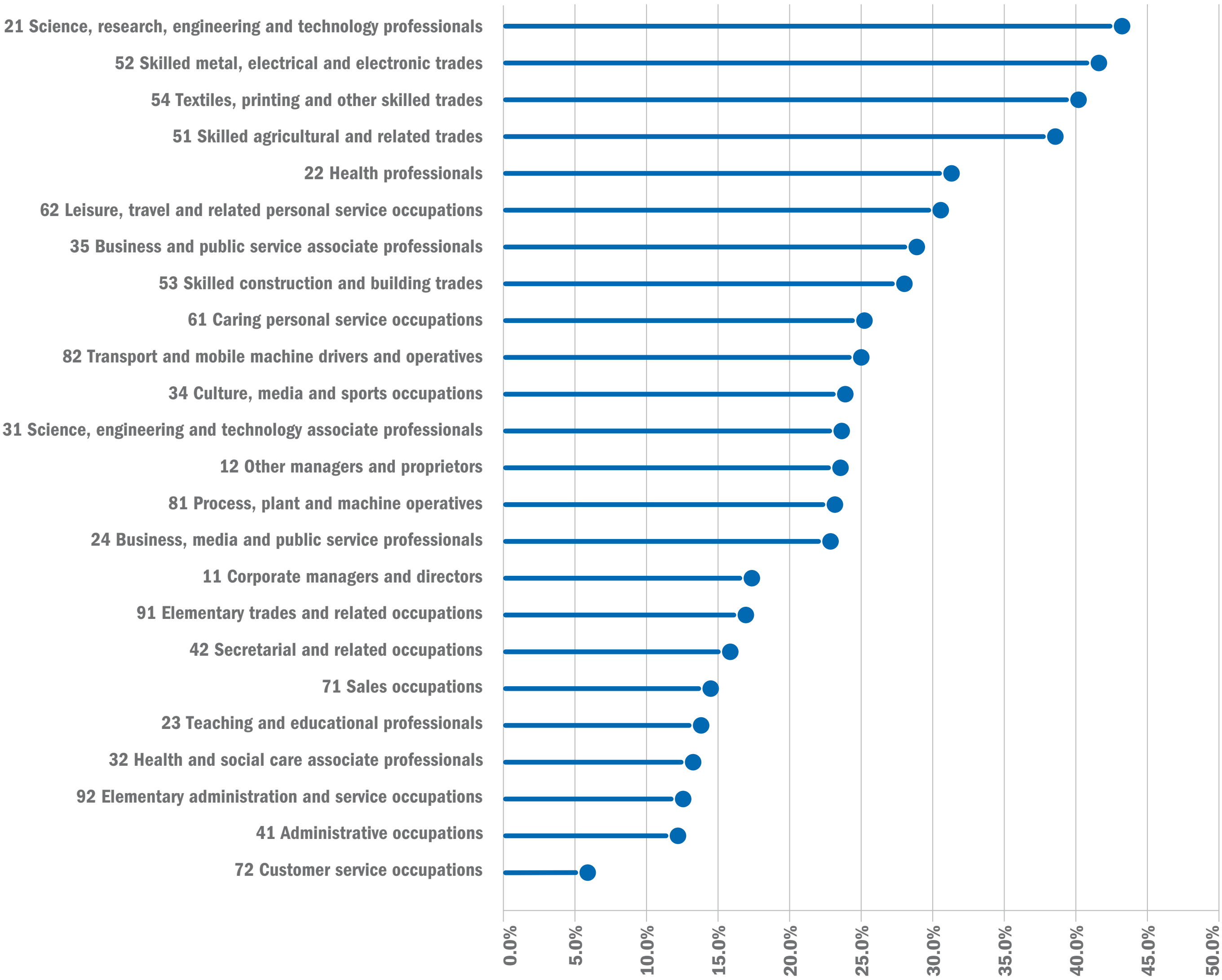
It is therefore important to note three findings from the UK Commission for Employment & Skills' (UKCES) report, *Growth Through People:*[52]

1. In 2013, the estimated value of employed human capital was £17.61 trillion – two and a half times the value of 'hard' assets such as buildings, vehicles and machinery.[53]
2. Up to 90% of the current workforce will still be in work in the next decade. To tackle the productivity deficit for the economy as a whole, there must be a much greater focus on job design, technology and progression for those in work.
3. The skills of a significant portion of the workforce – 4.3 million workers or 16% of employees – are underutilised.[54]

Closer investigation of skills shortages in the UK by occupation shows a large variance in the occupations affected by shortages. According to *The Employer Skills Survey 2013*, the science, research, engineering and technology professionals category (SOC submajor group 21) has the highest ratio of skill shortages to vacancies of any of the 25 occupational sub-major groups.[55] At 43%, it is almost twice as high as the overall average of 23%, and it is the third highest of the occupational groups in terms of overall volume of shortages with 13,000 (Figure 1.3).

The shortage of science and engineering-related professionals is EU-wide.[56] Research undertaken by the European Parliament analysed the number of countries experiencing bottleneck vacancies (skills shortages) by all occupational groups. Table 1.5 presents the top 10 occupational groups with bottlenecks in Europe.

Figure 1.3: Density of skills shortages by occupation (SOC submajor group) (2013)



Source: UK Commission's Employer Skills Survey 2013

52 Growth Through People. UKCES, November 2014. P2,3,6 53 ONS (2014) Human Capital Estimates, 2013. 54 UKCES (2014) Employer Skills Survey 2013. 55 Reviewing the requirement for high level STEM skills, UKCES, Evidence Report 94, July 2015, p31 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444052/stem_review_evidence_report_final.pdf 56 European Parliament, Labour Market Shortages in the European Union (2015), p44

Table 1.5: Top 10 occupational groups facing bottlenecks at EU level (ISCO 2-digit)

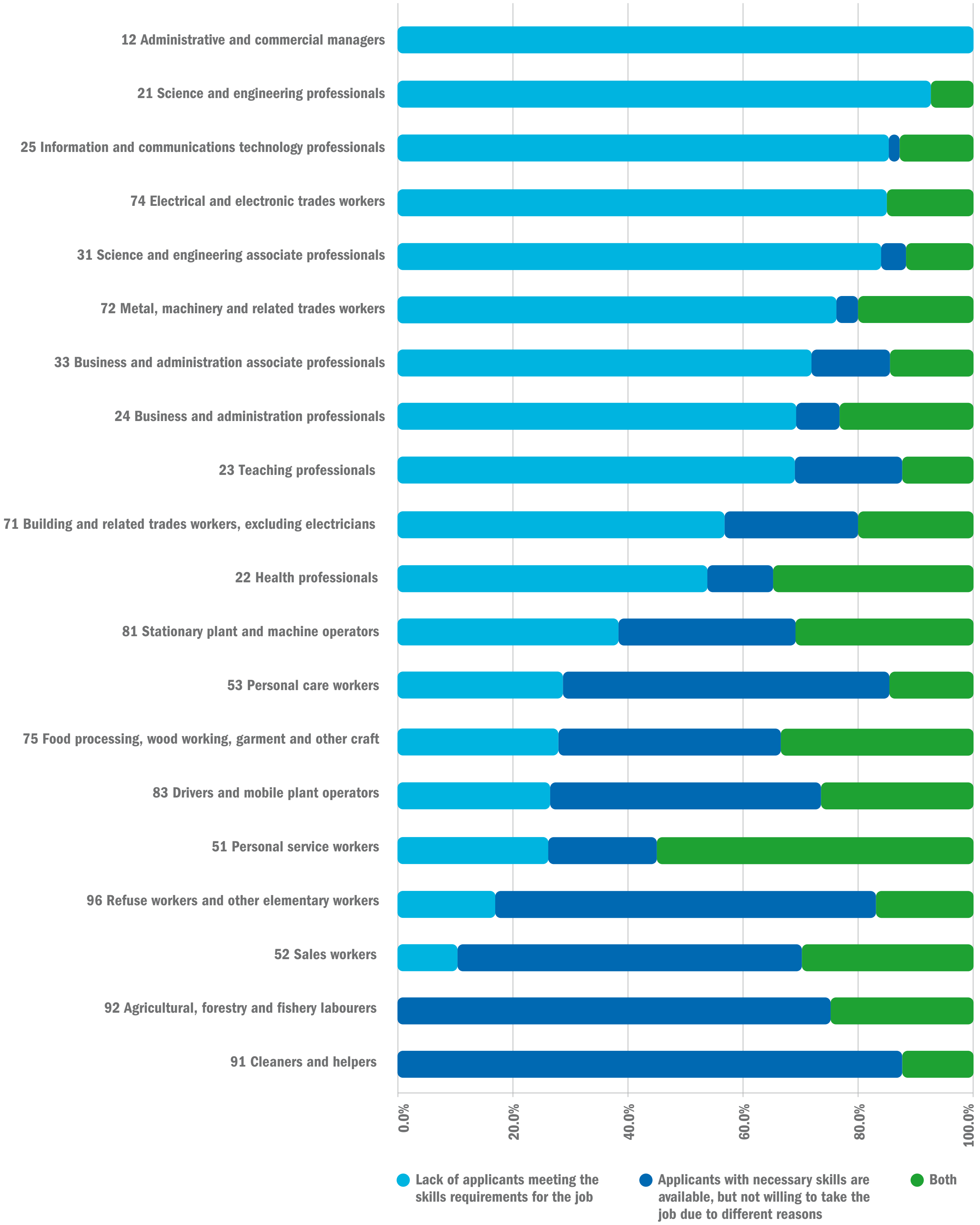
Occupational group	No. of countries reporting shortages	No. of bottleneck vacancies reported in this group
Metal, machinery and related trade workers	23	53
Science and engineering professionals	22	48
ICT professionals	20	47
Health professionals	21	45
Building and related trade workers, excluding electricians	18	41
Personal service workers	22	32
Science and engineering associate professionals	14	29
Sales workers	13	14
Drivers and mobile plant operators	16	21
Food processing, wood working, garment and other	12	20

Source: EC (2014), Mapping and Analysing Bottleneck Vacancies in EU Labour Markets, Overview report, Final, p10

When analysed, the reasons for bottleneck occupations vary, with most of them indicating skills shortages and mismatches, either due to tight labour markets with insufficient (skilled) workers, or due to the non-availability of the right skills in the available workforce (Figure 1.4).[57]

57 *ibid*, p45

Figure 1.4: Reasons for bottlenecks by occupation group (ISCO 2-digit)



Source: EC (2014), Mapping and Analysing Bottleneck Vacancies in EU Labour Markets, Overview report, Final, p37

1.1.3.1 The hourglass economy

We should also look beyond science and engineering skills shortages, to underlying trends in the labour market: what is recognised as the 'squeezed middle' or the 'hourglass' economy and the up-skilling of jobs.

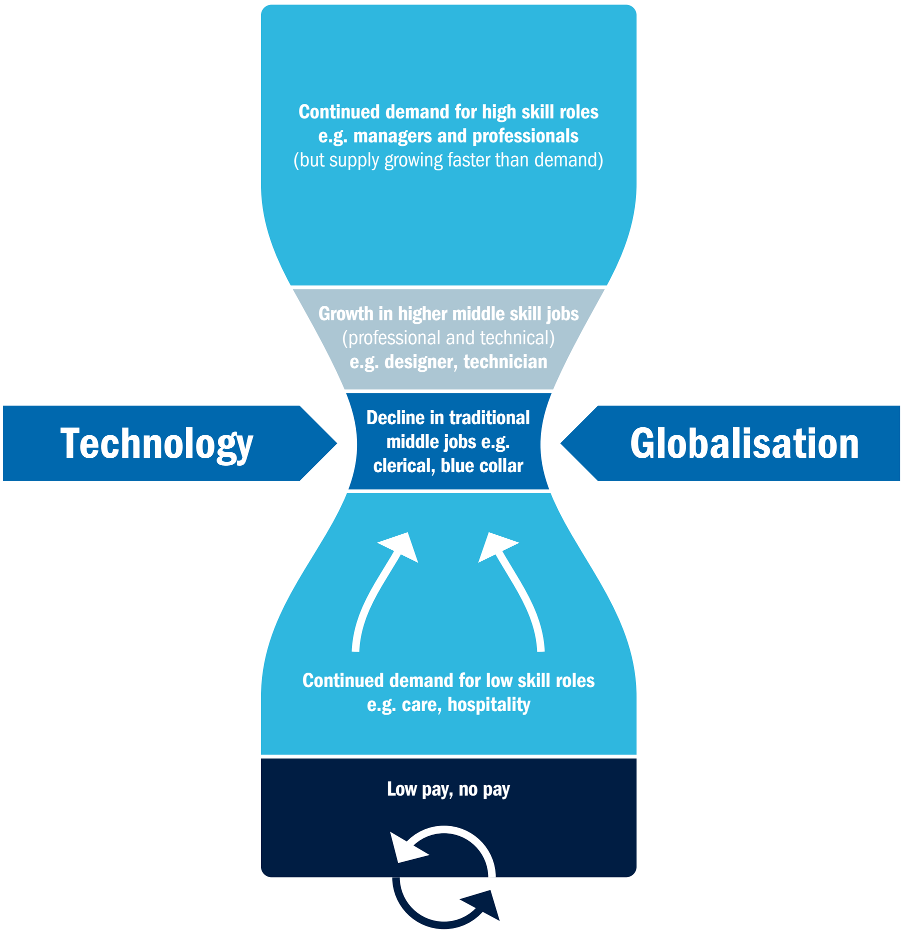
In the last two decades, the number of high-skilled jobs in the UK has risen by 2.3 million. In some occupations, like design, engineering and architecture, employers are struggling to fill positions. Demand for low-skilled roles has also grown, with 1.8 million more jobs in areas such as care, administration and leisure. Yet, over the same 20-year period, we have seen a significant decrease in demand for middle-skilled workers, with 1.2 million fewer jobs available for these largely routine-based roles.[58]

The projected trend towards an hourglass-shaped labour market (Figure 1.5)[59] is expected to continue into the foreseeable future and may even become more pronounced,[60] as the routine nature of many middle-skilled occupations makes them especially vulnerable to automation (see Section 1.1.5). The predictions are for faster growth of higher- and lower-skilled jobs compared with middle-skilled jobs in the UK into the next decade.[61]

As for the squeezed middle, while some intermediate roles would still emerge, their overall volume would be reduced. This could result in a labour market with great prospects for those able to demonstrate talent early, but with fewer pathways for those who need to progress to higher skilled occupations through career development in work.

This, of course, is not uniquely a UK phenomenon: this 'hollowing out' of the workforce can be seen in many other developed economies. In the US, for example, the share of middle-skilled roles fell by 14% from 59% to 45% between 1983 and 2012, while the share of low-skilled and high-skilled occupations both rose.

Figure 1.5: The future shape of the labour market



Source: UKCES

58 Owning The Future, How Britain can make it in a Fast-Changing World, A New Direction for a More Inclusive Economy, Sir Charlie Mayfield, Policy Network, August 2014, p50 **59** The Labour Market Story: An Overview, UKCES, July 2014, page 10 **60** Still in tune? The skills system and the changing structures of work, Skills Commission, November 2014, p24 **61** Owning The Future, How Britain can make it in a Fast-Changing World, A New Direction for a More Inclusive Economy, Sir Charlie Mayfield, Policy Network, August 2014, p50

1.1.3.2 The up-skilling of the UK workforce

The gradual up-skilling of the UK workforce from 2002 to 2012 is recorded in Table 1.6, which shows and is mirrored in the projections for qualifications in the UK from 2012 to 2020, shown in Table 1.7. It is important to note that this data refers to the level of qualification held by individuals, and not the skill level of their occupation.

Table 1.6 highlights the size of these changes in terms of the numbers of individuals involved. Over the ten year period, the number of individuals with level 4+ qualifications rose by more than 5 million (an 11 percentage point rise), while those below level 2 fell by more than 3 million (an 11 percentage point fall).[62] These changes took place against a population increase amongst 19- to 64-year-olds of nearly 3 million.

The results based on 2012-2020 trends are set out in Table 1.7. The proportion qualified to level 4+ is projected to rise from 37.1% to 46.7% over this period (a 9.6 percentage point increase). Projections suggest that level 7-8 will continue to be the fastest growing area.

The largest fall is predicted for those with no qualifications (a reduction of 3.7 percentage points, or a fall of 40% compared with its 2012 value). This comprises the majority of the 6.2 percentage point fall in the below level 2 group. In fact, all levels of qualification other than the highest two show falls, although some of these are quite modest. The projections suggest that there will be a fall of almost one million people at the intermediate levels (levels 2 and 3).[63]

1.1.3.3 The value of soft skills

'Soft skills' is a term widely bandied around the work place, but often misconstrued by employers. Nevertheless, the importance of soft skills for businesses and other organisations has been receiving considerable attention from senior executives, human resources specialists, economists and many public policy-makers with a responsibility for economic competitiveness, education and employment.[64]

The growing importance of soft skills in the modern workplace hinges on the increasing emphasis on team-working, collaboration, worker-to-worker interaction and/or worker-to-customer interactions in most working environments. In particular, they make an important contribution to financial and business services, retail, and public services, including education and health.

Table 1.6: Changing distribution of qualifications among 19- to 64-year-olds (2002-2012) – UK

	2002		2012		2002-2012 Change	
	%	Number	%	Number	Percentage point	Number
Level 7-8	4.7%	1,662,000	8.3%	3,190,000	3.7	1,528,000
Level 4-6	21.0%	7,490,000	28.8%	11,024,000	7.7	3,533,000
Level 4+	**25.7%**	**9,152,000**	**37.1%**	**14,214,000**	**11.4**	**5,061,000**
Level 3	19.2%	6,835,000	19.4%	7,446,000	0.2	610,000
Level 2	20.3%	7,217,000	19.7%	7,534,000	-0.6	316,000
Level <2	**34.8%**	**12,394,000**	**23.9%**	**9,144,000**	**-11.0**	**-3,250,000**
Level 1	19.0%	6,775,000	14.7%	5,627,000	-4.4	-1,148,000
No qualifications	15.8%	5,619,000	9.2%	3,516,000	-6.6	-2,102,000
All qualifications	**100.0%**	**35,599,000**	**100.0%**	**38,337,000**	**0.0**	**2,738,000**

Source: Time series model.
Note: "No qualifications" are all individuals below level 1 and, therefore, include some individuals with Entry level qualifications.

Table 1.7: Projected distribution of qualifications among 19- to 64-year-olds (2012-2020) – UK

	2012		2020		2012-2020 Change	
	%	Number	%	Number	Percentage point	Number
Level 7-8	8.3%	3,190,000	11.4%	4,483,000	3.0	1,293,000
Level 4-6	28.8%	11,024,000	35.3%	13,933,000	6.6	2,910,000
Level 4+	**37.1%**	**14,214,000**	**46.7%**	**18,416,000**	**9.6**	**4,202,000**
Level 3	19.4%	7,446,000	17.5%	6,884,000	-2.0	-562,000
Level 2	19.7%	7,534,000	18.2%	7,164,000	-1.5	-369,000
Level <2	**23.9%**	**9,144,000**	**17.7%**	**6,980,000**	**-6.2**	**-2,163,000**
Level 1	14.7%	5,627,000	12.1%	4,767,000	-2.6	-861,000
No qualifications	9.2%	3,516,000	5.6%	2,214,000	-3.7	-1,303,000
All qualifications	**100%**	**38,337,000**	**100%**	**39,445,000**	**0**	**1,108,000**

Source: Time series model.
Note: "No qualifications are" all individuals below level 1 and, therefore, include some individuals with Entry level qualifications.

A report undertaken by Development Economics on the value of soft skills to the UK economy shines a new light on them. It defines soft skills as, *"the personality traits and other personal attributes that enable individuals to interact effectively and harmoniously with other people in the workplace, including co-workers, managers and customers."* The report estimates that the current value of soft skills to the UK economy is over £88 billion a year GVA at 2011 prices.

The report expects the annual contribution of soft skills to grow strongly over the next five years, contributing £109 billion to the economy in real terms by 2020, and just over £127 billion by 2025.

Crucially, it also estimates that over half a million (535,000) UK workers will be significantly held back by soft skills deficits by 2020, an issue that is expected to affect all sectors of the economy. In absolute terms, the group found that the accommodation and food services, retail, and health and social work sectors will be most affected. Finally, it highlighted that the annual loss of production due to soft skills deficits is anticipated to amount to just under £8.4 billion per year by 2020.[65]

62 UK Skill Levels and International Competitiveness, 2013, UKCES, Evidence Report 85, August 2014, p4 **63** *ibid*, p5 **64** The Value of Soft Skills to the UK Economy, A Report Prepared on Behalf of Mcdonald's UK, Development Economics, January 2015, p3 **65** The Value of Soft Skills to the UK Economy, A Report Prepared on Behalf of Mcdonald's UK, Development Economics, January 2015, p38

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1.1.4 Teacher quality and quantity

The education of the future workforce needs to be underpinned by a highly valued and highly skilled teaching profession. There are currently too few teachers with specialist subject knowledge at all stages of education. More than 20% of mathematics and chemistry teachers, a third of physics teachers and more than half of computing teachers in state-funded schools in England have no relevant post A level qualification in the subject they are teaching.[66]

This is not only important in the UK: there are around 1.3 billion children enrolled in primary and secondary schools worldwide.[67] Education is an enormous global operation where cultures and strategies are remarkably different.[68]

The relationship to high-quality teaching is reinforced and quantified by the work of the Sutton Trust, which showed that being taught over a two-year course by a high-quality teacher adds 0.565 of a GCSE point per subject. It also found that, "over a school year, these pupils can gain 1.5 years' worth of learning with very effective teachers, compared with 0.5 years with poorly performing teachers." In other words, for poor pupils the difference between a good teacher and a bad teacher is a whole year's worth of learning.[69]

By 2030, 7m jobs UK jobs will be in science-based industries, and children must be prepared for this. So it's pleasing to see that the government has instigated a series of measures to increase the number of maths and physics teachers by 2,500, as part of a £67m package.[70]

To help attract the best and brightest graduates with the potential to be exceptional teachers in the core Ebacc subjects, the government has increased tax-free bursaries and prestigious scholarships available for the academic year 2016 to 2017:[71]

- £30,000 tax free for graduates with a first class degree who are training to teach physics, an increase from £25,000 in 2015 to 2016 – trainees in physics with a 2:1 will continue to receive a £25,000 bursary, and trainees with a 2:2 will also now receive £25,000, up from £15,000 last year.
- Increased bursaries of up to £25,000 in other EBacc subjects including maths, biology, chemistry, computing, languages and geography.
- A further 700 prestigious tax-free scholarships worth up to £30,000 for physics and £25,000 for maths, chemistry and computing trainees, delivered in partnership with the professional bodies for these subjects.

1.1.5 Automation and its effect on skills

In Section 1.1.3.1, we described that the 'hollowing out' of the UK workforce could be seen in many other developed economies and that it was a trend that was here to stay. This same trend is also visible in the progression of automation, and its effects will be experienced globally well into the future.

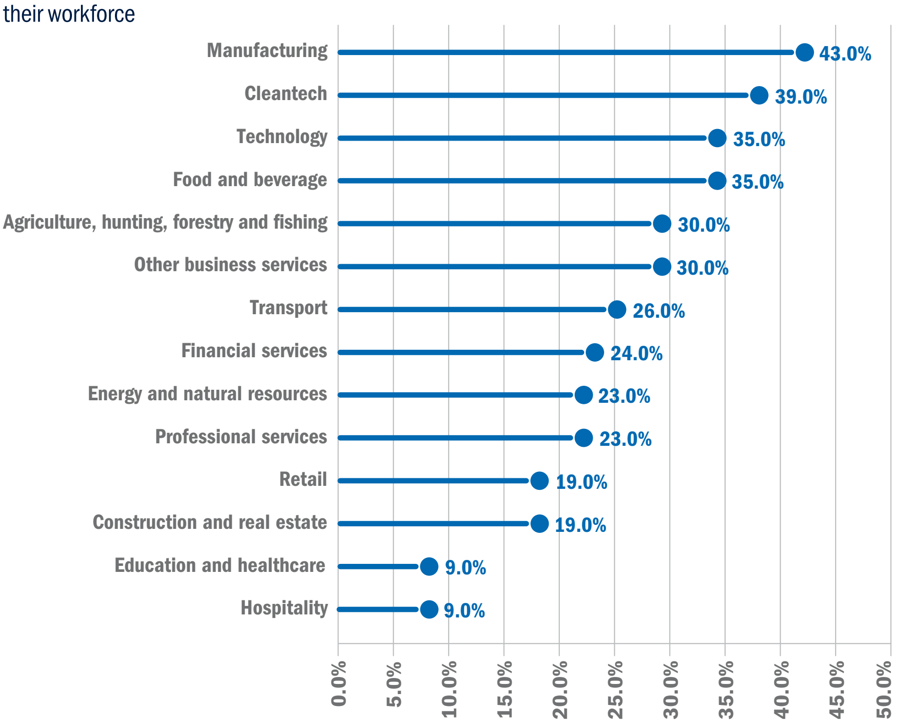
Fifty years on from the world's first personal computer going into mass production, the Grant Thornton *International Business Report*, a survey of 2,571 executives in 36 economies, reveals the scale of technology's influence on business. The report's findings suggest that the majority of firms now plan to automate operations and practices, and some jobs will go as a result, with the manufacturing, cleantech and food & beverage sectors in particular reporting upheaval. With capital costs low as labour costs rise, the findings pose fundamental questions about the extent to which machines will eventually replace humans.

Globally, over half (56%) of firms surveyed told Grant Thornton they are either already automating business practices or may do over the next 12 months. By industry, 43% of manufacturing firms said they expect this to eventually replace at least 5% of their workforce. Cleantech was in second place on 39%, followed by the technology and food & beverage sectors on 35%. At the other end of the spectrum, just 9% of hospitality, education and healthcare firms expect 5% or more of workers to be replaced (Figure 1.6).[72]

The report states that: "While some job losses will occur as technological advances increasingly transform both the private and the public sector, technology will complement and enhance human capabilities, increasing both the quality and quantity of our efforts."

Conversely, the findings also suggest that opportunities will arise for workers to assume new roles and responsibilities created by an increased use of technology. Globally, over half of automating firms (54%) expect to redeploy workers in other areas, with 28% saying that workers will be trained to operate new machinery. Even in manufacturing, 44% of firms plan to redeploy rather than remove staff.

Figure 1.6: Percentage of businesses that expect automation to replace at least 5% of their workforce



Source: Grant Thornton IBR 2015
Low sample size, (1) Oil & gas, mining, utilities, (2) includes social services

66 The Royal Society 2014 Vision for science and mathematics education. https://royalsociety.org/education/policy/vision **67** UNESCO Institute for Statistics, Authors' calculation. **68** The Efficiency Index, Which education systems deliver the best value for money? GEMS Education Solutions, September 2014, p13 **69** Improving the impact of teachers on pupil achievement in the UK – interim findings, The Sutton Trust, September 2011, http://www.suttontrust.com/public/documents/1teachersimpact-report-final.pdf **70** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/438352/itt-training-bursary-guide-2015-to-2016-2.pdf **71** https://www.gov.uk/government/news/top-graduates-to-get-up-to-30k-to-train-to-teach-core-subjects **72** http://www.grantthornton.ae/page/businesses-embrace-automation-to-innovate-and-promote-efficiency

1.1.6 International student immigration/ the Migration Advisory Committee

"The UK desperately needs engineers, for example, to help grow the economy. It is self-defeating to have a system in place which deters international STEM students from contributing to UK plc."[73]

International student immigration was an issue that we covered in some detail in last year's report.[74] One year on, it is still causing controversy and looks set to continue to do so. Rather than repeating the points made in last year's report, we will just restate the IPPR's viewpoint that, "the Government should abandon the net migration target as it is a bad measure for policy: it creates a perverse incentive for cutting international student numbers, and is incompatible with the growth of one of the UK's crucial export industries".[75]

Aside from the international student issue, the area of greatest concern to the Migration Advisory Committee (MAC) is clearly engineering jobs. The Committee points to an increase in the number of engineering job titles on its 2013 shortage list and the 2011 list. The newly added job titles relate to the aerospace, railway, electronics, mining, automotive manufacturing and design and the civil nuclear industries. It is MAC's view that this reflects increasing demand for specialist engineering skills continuing to outstrip potential supply, partly as a result of insufficient joined up activity on the part of employers and public bodies.[76]

Those interested can view the Shortage Occupation Lists in full in tables A1 and A2 (p14-26) of MAC's partial review call for evidence.[77] The prominent presence of various engineering roles is worth noting.

Finally, at the time of writing, the government is considering how to significantly reduce non-EEA economic migration,[78] and has asked MAC to advise it by the end of the year on:

- restricting work visas to genuine skills shortages and highly specialist experts
- putting a time limit on how long a sector can claim to have a skills shortage
- a new skills levy on Tier 2 visas to boost funding to UK apprenticeships
- raising salary thresholds to stop businesses using foreign workers to undercut wages

The bulk of the Committee's proposals will be delivered by the end of the year. However, it's worth noting that the Home Secretary has asked MAC to fast track proposals on raising the salary thresholds of Tier 2 visas in time for the Autumn Immigration Rule changes, to make sure that our immigration system is **focused on attracting the brightest and the best skilled workers.**

1.2 Government ambition and intent

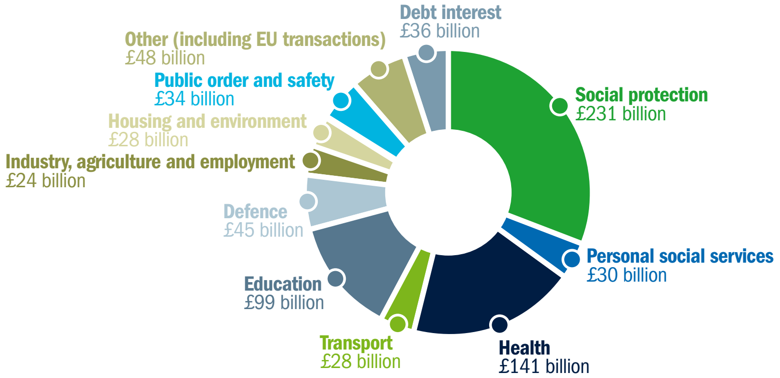
Figure 1.6 presents public sector spending by main function and shows that total managed expenditure is expected to be £742 billion in 2015/16, a £10 billion increase over the previous year.[79]

Trying to capture the previous government's major announcements on science, innovation, education and skills from the March 2015 budget,[80] the new government's equivalent announcements from the July 2015 budget,[81] and all the interstitial announcements, and not risk double counting, is an unproductive task.[82] Instead, we have provided a top level overview of the direction and key vehicles that government is utilising with respect to science, innovation, education and skills and its long-term economic plan to build a stronger, more competitive economy, a fairer society, and secure a better future for Britain.

In a nutshell, from a science, engineering and innovation perspective, the government is attempting to develop a more highly-skilled UK labour market and further invest in the UK's world-leading science and innovation base. The main instruments remain the same: **the industrial strategy,**[83] the **eight great technologies** and the **Regional Growth Fund.**[84] However, these have been underpinned by the **Productivity Plan,**[85 86] and complimented at a regional level by the **Growth Deals,**[87] the **City Deals,**[88] the bolstering of the **Local Enterprise Partnerships**[89] and the **employer ownership** of skills pilots (a competitive fund open to employers in England to invest in their current and future workforce).[90]

The industrial strategy builds on the government's Plan for Growth and the Growth Review, which looked at how it was addressing the barriers faced by industry.[91] On-going progress reports are available on-line.[92] The significant contribution of these Industrial Strategy sectors by GVA and employment[93] is shown in Table 1.8. These sectors embrace around 10.9 million people and approximately 39% of the workforce.

Figure 1.7: Public sector spending (2015/16)



Source: Office for Budget Responsibility 2015/16 estimates. Illustrative allocations to functions are based on HMT analysis including capital consumption figures from the Office for National Statistics. Figures may not sum due to rounding.

73 International Science, Technology, Engineering and Mathematics (STEM) students, House of Lords Science and Technology Select Committee, 11 April 2014, p6 **74** Engineering UK 2015 the state of engineering, EngineeringUK, December 2015, section 1.1.7 **75** Britain wants you, Why the UK should commit to increasing international student numbers, Institute of Public Policy Research, November 2013 **76** Reviewing the requirement for high level STEM skills, UKCES, Evidence Report 94, July 2015, p13 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444052/stem_review_evidence_report_final.pdf **77** Call for Evidence Migration Advisory Committee September 2014, Partial review of the Shortage Occupation Lists for the UK and for Scotland, Migration Advisory Committee, September 2014, p14 – 26 **78** https://www.gov.uk/government/news/pm-announces-migration-advisory-committee June 10 2015 **79** Summer Budget 2015, HM Treasury, July 2015 **80** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/416330/47881_Budget_2015_Web_Accessible.pdf **81** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/443232/50325_Summer_Budget_15_Web_Accessible.pdf **82** Nevertheless, section 3.2, Government intentions, does list some key science and innovation interventions. **83** https://www.gov.uk/government/policies/industrial-strategy **84** https://www.gov.uk/guidance/understanding-the-regional-growth-fund **85** Fixing the foundations: Creating a more prosperous nation, HM Treasury, July 2015 **86** See section 1.1.1.2 for details **87** https://www.gov.uk/government/news/growth-deals-firing-up-local-economies **88** https://www.gov.uk/government/collections/city-deals **89** http://www.lepnetwork.net/ **90** https://www.gov.uk/government/publications/employer-ownership-of-skills-pilot **91** https://www.gov.uk/government/collections/industrial-strategy-government-and-industry-in-partnership **92** https://www.gov.uk/government/policies/industrial-strategy **93** Industrial Strategy Conference 2013: Securing Jobs and a Stronger Economy, Department for Business, Innovation and Skills, September 2013, p58

Table 1.8: Economic contribution of industrial strategy sectors

	Output (GVA billion)	% of UK Total	Employment	% of UK Total
Aerospace	£7.3	0.50%	118,000[94]	0.40%
Automotive[95]	£11.2	80.00%	129,000	0.40%
Construction[96]	£90.0	6.70%	2.98 million	10.00%
Education[97]	£88.2	6.40%	2.77 million	8.70%
Information economy[98]	£58.0	4.20%	885,000	4.80%
Life sciences[99]	£11.8	0.90%	160,000	0.50%
Nuclear[100]	N/A	N/A	ca. 40,000	10.00%
Offshore wind[101]	N/A	N/A	ca. 4,000	1.00%
Oil and gas	£24.8	1.80%	35,000[102]	0.10%
Professional business services[103]	£153.0	11.20%	3.8 million	12.00%

Source: Industrial strategies and ONS data – Annual Business Survey 2011 or National Accounts and Workforce Jobs, 2012; unless stated otherwise.
Notes: Direct sector comparisons should be made with some caution as they may be based on different data sources and time frames.

The **eight great technologies** funds are allocated on an on-going basis against each of the 'eight'[104] technologies: Big Data, satellites, robots, modern genetics, regenerative medicine, agricultural technologies, advanced materials and energy storage. Current reports investigating the eight great technologies can be found on-line.[105]

In total, £2.85 billion has now been invested in regional companies through the **Regional Growth Fund,** helping them to expand and take on more staff.[106] Businesses across all industrial sectors will benefit from the funding, with over £1.1 billion being invested in manufacturing, including £364 million in automotive, £100 million in aerospace and £104 million for low carbon enterprises. For every £1 the government has invested through the Regional Growth Fund, the private sector has put in £5.50, meaning the total investment is now expected to attract £16 billion of private sector support. Over 100,000 jobs have already been created with a further 480,000 expected by the mid-2020s.

The **Growth Deals** provide funds to LEPs (partnerships between local authorities and businesses) for projects that benefit the local area and economy. The first wave of Growth Deals was announced on 7 July 2014.[107] The money will go towards providing support for local businesses to train young people, create thousands of new jobs, build thousands of new homes and start hundreds of infrastructure projects, including transport improvements and superfast broadband networks.

In 2014, the government announced plans to invest at least £12 billion (2015/16 to 2020/21) in local economies in a series of Growth Deals with LEPs. This included skills capital allocations worth £665 million across 2015/16 and 2016/17. LEPs have also developed European Structural and Investment Fund (ESIF) strategies (2014-20).

City Deals give local areas specific powers and freedoms to help the region support economic growth, create jobs or invest in local projects.[108] A City Deal is an agreement between government and a city, giving the city and its surrounding area certain powers and freedom to:

- take charge and responsibility of decisions that affect their area
- do what they think is best to help businesses grow
- create economic growth
- decide how public money should be spent

City Deals have been developed with many UK cities. The first wave was concluded with the eight 'core' cities in 2012, with a further 20 city regions obtaining City Deals during 2013/14.

The City Deals trialled new approaches to the skills and employment system, for example, devolved funding models and coordinating employer-led apprenticeships and training activity.

Following the abolition of Regional Development Agencies,[109] 39 **Local Enterprise Partnerships,**[110] led by business but with local authority representation, have been created since 2011.

They are now key players in steering support for innovation at the local level – as well as focusing on education and skills for those Not in Education, Employment or Training (NEETs)[111] – and their role is growing.[112]

Many LEPs are already delivering innovation initiatives through Regional Growth Fund, Growing Places Fund and City-Deals, working with universities, businesses and other partners, to put in place local solutions to help businesses grow.[113 114]

Through these initiatives it can be seen that a number of measures have been taken by central government during the course of the last Parliament passing to the responsibility of the new government that are relevant to the localisation of employment and skills policy.[115]

1.3 UK industries' strengths and opportunities

Our annual Engineers and Engineering Brand Monitor (Section 5) clearly shows, in the eyes of the general public and young people in particular, we have broken away from the Victorian image of engineering. Nevertheless, it still needs to be reinforced that modern engineering encompasses a broad range of technologies and industries, as the following list illustrates. It depicts new or existing engineering sub-sectors where the UK has proven strengths and is showing the capability to boost productivity.

Automotive

Since the economic crisis, UK car production has bucked the EU-wide trend. In 2013, production rose to 1.6 million vehicles, generating turnover of £59.3 billion and exports of £30.7 billion.[116] From 2000-13, the automotive sector accounted for an average of

94 Includes direct jobs only. The Aerospace Strategy identified about 230,000 direct and indirect jobs in the aerospace sector. **95** Source: ONS Annual Business Survey 2011 provisional results. **96** Construction includes construction contracting industry, provision of construction related professional services, and construction related products and materials. GVA figures from the ONS Annual Business Survey (2011 provisional results), employment figures from the ONS Labour Force Survey (Q1 2013 non-seasonally adjusted). **97** Education statistics include economic contribution of domestic and foreign students but exclude educational products and services. **98** For the purpose of the Strategy, Information Economy is defines as: Software, IT services and Telecoms services. In addition to the 885,000 jobs directly provided by information economy businesses, there are estimated to be a further 600,000 IT jobs in other sectors of the economy. Note that the wider ICT sector contributed around 8% (£105 billion) to GVA (at current prices) and there were around 1.3 million jobs in the ICT sector in 2011. **99** Source: ONS Annual Business Survey (2011) and BIS Bioscience and Health Technology database. **100** Source: Industrial Strategy: UK's Nuclear Future (2013). There are no GVA stats available. Commercial turnover estimated at £4 billion. **101** Source: Industrial Strategy and RenewableUK; 2012 data. **102** The Oil and Gas Industrial Strategy identified that some 400,000 jobs are supported directly and indirectly by the upstream oil and gas industry. **103** Source: Industrial Strategy for Professional and Business Services based on ONS statistics. GVA data for 2011 and employment data for 2012. **104** https://www.gov.uk/government/publications/eight-great-technologies-infographics **105** https://www.gov.uk/government/publications/eight-great-technologies-satellites **106** https://www.gov.uk/understanding-the-regional-growth-fund **107** https://www.gov.uk/government/news/growth-deals-firing-up-local-economies **108** https://www.gov.uk/government/collections/city-deals **109** https://www.gov.uk/government/publications/2010-to-2015-government-policy-local-enterprise-partnerships-leps-and-enterprise-zones/2010-to-2015-government-policy-local-enterprise-partnerships-leps-and-enterprise-zones **110** http://www.lepnetwork.net/ **111** Government evidence on EU action to tackle youth unemployment, Report to the EU sub-committee on the Internal Market, Infrastructure and Employment, Department for Business, Innovation and Skills, October 2013, p21 **112** Innovation Report 2014, Innovation, Research and Growth, Department for Business Innovation and Skills, March 2014, p14 **113** The role of LEPs in driving innovation is covered in section 3.3 **114** See section 4 for detailed LEP data **115** Local Action, National Success: How Outcome Agreements Can Improve Skills Delivery, UKCES, 29 June 2015 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/438493/150624_OA_cover_design_V3.1.pdf **116** http://www.smmt.co.uk/wp-content/uploads/sites/2/SMMT_Facts-Guide_May.pdf

0.7% of UK GVA and 5.9% of UK manufacturing jobs. The sector employs 731,000 people and invested £1.7 billion in R&D in 2013.

Aerospace

The UK is Europe's number one aerospace manufacturer, and globally second only to the United States. UK firms produce the most advanced and valuable elements of today's airliners, including the wings, engines, aerostructures and advanced aircraft systems. The sector supports more than 3,000 companies distributed across the UK, employing around 230,000 people within the supply chain. It creates annual revenues of over £24 billion and exports around 75% of what it produces, making a positive contribution to the UK's trade balance.[117] Globally, the demand for new aircraft is at record levels – around 45,000 new aircraft and 40,000 helicopters are needed between now and 2032, worth over US $5 trillion.[118] Aerospace is a highly R&D intensive industry with annual R&D spend of some £1.4 billion: this represents around 12% of total R&D spending in UK manufacturing.

The sector has received a £100 million boost that will take it to new heights. This includes £20 million investment in skills – including high-tech masters courses and apprenticeships. Six projects will share £80 million for aerospace research to help deliver growth and innovation in key areas of technology.[119]

Agri-tech

Agricultural science and technology represents one of the world's fastest growing markets, driven by fundamental global changes including population growth, the development of emerging economies with western lifestyle aspirations, as well as geopolitical instability around shortages of land, water and energy. At the same time agricultural is being transformed by a technological revolution based on breakthroughs in nutrition, genetics, informatics, satellite imaging, remote sensing, meteorology, precision farming and low impact agriculture. A strong scientific capability is needed to support the agri-food supply chain, which plays a crucial part in the UK economy, making an estimated contribution of £96 billion or 7% of gross value added and employing 3.8 million people.[120]

Big Data

Big Data refers to ways of handling data sets so large, dynamic and complex that traditional techniques are insufficient. It is one of the government's eight great technologies[121] to support UK science's strengths and business capabilities. The global market for business data analysis products grew by 14% in 2011 and is expected to continue to £31 billion by 2016.[122]

The Centre for Economics and Business Research estimates that the Big Data marketplace could create 58,000 new jobs in the UK between 2012 and 2017.[123] Similarly, a recent report from Deloitte estimates that the direct value of public sector information alone to the UK economy is around £1.8 billion per annum, with wider social and economic benefits bringing this up to around £6.8 billion.[124]

In support of this potential opportunity, the government recently unveiled a £313 million partnership with information technology leader IBM to boost big data research in the UK.[125]

Cities

A new global picture of growth is taking shape. This is not about a transfer of economic power from North to South, or West to East. It is about the rise of cities, the concentration of productivity, innovation and creativity that will drive our economic future.[126] Cities already account for up to 80% of global growth.[127]

Cities offer opportunities for the UK. The performance of cities is crucial to the performance of the UK economy. They account for 9% of land use, but 54% of population, 59% of jobs and 61% of output.[128] In the UK, 61% of growth is generated by city regions.[129] If the UK's top 15 metros were to realise their potential, they would generate an estimated additional £79 billion growth.[130]

Economic growth is not the only area where cities can make an impact. The New Climate Economy study by the Global Commission on the Economy and Climate, found that if cities commit to low-carbon urban development, the world's largest 500 cities could generate US $16.6 trillion of net savings by 2050.[131] These low-carbon investments could also reduce carbon dioxide emissions by 3.7 gigatons per year by 2030 – more than the current annual emissions of India.

Construction

Construction contributed £83.0 billion in economic output – 6% of the total – and employed 2.15 million people or 6.5% of the UK total in 2013. If you include construction related services and products and materials, the industry contributes nearly 7% of GVA and over 9% of employment. The sector's large supply chain accounted for £119 billion of intermediate consumption in 2012.

In July 2013, the government published Construction 2025, which summarises the industrial strategy for the construction sector in the coming decade.[132]

Digital and creative

The digital and creative sector has grown rapidly in recent years and contributed £134 billion in GVA, almost 9% of total UK GVA, in 2014. The sector employed 2.1 million people in 2012. Of this total, one million were employed in digital activities, and 1.1 million in creative activities. Furthermore, the sector is expected to need 1.2 million new workers between 2012 and 2022, to both support growth and replace those leaving. This is equivalent to half the current workforce.[133]

The digital sub-sector includes those working in computer programming and consultancy; telecommunications; the repair of computers and other goods; and in information service activities such as data processing, web portals, and news agencies.

The creative sub-sector encompasses a wide range of activities including design and photographic services; advertising and market research; creative arts and entertainment; publishing; film and music; libraries, archives and museums; and television and radio programming and broadcasting.

Life sciences

Life sciences employ 176,000 people with an estimated £51 billion UK turnover.[134] Growth forecasts for this sector stand at 36.4% across its combined global pharma/biotech/ life science/ healthcare equipment and supplies markets between 2011 and 2016.[135]

Within life sciences, there are around 380 pharmaceutical companies based in the UK, employing nearly 70,000 people, with an annual turnover of £30 billion. In addition, the medical

117 Reviewing the requirement for high level STEM skills, UKCES, Evidence Report 94, July 2015, p14 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444052/stem_review_evidence_report_final.pdf **118** https://www.gov.uk/government/news/boost-for-aerospace-industry 22 June 2015 **119** https://www.gov.uk/government/news/100-million-to-propel-future-of-aerospace-industry **120** Reviewing the requirement for high level STEM skills, UKCES, Evidence Report 94, July 2015, p32 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444052/stem_review_evidence_report_final.pdf **121** https://www.gov.uk/government/speeches/eight-great-technologies **122** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249260/big_data_infographic.pdf **123** CEBR, Data equity: Unlocking the value of Big Data, 2012 http://www.sas.com/offices/europe/uk/downloads/data-equity-cebr.pdf **124** Based on 2011 prices. Deloitte, Market assessment of public sector information, commissioned by BIS, 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/198905/bis-13-743-market-assessment-of-public-sector-information.pdf **125** http://www.stfc.ac.uk/news/313-million-boost-for-uk-big-data-research/ June 2015 **126** Unleashing Metro Growth – Final Recommendations of The City Growth Commission, RSA, October 2014, p2 **127** The Economist Intelligence Unit, 2013 **128** Cities Outlook 2014, Centre for Cities, January 2014, p6 **129** Calculated by Centre for Cities, 2014; refers to the 56 largest Primary Urban Areas in the UK **130** This estimate is calculated by estimating the potential additional growth that metros could achieve if the 14 non-London metros were to grow at the UK average (forecast by the Office for Budget Responsibility) between 2013 and 2030 compared to their past growth rate between 1997 and 2012 and if London were to maintain its growth rate between 1997 and 2012 **131** Accelerating Low-Carbon Development in the World's Cities, The Global Commission on the Economy and Climate, September 2015 **132** https://www.gov.uk/government/publications/construction-2025-strategy **133** Sector insights: skills and performance challenges in the digital and creative sector, Evidence Report 92, UKCES, June 2015 **134** https://www.gov.uk/government/collections/industrial-strategy-government-and-industry-in-partnership#life-sciences **135** https://www.gov.uk/government/collections/industrial-strategy-government-and-industry-in-partnership technology and medical biotechnology sectors together employ over 96,000 people with a combined annual turnover of around £20 billion.[136]

Advances in the UK-led life science research has helped to reduce the time taken to sequence the human genome from 10 years to one day!

Low carbon – renewables

The turnover of the UK's low carbon economy was assessed at £122 billion in 2013, supported by over 460,000 jobs. This sector continues to grow strongly[137] and currently accounts for 1.5% of all UK jobs.[138] To give an indication of scale, the low carbon economy is worth more than double the UK's automotive manufacturing industry, it is five times larger than the aerospace industry and on a par with the food and drinks industry.

Renewable generation now provides almost a fifth of our electricity needs, powering the equivalent of 14.5 million homes annually. The UK is one of the most attractive countries in the world for green growth, with almost £37 billion invested in renewable energy since 2010. We lead the world in offshore wind and remain one of the world leaders in marine energy. This brings great opportunities for UK businesses, for jobs, and for boosting local economies.[139]

It should be recognised that renewables is a collective term for many specific low carbon technologies. A recent report by the Department of Energy & Climate Change (DECC) on the progress made in low carbon energy investment, usefully collates these various sub-sectors:[140]

Offshore wind

In 2013, the sector supported 13,700 jobs – an average annual increase of 8% since 2010.[141] In the year to Q3 2014, offshore wind provided around 3.7% of the UK's total electricity generation. By 2020, it could account for around 7-12% of our electricity generation, powering the equivalent of around 5.2 million to 9.5 million homes.[142]

Onshore wind

In 2013, the sector supported 19,000 jobs – an average annual increase of 10% since 2010.[143] In the year to 2014, onshore wind provided around 5.5% of the UK's total electricity generation. By 2020, it could account for 9-10% of our electricity generation, powering the equivalent of around 7 million homes.[144]

Solar PV

In 2013, the solar PV sector and its supply chain supported 34,400 jobs – an average annual increase of over 20% since 2010.[145] In the year to Q3 2014, solar PV provided around 1.7% of the UK's total electricity generation. By 2020, it could account for around 3-5% of our electricity generation, powering the equivalent of around 2.5 million to 3.3 million homes.[146]

Marine technologies

In 2013, the marine technologies sector supported 3,100 jobs – an average 1.5% increase since 2010.[147] The UK is ranked as the world's second most attractive place to invest in marine energy,[148] with theoretical potential for up to 27 GW of wave, 32 GW of tidal stream, 45 GW of tidal barrages, and 14 GW of tidal lagoons in the UK.[149]

Biomass and bioenergy

In 2013, biomass and bioenergy supported 31,700 jobs.[150] In the year to Q3 2014, biomass electricity provided around 6.1% of the UK's total electricity generation. By 2020, it could account for around 10-11% of our electricity generation, powering the equivalent of around 7.6 million to 8.1 million homes.[151]

Hydropower

In 2013, the sector and its supply chain supported 7,400 jobs – an average increase of nearly 3% per annum since 2010.[152] In the year to Q3 2014, hydroelectricity provided around 1.7% of the UK's total electricity generation. By 2020, it could account for around 2% of our electricity generation, powering the equivalent of around 1.3 million homes.[153]

Nuclear

In 2013, 59,000 people worked in the civil nuclear industry and its supply chain.[154] In October 2014, the European Commission approved the state aid package for Hinkley Point C, bringing the first new nuclear power station in a generation an important step closer.[155] Estimated investment in nuclear power between 2010 and 2014 was £2.5 billion, and there are development plans for at least 12 nuclear reactors on five different sites by 2030.[156]

Globally, £930 billion of investment is planned to build new reactors, plus £250 billion to decommission those that are coming off-line.

Carbon capture and storage

In 2013, the CCS sector and its supply chain supported 4,100 jobs across the UK.[157] A £1 billion initiative, the CCS Commercialisation Programme aims to launch the first commercial-scale plants in the UK – White Rose and Peterhead CCS projects – which could support more than 2,000 jobs and provide enough clean electricity to power the equivalent of 1 million homes.

136 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/36684/12-1346-strategy-for-uk-life-sciences-one-year-on.pdf **137** Delivering UK Energy Investment: Low Carbon Energy, Department of Energy & Climate Change, March 2015, p3 **138** Size and Performance of the UK Low Carbon Economy, BIS, 24 March 2015 **139** Delivering UK Energy Investment: Low Carbon Energy, Department of Energy & Climate Change, March 2015, p3 **140** Delivering UK Energy Investment: Low Carbon Energy, Department of Energy & Climate Change, March 2015 **141** Size and Performance of the UK Low Carbon Economy, BIS, 2015 **142** The Size and Performance of the UK Low Carbon Economy. This figure includes supply chain jobs, BIS, 2015. List extracted from various sections within report. **143** Size and Performance of the UK Low Carbon Economy, BIS, 2015 **144** As set out in the EMR Delivery Plan, Annex D: Report from the System Operator, Table 6.1.4 GB Generation in 2020, in certain scenarios onshore wind could generate 10% of our electricity by 2020. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/267614/Annex_D_-_National_Grid_EMR_Report.pdf **145** Size and Performance of the UK Low Carbon Economy, BIS, 2015 **146** Energy Trends December 2014, https://www.gov.uk/government/statistics/energy-trends-december-2014 **147** Size and Performance of the UK Low Carbon Economy, BIS, 2015 **148** Renewable Energy Country Attractiveness Index, EY, March 2015: http://www.ey.com/Publication/vwLUAssets/Renewable_Energy_Country_Attractiveness_Index_43/$FILE/RECAI%2043_March%20 2015.pdf **149** UK Wave and Tidal Key Resource Areas Project, The Crown Estate (2012): http://www.thecrownestate.co.uk/media/5476/uk-wave-and-tidal-key-resource-areas-project.pdf **150** DECC analysis based on BIS (March 2015): The Size and Performance of the Low Carbon Economy and REA: Review (April 2014): http://www.r-e-a.net/resources/rea-publications. Includes power from biomass, waste and anaerobic digestion, and includes supply chain. **151** Energy Trends December 2014, https://www.gov.uk/government/statistics/energy-trends-december-2014 **152** UK Wave and Tidal Key Resource Areas Project, The Crown Estate (2012): http://www.thecrownestate.co.uk/media/5476/uk-wave-and-tidal-key-resource-areas-project.pdf **153** Energy Trends December 2014, https://www.gov.uk/government/statistics/energy-trends-december-2014 **154** Size and Performance of the UK Low Carbon Economy, BIS, 2015 **155** Includes investment by NNB, NuGen and Horizon. **156** The Size and Performance of the UK Low Carbon Economy, BIS, 2015. This figure includes supply chain jobs. **157** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/371387/43586_Cm_8945_accessible.pdf

Renewable and low carbon heat

In 2013, the wider renewable heat sector supported over 58,000 jobs.[158]

It has been estimated that the introduction of the domestic Renewable Heat Incentive (RHI) would drive around £3 billion of investment in new, renewable heating systems between now and 2020,[159] supporting up to 5,000 jobs by 2020.

The introduction of the non-domestic Renewable Heat Incentive (RHI) is estimated to drive around £9 billion of investment in new, renewable heating systems between now and 2020,[160] supporting up to 20,000 jobs by 2020.

Whilst the above figures make for positive reading, we should note new research which suggests that a skills deficit of 50,000 STEM graduates per year in science, technology, engineering and maths could lead to the UK's low-carbon economy missing out on £6.7 billion of annual growth by 2023.[161]

Oil and gas

The UK oil and gas supply chain is well positioned across the value chain, with 1,585 companies achieving combined revenues of £35 billion in 2012.[162] The UK upstream oil and gas supply chain generated more than £35 billion of turnover in 2012: 42% of this was as export turnover.

Oil & Gas UK estimates the total number of employees involved in the UK upstream oil and gas supply chain to be 450,000. This includes 200,000 employees directly involved in the UK upstream oil and gas supply chain. In 2013, its capital investment of £14.4 billion in the UK's oil and gas reserves is the highest it has been for 30 years.[163]

Rail

In 2013/14, UK rail passengers made 1.6 billion journeys with franchised operators, travelling over 37 billion miles.[164]

The rail sector contributes £7 billion a year to the UK economy, employs over 85,000 people and is enjoying an investment boom on the back of a decade-long 50% growth in passenger journeys. Significant future growth in freight and passenger traffic is also expected, potentially doubling by 2030, enhanced by strategic investments such as HS2, Crossrail, Thameslink, London Underground upgrades and the nationwide electrification programme.[165]

Retail

The UK retail sector employs 2.8 million people, about 10% of all UK employment, across almost 300,000 establishments. More than 30% of workers in the sector are aged between 16 and 24 years old, compared with around 13% across all sectors. It contributes 10% to overall UK GVA and has a turnover of £1,211 billion and approximately 5% of GDP.[166]

The UK retail sector is the 3rd largest in the world by sales (behind the USA and Japan). The value of overseas shoppers in London alone is around £2 billion per annum, with many retailers in other locations benefiting from tourism. Notably, it also underpins local economies, and is a key partner in delivering government policy in a number of areas.[167]

Shale gas

The concept of shale gas is becoming very real, alongside the vilified term 'fracking'. The Institute of Directors (IoD) claims that shale gas production could satisfy one third of the UK's annual gas demand at peak output by 2030 and could create 74,000 jobs.[168] The business group said the industry, which involves the process of fracking, could also help to support manufacturers and reduce gas imports.

According to a report by PwC, shale oil production could boost the world economy by up to US $2.7 trillion (£1.7 trillion) by 2035. The extra supply could reach up to 12% of global oil production, or 14 million barrels a day, and push global oil prices down by as much as 40%.[169]

Universities

Universities play an intrinsic role in the UK economy. They increase skills, support innovation, attract investment and talent, and directly help support UK productivity.

Research shows that, across public and private sectors, the knowledge and higher level skills possessed by workers influence productivity, both directly and indirectly.[170]

Analysis by the Department for Business, Innovation and Skills estimates that a 1% increase in the share of the workforce with a university degree raises the level of long-run productivity by 0.2-0.5%.[171]

Higher education is a high-growth UK export industry in its own right. In 2011–12:[172]

- Universities generated over £73 billion of output
- Universities directly employed 378,250 people, and a further 373,794 full-time equivalent (FTE) jobs in other sectors of the economy were dependent on expenditure of universities. This accounts for 757,268 FTE jobs throughout the economy and is equivalent to 2.7% of all UK employment in 2011[173]
- The higher education sector as a whole (including universities and off-campus spending of non-UK students and visitors) generated an estimated £10.71 billion of export earnings for the UK[174]
- Universities contributed over £36.4 billion to UK GDP. Off-campus expenditure of international students and visitors contributed a further £3.5 billion. In total, this contribution comes to over £39.9 billion, equivalent to 2.8% of GDP in 2011[175]
- For every £1 million of university output, a further £1.35 million of output was generated elsewhere in the economy: in GVA terms, every £1 million of university GVA was associated with the generation of a further £1.03 million in other UK industries.[176]

1.3.1 Manufacturing

Manufacturing continues to be an essential part of the UK economy. Indeed, since the recession it has been viewed as the Holy Grail of productivity growth: it contributes £8.9 trillion to the global economy, putting the UK 10th in world manufacturing rankings.[177]

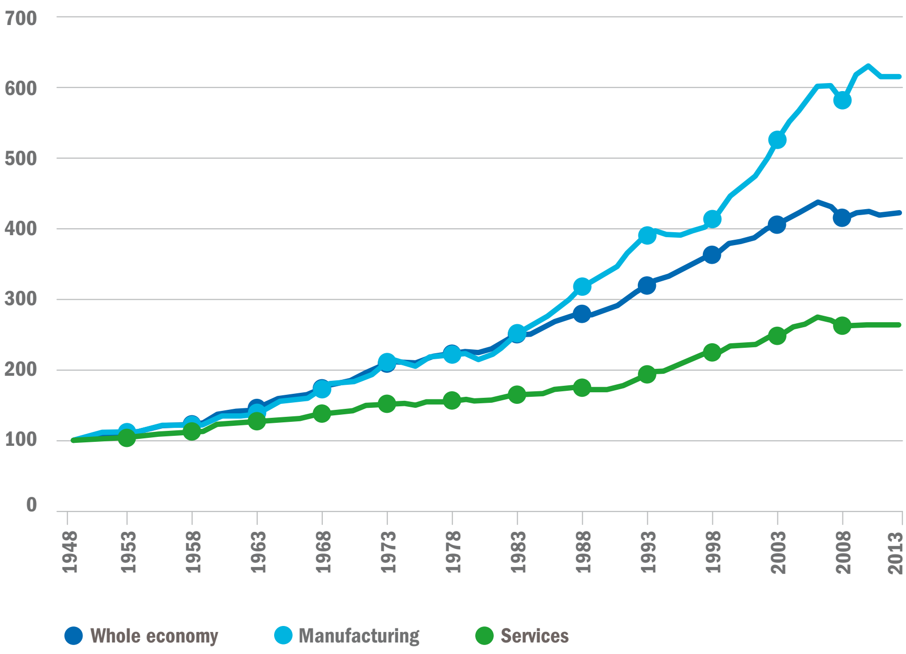
Manufacturing makes up 10% of UK GVA and 54% of UK exports, and directly employs more than 2.5 million people.[178]

Since 1948, manufacturing productivity has actually grown by 2.8% on average per annum – compared with 1.5% in the services industry. The 2008/09 economic downturn resulted in heavy declines in productivity in both manufacturing and services, neither of which have recovered to pre-crisis growth rates (Figure 1.8). However, over the long term, manufacturing productivity continues to compare favourably to that of the services industry and the economy as a whole.[179]

With respect to employment trends, the number of UK manufacturing jobs has tumbled from 7 million in 1970 to 2.6 million in 2012, even though UK manufacturing output has risen. Similar trends are evident for other developed nations. This underlines how important

158 Estimated Investment 2013/14-2020/21 and "Jobs Supported" figures are based upon RHI central renewable heat deployment projection. See Annex 10 in: https://www.gov.uk/government/consultations/renewable-heat-incentive-expanding-thenon-domestic-scheme **159** *ibid* **160** https://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi **161** http://renews.biz/86107/uk-faces-6-7bn-skills-gap-loss/ **162** UK upstream oil and gas supply chain Economic contribution, EY, April 2014 file:///C:/Users/akumar/Downloads/EY%20UK%20Upstream%20oil%20and%20gas%20supply%20chain%20-%20Economic%20contribution.pdf **163** http://www.oilandgasuk.co.uk/economics.cfm **164** Rail Trends, Great Britain 2013/14, Rail Statistics Factsheet, published 15 October 2014 **165** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf **166** Sector Skills Insights: Retail, Evidence Report 53, UKCES, July 2012 https://www.gov.uk/government/publications/retail-sector-skills-insights **167** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf **168** http://www.telegraph.co.uk/finance/newsbysector/energy/10072029/Shale-gas-could-be-a-new-North-Sea-for-Britain.html **169** http://www.bbc.co.uk/news/business-21453393 **170** The Economic Role of UK Universities, UniversitiesUK, June 2015, p2 **171** The relationship between graduates and economic growth across countries, a report by NIESR, BIS, 2013 **172** The Economic Role of UK Universities, UniversitiesUK, June 2013, p2 **173** Universities UK (2014) "The impact of universities on the UK economy", report by Viewforth Consulting, Universities UK, 2014. http://www.universitiesuk.ac.uk/highereducation/Pages/ImpactOfUniversities.aspx **174** *ibid* **175** *ibid* **176** *ibid* **177** Website accessed on the 17th August 2015, http://unstats.un.org/unsd/snaama/dnllist.asp (spreadsheet: GDP and its breakdown at current prices in US Dollars, All countries for all years – sorted alphabetically). **178** Technology Strategy Board- Driving Innovation, Delivery Plan Financial Year 2014/15 **179** The Changing Shape of UK Manufacturing, ONS, 22 October 2014, p2

Figure 1.8: UK labour productivity (1948-2013)



Source: Labour productivity (ONS) (1948=100)

productivity gains have been in manufacturing: the number of employees can fall even as output rises because companies have invested in capital equipment that can greatly increase output per employee.[180]

Projecting the future, the UKCES Working Futures 2012-22 forecasts show that employment in manufacturing is expected to decline from 2.6 million in 2012 to 2.4 million in 2022: a fall of 9%.[181] Manufacturing's share of total UK employment is expected to drop from 8.2% to 7.1% over the same period. However, there will be 650,000 vacancies in the sector linked to replacement demand (the need to replace people who leave the sector workforce, for example through retirement or moving to another sector). Despite this decline in overall employment, GVA over the same period is expected to increase from £138 billion in 2012 to £160 billion in 2022, with the manufacturing share of the UK GVA remaining relatively constant.[182]

1.3.1.1 Advanced manufacturing

Often seen as the favoured face of manufacturing, advanced manufacturing is broadly described as manufacturing that is, *"intensive in its use of capital and knowledge and requires a high level of technology utilisation and Research and Development (R&D)"*.[183] This can apply to all manufacturing industries, but is most commonly associated with medium and high-tech industries. The Annual Business Survey estimates that there were approximately 29,000 advanced manufacturing enterprises operating in the UK in 2013, comprising around 23% of the total number of manufacturing enterprises (128,000).

There are approximately 1.3 million people employed in the advanced manufacturing industries in the UK. This compares to just over three million employees for the manufacturing sector as a whole – approximately 4% of total UK employment.[184]

Advanced manufacturing is often reported as an area of significant potential growth for the UK economy. A range of key drivers are helping to shape and drive the performance of the sector, most of which have a skills dimension.[185] They include:

- translating innovation into growth
- increasing investment in Research and Development (R&D)
- meeting low carbon policies and legislation
- maximising export opportunities
- taking advantage of potentially transformative enabling technologies

The skills component becomes more obvious when you note that a high proportion (44%) of the advanced manufacturing workforce holds high-level qualifications (qualifications at level 4 and above). This is a much higher proportion than for manufacturing as a whole (31%) and slightly higher than for the economy as a whole (41%).

The sector is also heavily-influenced by evolving developments relating to advanced manufacturing technologies. The UKCES have identified a host of enabling technologies that could have profound implications for future advanced manufacturing. These are summarised in the box below:[186]

Current enabling technologies that could have profound future implications for advanced manufacturing – summary

Additive manufacturing

The development of products using digitally-controlled machine tools. Products are built through layering rather than traditional methods of moulding, casting or welding.

Composite manufacturing

The joining of two materials together to produce one material with superior mechanical properties. Composites are increasingly being used to replace metal due to their high-tensile strength and low weight.

Nanotechnology

The manipulation of materials at a sub-atomic level to create new materials. It is used for both organic and non-organic materials.

Plastic electronics

Electronics built using semi-conducting plastic polymers. Diodes and transistors are 'printed' on plastic substrates using inks of semi-conducting plastic materials.

Silicon electronics

The development of electronic circuits built on a single layer of single-crystal silicon. It is considered advantageous because it consumes very little power.

Industrial biotechnology

The industrial manufacture of chemical products using biological rather than oil-based materials.

Robotics and artificial intelligence

The use of machinery to automate parts of the production process. A potential recent development in this area is artificial intelligence, which is software that make decisions on optimising the production process.

Source: SSC Advanced Manufacturing Cluster (2009); European Commission (2011); UKCES, (2013); Foresight (2013)

180 http://www.madeherenow.com/background **181** *Working Futures 2012-2022*, UK Commission for Employment and Skills, March 2014, **182** Sector insights: skills and performance challenges in the advanced manufacturing sector, Executive Summary 93, UKCES, 29 June 2015, p39 https://www.gov.uk/government/publications/sector-insights-skills-and-performance-challenges-in-the-advanced-manufacturing-sector **183** *Ibid*, p2 **184** *ibid*, p6 **185** *ibid*, p3 **186** *ibid*, p11

1.3.1.2 Reshoring manufacturing

Last year's report made much of the idea that *reshoring is an idea whose time has come*. This remains the case, with the trend growing steadily.[187] Over the past two years, reshoring has added £600 million to the UK economy and created approximately 10,000 new jobs.

Since last year's report, new research from EY in a report entitled *Reshoring – time to seize the opportunity*,[188] has calculated the potential GDP and employment impacts of reshoring on UK regions over a ten-year period to 2025, showing that:

- Reshoring presents a once-in-a-lifetime opportunity for the UK to add £15.3 billion of GDP to the economy, and more than 315,000 jobs.
- The regions of the UK that are likely to benefit the most from this trend are the North West (£2.4 billion GDP, 46,200 jobs), the South East, outside London (£2 billion GDP, 35,500 jobs), and the West Midlands (£1.8 billion GDP, 35,000 jobs).
- The aerospace, defence and automotive industries would see the biggest benefit.

The report also points out that, while increasing wages in developing countries are eroding their labour cost advantage, there are many more factors driving business to choose British shores. The desire to guarantee quality and the imperative to reduce time to market are increasingly important drivers of location decisions.

Furthermore, they state that those businesses that do relocate to the UK will predominantly be capital-intensive sectors such as aerospace, defence, automotive, petroleum products and clothing, serving the European market. They will be businesses where quality and brand are important and consequently the supply of a highly skilled workforce is imperative. When firms do choose to reshore to the UK, they will tend to cluster in regions that best serve their business, close to key suppliers, infrastructure and an able workforce.

Likewise, the Manufacturing Advisory Service (MAS) has ranked, in order, four key factors that have prompted companies to move production home:[189]

- To improve quality
- To shorten lead times
- To improve delivery performance and strengthen the supply chain
- To reduce labour costs

1.3.2 Emerging technologies

Finally, it is important to recognise the often invisible underpinning contribution that research and development makes to economic and social wellbeing. (A full description is provided in Section 3 *UK engineering research and innovation*.)

Innovate UK has identified several high-potential emerging technologies for support. These are listed below for information:[190]

Energy-efficient computing

This is the design of hardware and software to reduce the energy needed to execute computing processes. The applications lie anywhere that computing is done – from mobile devices to high-performance computing, from the 'internet of things' to data centres, and many others.

Energy harvesting

This is the scavenging of low levels of energy (milliwatts to watts) from, for example, environmental temperature gradients, vibration or pressure. It can be used to enable miniature electronic devices to power themselves independently, reducing or eliminating battery use, in markets such as wireless sensor networks, automotive power management, building controls and consumer devices.

Non-animal technologies

This is the development and use of in-vitro or in-silico technologies that give better answers to new substance-related questions such as "does it work?" and "is it safe?" It has applications in numerous areas, including drug discovery and the evaluation of new medicines, improved crop protection chemicals and new personal care products. The opportunity is not solely to replace current animal models with their non-animal equivalents, but to develop better tests that are fundamentally more predictive.

Recent advances in relevant fields in the biosciences (including induced pluripotent stem cells, tissue engineering technologies, high-throughput platforms, computational methods and modelling) offer many more opportunities for these systems to transform drug and chemical development. The UK leads the science in these technologies.

Emerging imaging technologies

These are new techniques to create or process images, allowing better extraction of data from imaged areas and/or enhanced data processing techniques to create a richer understanding of the observed area. There are applications in medical diagnostics, industrial process and quality control, enhanced security and traffic management. The UK is a world leader in scientific research into technologies that could transform the imaging sector. For example, we have significant capability in photonics, computing, optics, terahertz sources and detectors, visualisation, photonic crystals and fibres, meta-materials and plasmonics, graphene and optical signal processing.

Graphene

This is a form of carbon having a two-dimensional, single layer structure and extraordinary mechanical, electrical, optical, gas-barrier and other properties. It could find applications in enhanced composite materials, electronic devices such as capacitors and display screens, conductive inks and many other areas. The government is investing more than £90 million in graphene research and infrastructure, building on the Nobel Prize awarded to University of Manchester researchers Andre Geim and Konstantin Novoselov, and other UK research strengths in universities and business. More than 35 UK university groups are active in fundamental and applied graphene research, having attracted significant funding from Europe, global corporations and learned societies such as the Royal Society and the Royal Academy of Engineering.

Quantum technologies

These have the potential, amongst other things, to allow ultra- secure communications, highly sensitive sensing, measuring and imaging techniques, and massively faster computing and simulation. Potential applications include mineral extraction, navigation without use of satellites, medical imaging and secure communications.

The government is investing £270 million over five years in the development of quantum technologies. The investment will support the development of a national network of research hubs, as well as postgraduate skills, research and infrastructure, and a £50 million innovation programme.

Synthetic biology

This is the design and engineering of novel biologically-based parts, devices and systems, or the redesign of existing biological systems for useful purposes. There are numerous potential applications, including the creation of new medicines and vaccines, new routes to bio-fuels and highly selective sensors.

187 EngineeringUK 2015 the state of engineering, EngineeringUK, December 2014, p20-21 **188** Reshoring manufacturing – time to seize the opportunity, The economic opportunity for the UK to reshore and the implications for Government and businesses, Ernst & Young LLP, 2015 http://www.ey.com/UK/en/Newsroom/News-releases/15-02-16-Re-shoring-presents-15-billion-opportunity-for-the-UK-economy **189** An analysis of the UK's Capability to Reshore Production – A White Paper by Cranfield University, 20 May 2015, p3 **190** Emerging technologies & industries strategy, 2014-2018, Innovate UK, 22 October 2014, p9

1.4 Self-employment

At the outset we have highlighted the acute shortage of skilled engineers and technicians in the UK. A recurring theme throughout this report is increasing the pool of skilled people. We should therefore be mindful of the changing patterns in employment that have been taking place over the past decade, originally influenced by the power of technology and latterly by the last recession.

The proportion of the UK workforce who are self-employed is now at its highest ever and has been growing steadily for more than a decade.[191] There are now 4.6 million self-employed people in the UK – around 1 in 7 of the UK workforce.[192] On current trends, this growing group is set to outnumber the public sector workforce by 2020.[193]

The rise in self-employment predates the downturn and is expected to continue independently of the economic cycle.[194] This is an important trend as this cohort can provide significant value to organisations.[195] Professor Andre Burke of Cranfield Business School has identified a number of key benefits (abridged)[196] for organisations in employing self-employed workers:

Capability: freelancers can provide access to a range of skills and expertise beyond those held by the permanent employees of a firm.

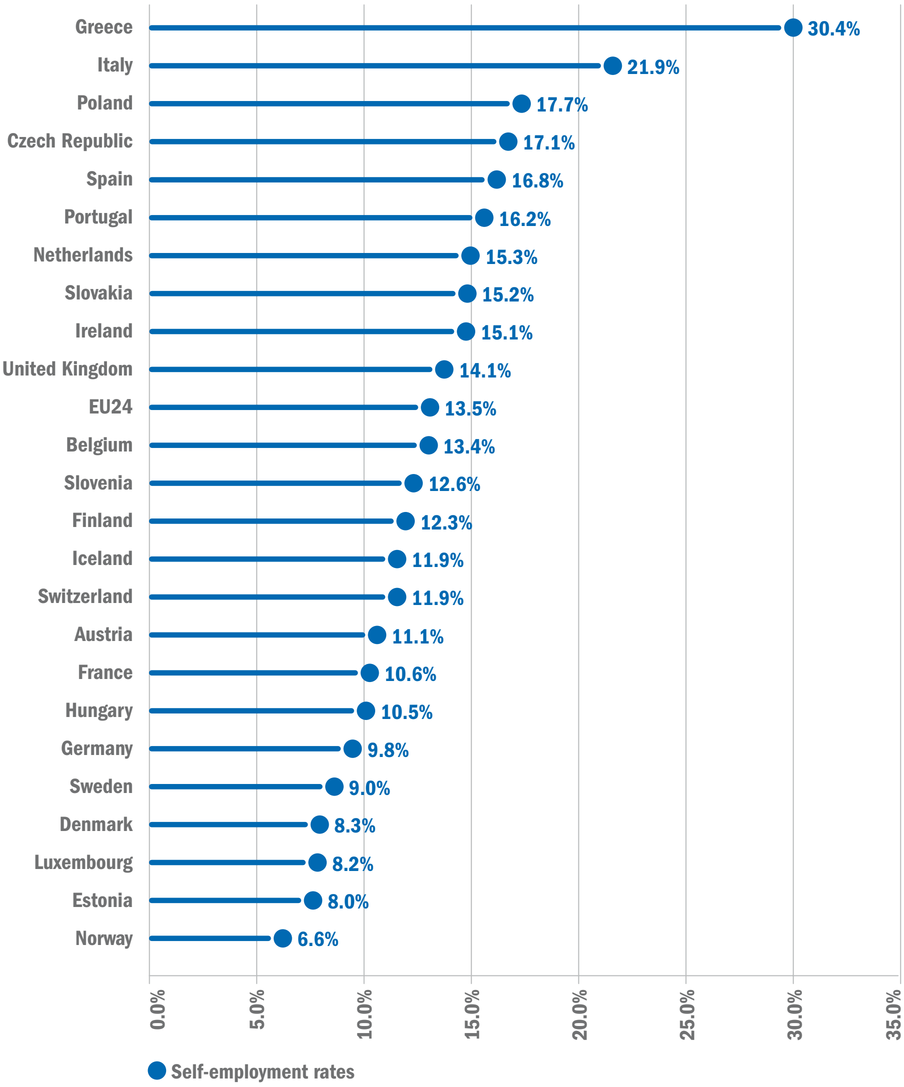
Productivity: contractors can help firms deal with peaks and troughs in demand for their services. A firm might be reluctant to miss out on new business but nervous about the risks of taking on permanent staff.

Innovation: contractors can help ensure that growing a business, or trying out a new idea, is less risky than it might otherwise be.

Competitiveness: contractors can reduce barriers to entry for new firms facing problems such as financial constraints.

Unsurprisingly, the UK is not alone in experiencing this growing trend. Analysis by IPPR on self-employment in Europe shows the variability in self-employment rates across Europe (Figure 1.9).[197]

Figure 1.9: Self-employment rates, Europe-24 countries (Q2 2014)



Source: Eurostat Labour Market Database (Eurostat 2014a)
Base: Total employment

However, the report highlights an important dichotomy: self-employment is an important part of the labour market, but living standards of self-employed workers appear to have fallen further than those of employees. Concluding that self-employment and entrepreneurship have been identified as key drivers of economic growth they send out a stark message to policy makers reminding them of the need to consider self-employment carefully in order to help support economic growth, as well as the living standards of this group.

191 C D'Arcy and L Gardiner, Just the Job – or a Working Compromise? The changing nature of self-employment in the UK?, Resolution Foundation, 2014 www.resolutionfoundation.org/media/Media/downloads/Just_the_job_-_or_a_working_compromise_1.pdf **192** ONS, 'Single month Labour Force Survey estimates', Office for National Statistics, May 2014. **193** B Dellot, 'Why the self-employed will soon be a political force', blog, RSA, 22 Feb 2014, www.rsablogs.org.uk/2014/enterprise/selfemployed-kids-electoral-block **194** C D'Arcy and L Gardiner, Just the Job – or a Working Compromise? The changing nature of self-employment in the UK?, Resolution Foundation, 2014 www.resolutionfoundation.org/media/Media/downloads/Just_the_job_-_or_a_working_compromise_1.pdf **195** A Burke, The Role of Freelancers in the 21st Century Economy, Professional Contractors Group, 2012, www.som.cranfield.ac.uk/som/dinamic-content/media/Wendy%20Lewis/Research/Andrew%20Burke,%20The%20Role%20of%20Freelancers%20in%20the%2021st%20Century%20British%20Economy,%20PCG%20REPORT.pdf **196** Going it Alone, Duncan O'Leary, Demos, August 2014, p18, 19 **197** Self-Employment in Europe, IPPR, January 2015, p8 **197** ONS: Gross Domestic Product Preliminary Estimate, Quarter 2 (Apr to June) 2015, 28th July 20

Part 1 – Engineering in Context
2.0 Engineering in the UK

The economic recovery is accelerating, with the number of engineering enterprises in the UK growing by 4.4% – the fastest growth in years. Turnover grew by 3.4% in 2014 to over £1.2 trillion: nearly a quarter of total UK turnover. The UK was the fastest growing G7 economy in 2014. In Q2 2015, the Office for National Statistics (ONS) estimated GDP to have been 5.2% higher than at its pre-financial crisis peak in 2008.[198] Furthermore, engineering's output has rebounded above its 2007 level, recouping the ground lost during the financial crisis.[199] However, the fall in labour productivity experienced during the recession has been larger than in any other post-war recession. As a result, the level of productivity is around 4% below its pre-crisis peak. This 'productivity puzzle'[200] is perhaps the single most challenging issue that the UK economy faces, and the engineering sector has a vital role to play in ensuring that long-term, stable economic growth is achieved.

Figure 2.1 details the contribution of different industrial sectors to UK economic output per hour, relative to Q1 2008. Although overall productivity is still below its Q1 2008 level, the manufacturing and construction industries have both been net positive contributors to UK productivity since 2011. In contrast, agriculture & non-manufacturing production, which includes the oil and gas industry, has experienced lower levels of output per hour since Q1 2008.

Table 2.1 includes data from research conducted by the Centre for Economics and Business Research (Cebr) on behalf of EngineeringUK, which breaks down the GVA[202] values and employment numbers of different industrial sectors in 2014.[203]

According to the Cebr, the engineering sector contributed £412 billion in gross value added in 2014, employing 5,636,000 individuals. Indeed, the gross value added of engineering businesses is larger than the retail & wholesale, and financial and insurance sectors combined.

Considering the economic contributions of specific engineering sub-sectors, Table 2.2 shows that electronic and electrical engineering contributed the most of any sector, responsible for over £131 billion in GVA in 2014, and employing 1.5 million people.

The following sections of this chapter discuss the count, employee number and turnover of VAT/PAYE registered enterprises in the UK. Data is sourced from the Inter Departmental Business Register (IDBR) on the 14th of March 2014.

198 ONS: *Gross Domestic Product Preliminary Estimate, Quarter 2 (Apr to June) 2015, 28th July 2015*, p11 **199** Technopolis: Assessing the economic returns of engineering research and postgraduate training in the UK, March 2015, p1 **200** Section 1.1.1 **202** GVA measures the contribution to the economy of each individual producer, industry or sector in the UK. It is used in the estimation of gross domestic product (GDP). **203** Source: Cebr analysis utilises data from the following resources: Annual Business Survey 2013, Business Register and Employment Survey 2013, Cebr projections (GVA 2014), European Commission CEDEFOP forecasts (employment 2014), UK Quarterly National Accounts low level aggregates.

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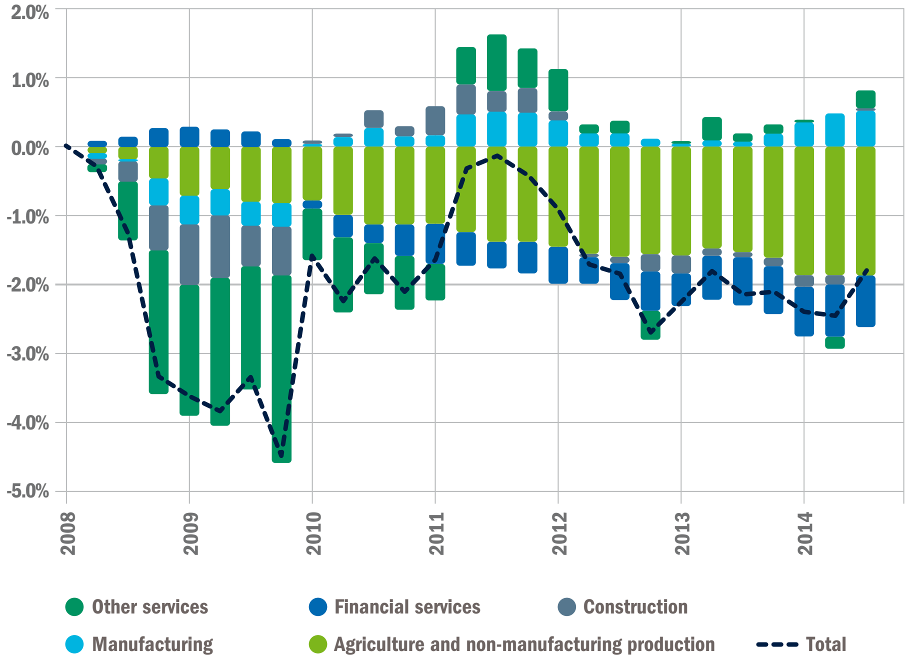
Figure 2.1: Contributions to the growth of UK output per hour relative to Q1 (2008)[201]



Source: ONS

Table 2.1: Comparison of GVA and employment in the engineering sector[204] compared to other major sectors (2014)

Industry	GVA £	Employment
Engineering	412,195,000,000	5,636,000
Retail and wholesale	187,453,000,000	4,300,000
Professional, scientific and technical activities	129,108,000,000	2,545,000
Financial and insurance	120,148,000,000	1,029,000
Construction	98,766,000,000	1,457,000

Source: Cebr analysis

Table 2.2: Breakdown of projected GVA and employment in engineering sub-sectors (2014)

Engineering sector	GVA £	Employment (average)
Automotive engineering	21,199,000,000	363,000
General engineering	28,731,000,000	380,000
Civil engineering	21,485,000,000	300,000
Mechanical engineering	13,547,000,000	205,000
Aerospace engineering	9,492,000,000	87,000
Electronic and electrical engineering	131,095,000,000	1,534,000
Production and manufacturing engineering	50,792,000,000	976,000
Chemical, process and energy engineering	84,516,000,000	943,000
Other	51,339,000,000	848,000
Total	**412,195,000,000**	**5,636,000**

Source: Cebr analysis

201 ONS: Economic Review, 8th January 2015, p7 204 The engineering sector is comprised of sub-sectors that also form part of some of the industry sectors listed above. An overlap therefore exists and this should be taken into account when these figures are quoted.

2.1 Number of engineering enterprises in the UK

Table 2.3 displays the total number of all registered enterprises in the UK, which grew by 4.4% between 2013 and 2014 to 2,263,645. The growth in the number of enterprises over the last six years was only 5.2%, which highlights the acceleration in the UK economic recovery over the last few years. London saw the highest growth, with 7.7% more businesses registered there in 2014 than the preceding year. In contrast, Northern Ireland was the only region which saw a decline in the number of registered enterprises. However, at -0.1%, this fall was substantially lower than in previous years and suggests a turn-around for the Northern Ireland economy.

Between 2013 and 2014, the number of registered engineering enterprises grew by 5.6% in the UK to 608,920 (Table 2.4); the highest growth in over six years. This reflects the increasingly buoyant nature of the sector over the last couple of years. Furthermore, all home nations and regions saw growth in the number of engineering enterprises, with the exception of Northern Ireland, where the number declined by 0.9% from 14,355 to 14,235.

London saw the highest growth of any region, with the number of registered companies increasing by 9.5% between 2013 and 2014. This was closely followed by the North East, which is home to 1,280 more engineering companies in 2014 than in 2013.

The distribution of registered engineering enterprises is not equal across the UK. As Figure 2.2 illustrates, in 2014 the South East is home to the largest proportion of engineering enterprises, with 17.3% registered there. At 16.5%, London has the second highest number of registered engineering enterprises: an increase of 0.6% on the previous year. This was the largest increase of any region – most of which saw their share decline – and attests to the London-centric nature of the post-crisis economy.

Table 2.5 displays the number of engineering enterprises as a proportion of all enterprises. Across the whole of the UK, 26.9% of all enterprises were in the engineering sector in 2014, an increase of 0.3% over the previous year. The East of England has the largest proportion of engineering enterprises, at 29.2%. The North East saw the largest growth number of engineering business as a proportion of all enterprises (0.9%).

Table 2.3: Number of VAT and/or PAYE registered enterprises (2009-2014) – UK

Home nation/ English region	2009	2010	2011	2012	2013	2014	Change over 1 year	Change over 6 years
North East	57,425	55,865	54,770	56,420	56,430	59,340	5.2%	3.3%
North West	211,915	204,990	201,060	205,690	206,815	216,665	4.8%	2.2%
Yorkshire and The Humber	152,475	148,855	146,605	150,060	150,715	156,320	3.7%	2.5%
East Midlands	147,980	143,310	140,940	144,510	145,295	151,770	4.5%	2.6%
West Midlands	177,195	171,410	167,585	171,200	171,750	177,880	3.6%	0.4%
East	217,925	213,635	210,845	216,595	217,605	226,940	4.3%	4.1%
London	339,185	331,535	334,395	359,880	372,380	400,925	7.7%	18.2%
South East	337,380	330,375	328,015	337,810	339,965	352,720	3.8%	4.5%
South West	202,550	197,935	196,605	200,500	201,145	207,470	3.1%	2.4%
England	1,844,030	1,797,910	1,780,820	1,842,665	1,862,100	1,950,030	4.7%	5.7%
Wales	92,005	89,370	87,430	88,575	87,685	90,205	2.9%	-2.0%
Scotland	145,745	144,565	144,650	150,455	151,105	156,765	3.7%	7.6%
Northern Ireland	70,620	68,525	67,960	67,490	66,690	66,645	-0.1%	-5.6%
UK total	2,152,400	2,100,370	2,080,860	2,149,185	2,167,580	2,263,645	4.4%	5.2%

Source: ONS/IDBR

Table 2.4: Engineering enterprises registered for VAT and/or PAYE (2009-2014) – UK[205]

Home nation/ English region	2009	2010	2011	2012	2013	2014	Change over 1 year	Change over 6 years
North East	15,545	15,010	14,545	15,275	15,675	16,995	8.4%	9.3%
North West	55,315	53,240	51,365	53,065	53,895	57,090	5.9%	3.2%
Yorkshire and The Humber	40,080	38,825	37,770	38,855	39,330	41,015	4.3%	2.3%
East Midlands	40,600	39,050	38,075	38,850	39,280	40,825	3.9%	0.6%
West Midlands	48,380	46,415	44,945	46,105	46,625	48,650	4.3%	0.6%
East	63,625	61,930	60,495	62,415	63,040	66,235	5.1%	4.1%
London	81,680	78,640	79,190	87,175	91,775	100,495	9.5%	23.0%
South East	98,005	95,500	94,535	98,020	99,800	104,865	5.1%	7.0%
South West	52,415	51,105	50,355	51,825	52,300	54,730	4.6%	4.4%
England	495,645	479,715	471,275	491,585	501,720	530,900	5.8%	7.1%
Wales	21,375	20,595	20,115	20,540	20,525	21,535	4.9%	0.7%
Scotland	36,125	35,920	36,180	38,490	39,840	42,250	6.0%	17.0%
Northern Ireland	15,860	15,290	14,870	14,705	14,355	14,235	-0.8%	-10.2%
UK total	569,005	551,520	542,440	565,320	576,440	608,920	5.6%	7.0%

Source: ONS/IDBR

205 Numbers rounded to nearest 5

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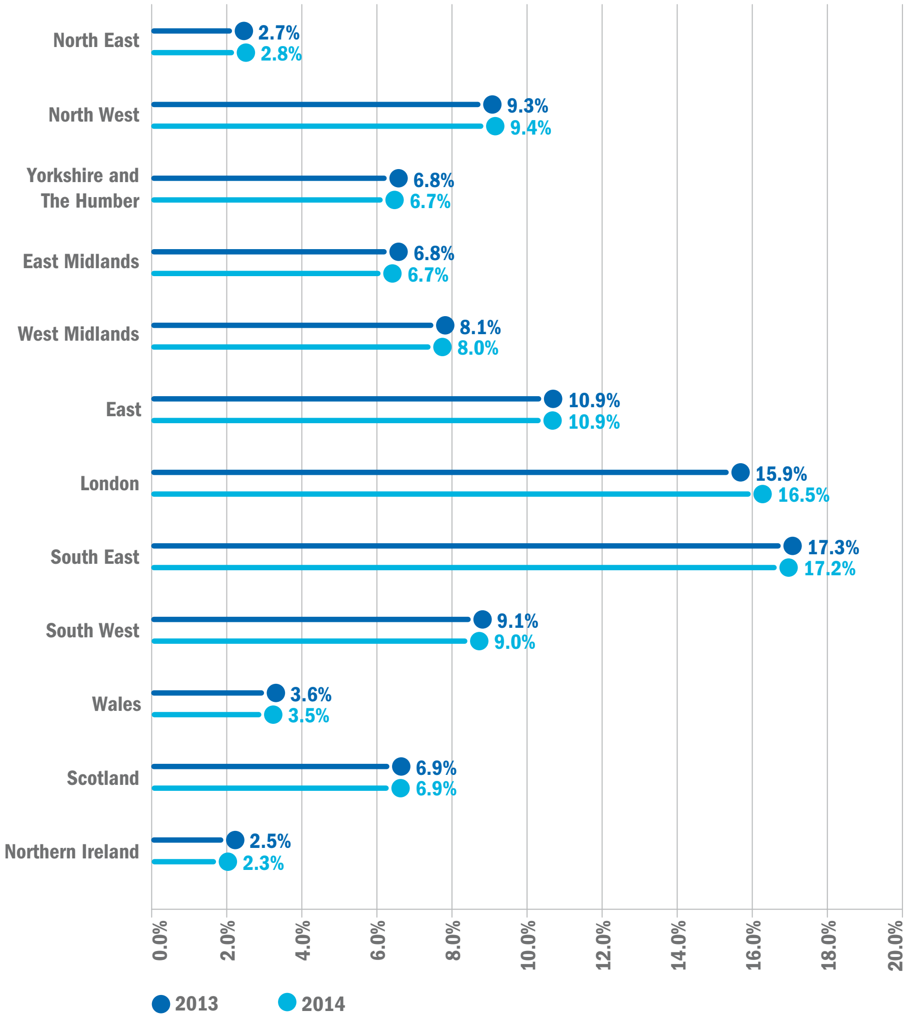
Figure 2.2: Percentage of VAT and/or PAYE registered **engineering** enterprises (2013-2014) – UK



Source: ONS/IDBR

A fact not always appreciated is that the vast majority of engineering enterprises have a very small number of employees compared with other sectors. As Figure 2.3 illustrates, 79.5% of engineering enterprises registered in the UK employed fewer than four people, whereas over half of enterprises across all sectors employed over 250. London has the highest proportion of these micro-enterprises, whereas Yorkshire and The Humber is home to the highest percentage of larger employers – with a quarter employing five or more.

Table 2.5: Number of VAT and/or PAYE registered **engineering** enterprises as a proportion of all enterprises (2013-2014) – UK

Home nation/ English region	Proportion of enterprises that are engineering enterprises		Change over 1 year
	2013	2014	
North East	27.8%	28.6%	0.9%
North West	26.1%	26.3%	0.3%
Yorkshire and The Humber	26.1%	26.2%	0.1%
East Midlands	27.0%	26.9%	-0.1%
West Midlands	27.1%	27.3%	0.2%
East	29.0%	29.2%	0.2%
London	24.6%	25.1%	0.4%
South East	29.4%	29.7%	0.4%
South West	26.0%	26.4%	0.4%
England	26.9%	27.2%	0.3%
Wales	23.4%	23.9%	0.5%
Scotland	26.4%	27.0%	0.6%
Northern Ireland	21.5%	21.4%	-0.2%
UK total	**26.6%**	**26.9%**	**0.3%**

Source: ONS/IDBR

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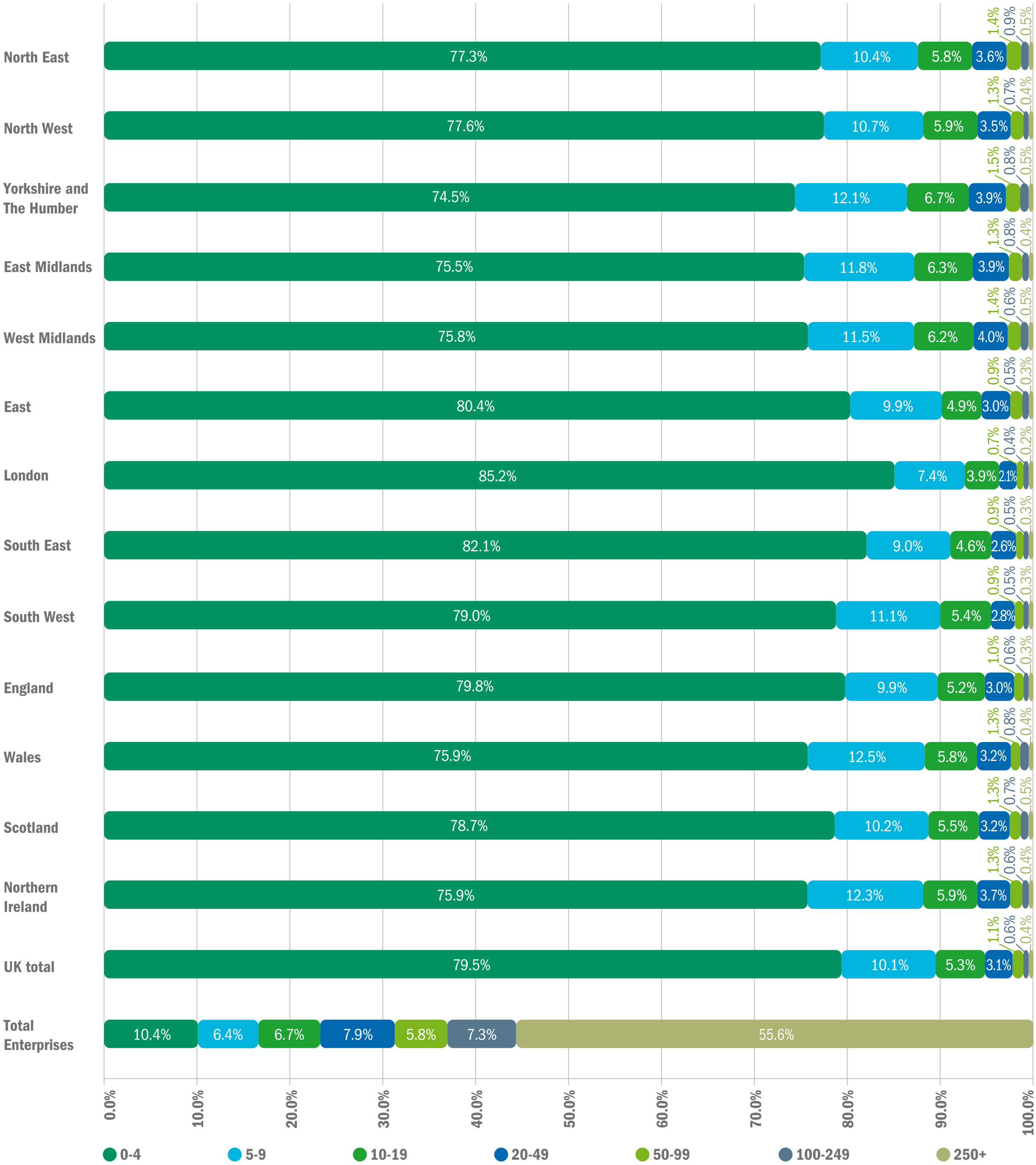
Figure 2.3: Share of VAT and/or PAYE registered **engineering** enterprises by number of employees and by home nation and English region (2014) – UK



Source: ONS/IDBR

Table 2.6 shows the proportion of engineering enterprises in different industrial groups.

Information and communication was the largest engineering group, accounting for 28.5% of all engineering enterprises: an increase of 0.8 percentage points from the preceding year. Mining and quarrying was by far the smallest sub-group, constituting only 0.2% of registered enterprises. However, this is not surprising, as mining and quarrying companies have a larger number of employees, with 73.7% employing more than 250 people.

Table 2.6: Number of **engineering** enterprises by selected industrial groups (2013-2014) – UK

Home nation/ English region	Year	Overall	Manufacturing	Mining and quarrying	Construction	Information and communication	All other industrial groups
North East	2013	15,675	3,820	50	4,175	2,335	5,290
	2014	16,995	3,905	45	4,465	2,535	6,035
North West	2013	53,895	13,710	80	13,790	11,345	14,970
	2014	57,090	13,750	70	14,400	12,385	16,485
Yorkshire and The Humber	2013	39,330	11,195	85	11,270	7,280	9,505
	2014	41,015	11,320	85	11,540	7,860	10,210
East Midlands	2013	39,280	11,265	85	11,345	7,310	9,275
	2014	40,825	11,335	80	11,635	7,825	9,945
West Midlands	2013	46,625	13,680	65	12,090	9,650	11,140
	2014	48,650	13,665	50	12,410	10,435	12,095
East	2013	63,040	13,215	95	19,050	16,495	14,185
	2014	66,235	13,165	85	19,745	17,905	15,335
London	2013	91,775	12,060	160	16,740	46,335	16,480
	2014	100,495	11,845	160	18,800	51,285	18,405
South East	2013	99,800	17,500	110	25,805	34,115	22,270
	2014	104,865	17,530	105	26,895	36,395	23,935
South West	2013	52,300	11,395	100	15,750	12,750	12,305
	2014	54,730	11,475	100	16,100	13,700	13,360
England	2013	501,720	107,840	830	130,015	147,615	115,420
	2014	530,900	107,990	780	135,990	160,325	125,805
Wales	2013	20,525	4,995	65	6,780	3,385	5,300
	2014	21,535	5,130	60	7,065	3,640	5,650
Scotland	2013	39,840	7,710	310	9,650	7,590	14,585
	2014	42,250	7,810	240	9,880	8,110	16,210
Northern Ireland	2013	14,355	3,705	85	6,285	1,315	2,965
	2014	14,235	3,700	80	6,005	1,405	3,045
UK total	2013	576,440	124,250	1,290	152,730	159,905	138,270
	2014	608,920	124,630	1,160	158,940	173,480	150710
Share of total UK engineering enterprises	2013	-	21.6%	0.2%	26.5%	27.7%	24.0%
	2014	-	20.5%	0.2%	26.1%	28.5%	24.8%

Source: ONS/IDBR

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2.2 Employment in engineering in the UK

In March 2014, there were 5,529,000 employees working in engineering enterprises in the UK – an increase of 1.8% on the previous year and the third consecutive year of growth (Table 2.7). London saw the largest growth in the number of employees, at 15.5%. The South East of England had the largest number of employees working in the engineering sector (981,000). Only the East of England saw a decline in the number of employees, with a fall of 11.9% from the 2013 figure. Due to its proximity to London, it is possible that this is due to a migration of workers from this region to the capital. Scotland employed 409,000 people in engineering enterprises in 2014, a figure unchanged from the preceding year. This was also the case for Northern Ireland, which remained at 120,000.

Table 2.8 shows employment in engineering enterprises as a proportion of employment in all enterprises. Of all UK employees, 19.3% were working in an engineering enterprise. While the number of engineering enterprises as a proportion of all enterprises grew by 0.3%, the proportion employed in engineering enterprises declined by 0.1%. In other words, the growth in employment was slightly higher for all enterprises than for engineering enterprises. Coupled with an increase in the number of engineering enterprises, this suggests that there are now fewer people working for more employers.

In the South East, 24.9% of employees are employed by an engineering enterprise – the highest proportion of any UK region. Moreover, at 1.4%, London saw the greatest growth in employees working for an engineering enterprise.

Figure 2.4 shows the proportion of workers in engineering enterprises by number of employees. In Figure 2.3, we demonstrated that companies with over 250 employees constituted only 0.4% of all engineering enterprises. However, these companies employ 42.4% of those working for an engineering enterprise.

The prominence of large employers is not consistent across all UK regions and home nations. For example, companies employing over 250 accounted for just over a third of employees in engineering enterprises in the North East, and over half (50.5%) in the South East. In Northern Ireland, 16.6% of the engineering workforce were employed by micro enterprises (0-4 employees), the largest share of any region. In contrast, enterprises with over 250 staff account for 30.7% of engineering employment.

Table 2.7: Employment in VAT and/or PAYE registered **engineering** enterprises (2009-2014) – UK

Home nation/ English region	2009	2010	2011	2012	2013	2014	Change over 1 year	Change over 6 years
North East	189,000	175,000	159,000	164,000	167,000	168,000	0.6%	-11.1%
North West	559,000	540,000	489,000	489,000	493,000	511,000	3.7%	-8.6%
Yorkshire and The Humber	462,000	423,000	403,000	410,000	404,000	418,000	3.5%	-9.5%
East Midlands	427,000	399,000	382,000	385,000	388,000	392,000	1.0%	-8.2%
West Midlands	550,000	519,000	497,000	491,000	500,000	501,000	0.2%	-8.9%
East	657,000	633,000	607,000	604,000	607,000	535,000	-11.9%	-18.6%
London	717,000	661,000	668,000	695,000	704,000	813,000	15.5%	13.4%
South East	1,018,000	1,000,000	961,000	969,000	960,000	981,000	2.2%	-3.6%
South West	505,000	497,000	491,000	493,000	477,000	479,000	0.4%	-5.1%
England	5,084,000	4,848,000	4,657,000	4,700,000	4,700,000	4,797,000	2.1%	-5.6%
Wales	223,000	208,000	206,000	203,000	201,000	203,000	1.0%	-9.0%
Scotland	435,000	408,000	403,000	408,000	409,000	409,000	0.0%	-6.0%
Northern Ireland	153,000	144,000	125,000	121,000	120,000	120,000	0.0%	-21.6%
UK	5,895,000	5,608,000	5,391,000	5,432,000	5,431,000	5,529,000	1.8%	-6.2%

Source: ONS/IDBR

Table 2.8: Employment in **engineering** enterprises as a proportion of employment in all enterprises (2013-2014) – UK[206]

Home nation/ English region	Proportion		Change over 1 year
	2013	2014	
North East	17.5%	17.5%	0.0%
North West	18.9%	19.2%	0.3%
Yorkshire and The Humber	17.9%	17.9%	0.1%
East Midlands	19.2%	19.0%	-0.3%
West Midlands	21.7%	21.2%	-0.5%
East	21.2%	18.7%	-2.5%
London	13.3%	14.7%	1.4%
South East	24.8%	24.9%	0.1%
South West	22.8%	22.7%	-0.1%
England	19.4%	19.3%	0.0%
Wales	20.0%	19.6%	-0.5%
Scotland	18.9%	18.9%	0.0%
Northern Ireland	18.0%	18.0%	0.0%
UK total	**19.3%**	**19.3%**	**-0.1%**

Source: ONS/IDBR

206 Percentage change may be different from percentages recorded due to rounding.

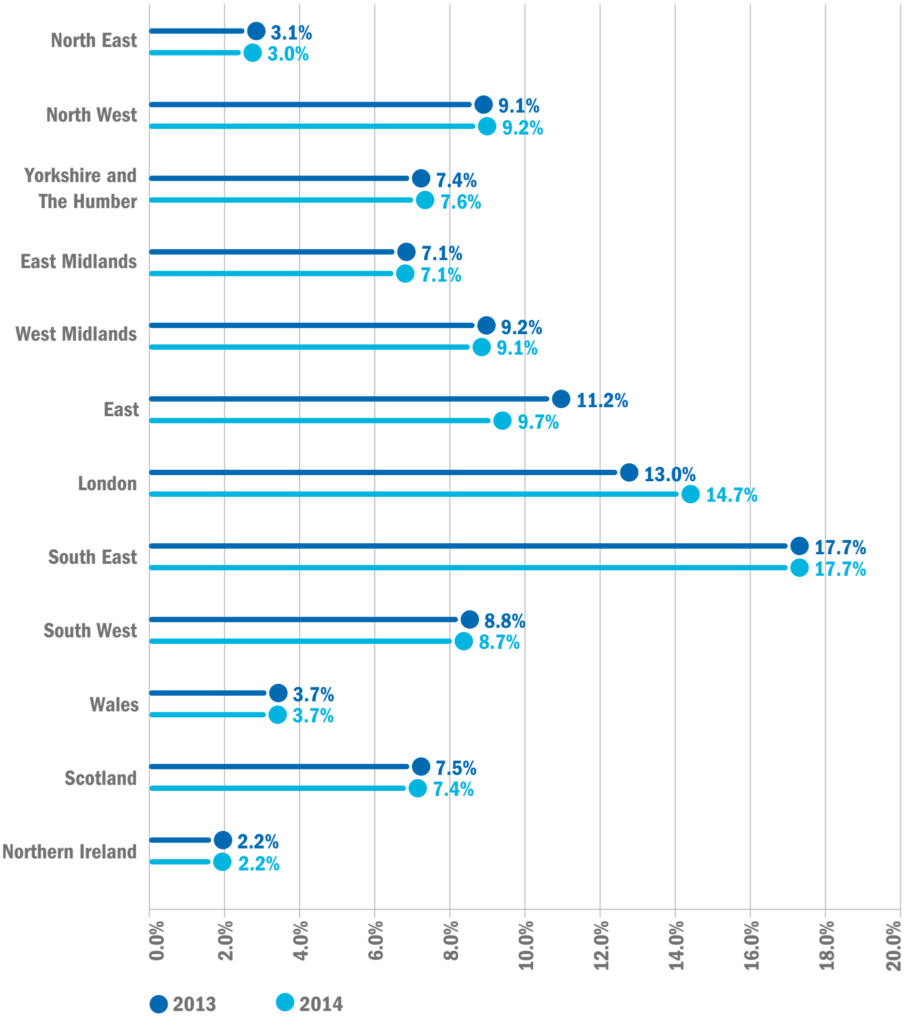
Figure 2.4: Share of employment in VAT and/or PAYE registered **engineering** enterprises by enterprise size, home nation and English region (2014) – UK

Source: ONS/IDBR

Figure 2.5 illustrates the proportion of employees working by devolved nation and English region. Nearly one in five (17.7%) of those working for engineering enterprises work in the South East, a figure unchanged from 2013. London employs the second highest number of workers in engineering enterprises, accounting for 14.7% of the total. This is an increase of 1.7% over the previous year. In contrast, only 3.1% work in the North East and 2.2% work in Northern Ireland.

Manufacturing and quarrying enterprises constitute a fifth (20.5%) of all engineering enterprises, yet account for over two fifths of all engineering sector employment (Table 2.9). Nearly a fifth (18.8%) of those employed in the engineering sector work for an information and communication enterprise, whilst only 1.0% work for mining and quarrying employers.

Figure 2.5: Share of employment for VAT and/or PAYE registered **engineering** enterprises by devolved nation and English region (2013-2014)



Source: ONS/IDBR

Table 2.9: Employment in VAT and/or PAYE registered **engineering** enterprises by selected industrial groups (2013-2014) – UK

Home nation/ English region	Year	Overall	Manufacturing	Mining and quarrying	Construction	Information and communication	All other industrial groups
North East	2013	167,000	88,000	2,000	32,000	12,000	33,000
	2014	168,000	88,000	2,000	31,000	12,000	34,000
North West	2013	493,000	270,000	1,000	86,000	46,000	88,000
	2014	511,000	273,000	1,000	95,000	49,000	93,000
Yorkshire and The Humber	2013	404,000	233,000	2,000	75,000	34,000	60,000
	2014	418,000	247,000	2,000	70,000	36,000	63,000
East Midlands	2013	388,000	235,000	4,000	63,000	37,000	49,000
	2014	392,000	236,000	3,000	65,000	36,000	52,000
West Midlands	2013	500,000	279,000	1,000	90,000	39,000	90,000
	2014	501,000	286,000	1,000	80,000	42,000	91,000
East	2013	607,000	235,000	1,000	113,000	163,000	95,000
	2014	535,000	225,000	1,000	110,000	97,000	103,000
London	2013	704,000	167,000	8,000	114,000	269,000	146,000
	2014	813,000	164,000	9,000	118,000	371,000	150,000
South East	2013	960,000	339,000	4,000	152,000	269,000	197,000
	2014	981,000	351,000	5,000	158,000	268,000	199,000
South West	2013	477,000	194,000	3,000	80,000	61,000	140,000
	2014	479,000	190,000	2,000	82,000	61,000	144,000
England	2013	4,700,000	2,040,000	26,000	806,000	930,000	898,000
	2014	4,797,000	2,060,000	25,000	810,000	974,000	929,000
Wales	2013	201,000	118,000	2,000	37,000	14,000	31,000
	2014	203,000	118,000	1,000	37,000	15,000	32,000
Scotland	2013	409,000	160,000	28,000	75,000	42,000	103,000
	2014	409,000	151,000	29,000	77,000	42,000	110,000
Northern Ireland	2013	120,000	62,000	1,000	31,000	13,000	13,000
	2014	120,000	64,000	1,000	28,000	11,000	15,000
UK total	2013	5,431,000	2,381,000	58,000	949,000	998,000	1,045,000
	2014	5,529,000	2,393,000	57,000	952,000	1,041,000	1,086,000
Share of total UK engineering enterprises turnover	2013	-	43.8%	1.1%	17.5%	18.4%	19.2%
	2014	-	43.3%	1.0%	17.2%	18.8%	19.6%

Source: ONS/IDBR

2.3 Turnover of engineering enterprises in the UK

In the year ending March 2014, engineering enterprises in the UK generated turnover of £1.21 trillion, up 3.4% on the previous year and 12.6% on 2009 (Table 2.10). Of all devolved nations, Scotland saw the greatest growth in engineering enterprise turnover since 2009, up 15.6%. However, between 2013 and 2014, growth in Scotland declined by 3.9%. London had the highest growth of any region: its engineering enterprises generated £268.1 billion revenue in 2014, and turnover grew by £30 billion (13.0%) from 2013 to 2014.

The East of England saw the largest change in magnitude, with a concerning 13.6% fall in turnover from engineering enterprises. Scotland and Wales also saw a decline in the turnover of their engineering enterprises, with the amount falling by 3.9% and 3.4% respectively.

Table 2.11 displays the turnover generated by engineering enterprises as a proportion of total turnover from all companies. In 2014, engineering companies generated almost a quarter of total UK turnover. Of all English regions, the South East had the largest proportion of turnover at 37.1%. Across all devolved nations, at 23.8% engineering enterprises in England had the lowest turnover as a proportion of turnover from all enterprises.

In contrast, nearly two fifths of turnover in Wales came from engineering enterprises, the largest share of any region. Even so, this figure was 2.6% down on the previous year. The North East saw the largest decline in turnover from engineering enterprises, with the rate declining by 7.5%.

Figure 2.6 shows the percentage of turnover from engineering enterprises generated in each region or devolved nation. Perhaps unsurprisingly, engineering enterprises in London generated the most turnover, accounting for 22.2% of the UK total. Furthermore, this proportion increased by 1.9 percentage points from 2013 to 2014. In contrast Wales, Scotland, the East, the West Midlands, the East Midlands and, Yorkshire and the Humber, all saw a decline in the percentage of total engineering enterprise turnover. Indeed, the only regions outside of London to increase their share of total UK turnover was the North West and the South West, which grew by 0.6 and 0.4 percentage points respectively.

Table 2.10: Turnover in VAT and/or PAYE registered **engineering** enterprises (2009-2014) – UK

Home nation/ English region	Turnover (millions) 2009	Turnover (millions) 2010	Turnover (millions) 2011	Turnover (millions) 2012	Turnover (millions) 2013	Turnover (millions) 2014	Change over 1 year	Change over 6 years
North East	38,171	35,807	27,065	27,694	28,790	30,255	5.1%	-20.7%
North West	82,209	85,323	77,817	81,790	89,851	100,721	12.1%	22.5%
Yorkshire and The Humber	64,580	62,709	56,371	60,684	62,974	64,271	2.1%	-0.5%
East Midlands	60,270	62,046	58,742	59,817	62,315	64,018	2.7%	6.2%
West Midlands	93,612	82,572	77,024	82,262	93,161	96,043	3.1%	2.6%
East	109,521	117,366	109,177	115,142	122,467	105,773	-13.6%	-3.4%
London	198,958	232,880	207,274	213,518	237,333	268,095	13.0%	34.7%
South East	211,568	237,578	230,367	223,813	235,763	241,327	2.4%	14.1%
South West	65,936	69,162	67,289	66,811	70,427	76,876	9.2%	16.6%
England	924,826	985,443	911,125	931,530	1,003,080	1,047,383	4.4%	13.3%
Wales	35,082	35,412	32,139	33,997	35,344	34,143	-3.4%	-2.7%
Scotland	94,329	107,388	98,805	113,339	113,503	109,064	-3.9%	15.6%
Northern Ireland	19,357	19,377	18,082	17,939	17,819	18,490	3.8%	-4.5%
UK total	1,073,594	1,147,619	1,060,151	1,096,806	1,169,747	1,209,082	3.4%	12.6%

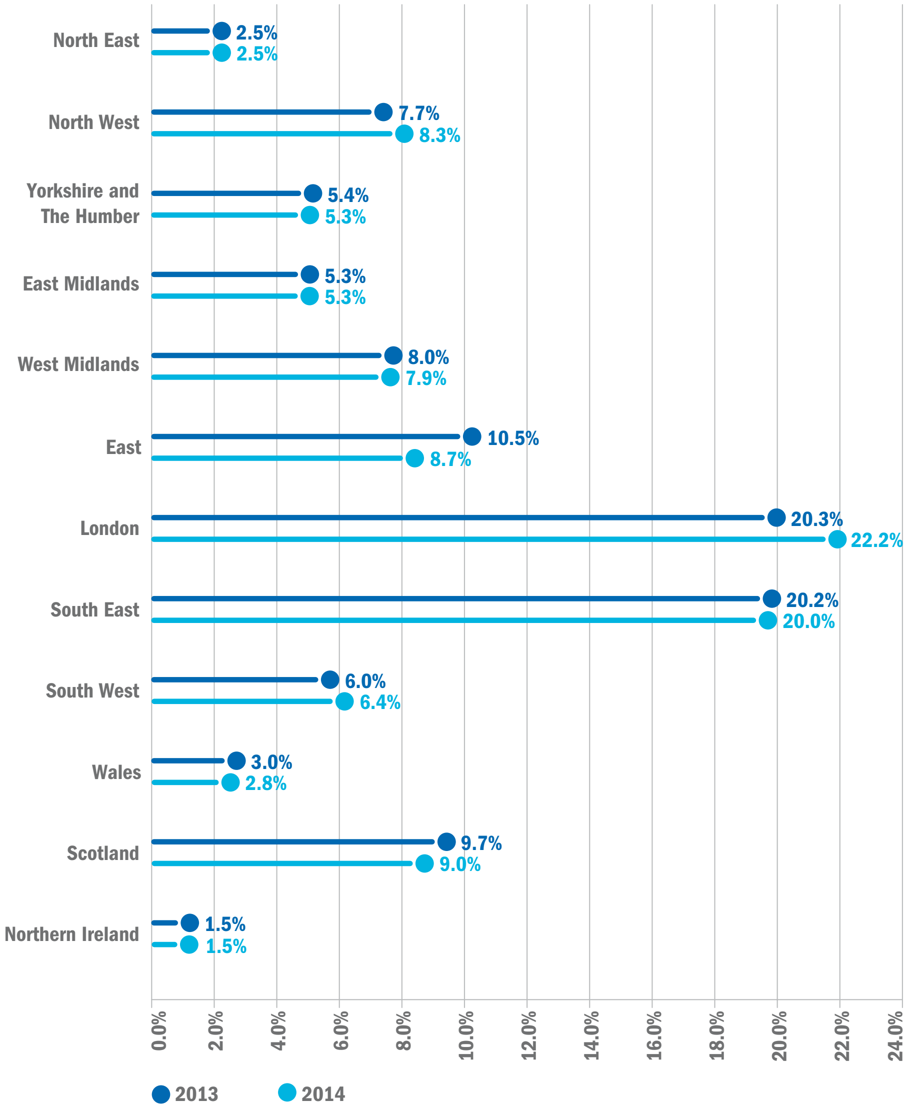
Source: ONS/IDBR

Table 2.11: Turnover in VAT and/or PAYE registered **engineering** enterprises as a proportion of turnover in all enterprises (2013-2014) – UK

Home nation/ English region	Proportion		Percentage change
	2013	2014	
North East	29.1%	21.5%	-7.5%
North West	30.3%	32.0%	1.8%
Yorkshire and The Humber	19.9%	22.1%	2.2%
East Midlands	28.3%	28.3%	0.0%
West Midlands	36.3%	34.1%	-2.2%
East	33.6%	29.5%	-4.1%
London	13.2%	14.4%	1.1%
South East	40.3%	37.1%	-3.2%
South West	27.7%	28.0%	0.3%
England	24.0%	23.8%	-0.2%
Wales	42.2%	39.6%	-2.6%
Scotland	30.4%	33.7%	3.4%
Northern Ireland	29.0%	28.7%	-0.3%
UK	24.9%	24.8%	-0.1%

Source: ONS/IDBR

Figure 2.6: Share of turnover of VAT and/or PAYE registered **engineering** enterprises by home nation and English region (2013-2014)



Source: ONS/IDBR

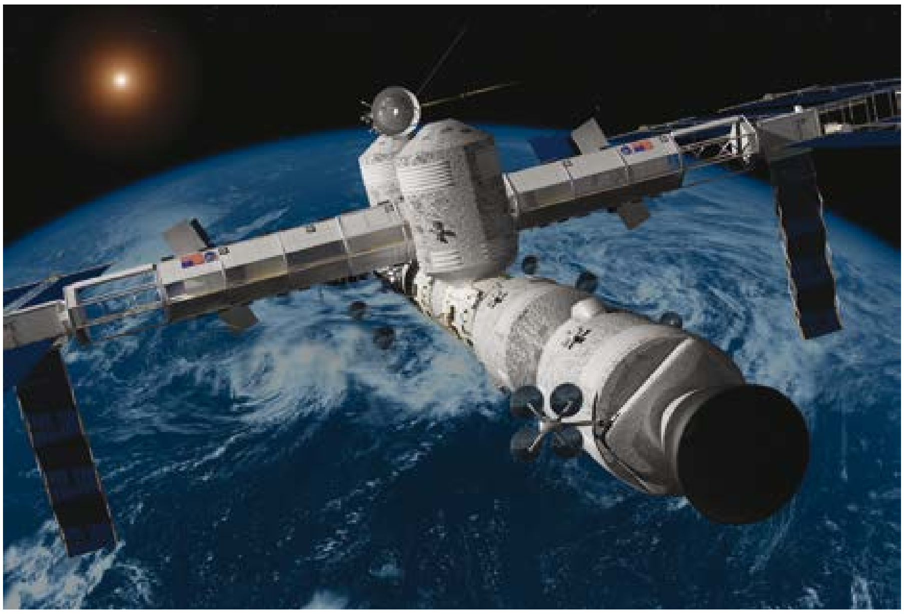


Table 2.12: Turnover in VAT and/or PAYE registered **engineering** enterprises by selected industrial groups (2013-2014) – UK

Home nation/ English region	Year	Overall (millions)	Manufacturing (millions)	Mining and quarrying (millions)	Construction (millions)	Information and communication (millions)	All other industrial groups (millions)
North East	2013	28,790	17,581	619	4,062	1,077	5,450
	2014	30,255	18,713	530	4,148	1,118	5,747
North West	2013	89,851	54,948	311	10,185	6,629	17,779
	2014	100,721	60,770	252	11540	6,461	21,698
Yorkshire and The Humber	2013	62,974	36,124	367	11,663	3,643	11,178
	2014	64,271	37,074	640	10,849	4,028	11,681
East Midlands	2013	62,315	41,157	843	10,764	3,708	5,843
	2014	64,019	42,169	745	11,038	3,851	6,216
West Midlands	2013	93,161	54,248	384	13,661	4,851	20,017
	2014	96,044	56,807	280	13,035	4,919	21,003
East	2013	122,467	63,770	91	20,498	25,004	13,103
	2014	105,773	59,209	90	20,200	11,718	14,557
London	2013	237,333	68,457	60,985	22,275	52,747	32,869
	2014	268,096	73,559	59,677	24,156	77,962	32,741
South East	2013	235,763	94,204	3,164	25,853	60,202	52,339
	2014	241,328	99,156	2,630	27,686	56,806	55,050
South West	2013	70,427	33,163	346	8,891	12,531	15,496
	2014	76,877	34,803	324	9,868	11,474	20,409
England	2013	1,003,080	463,650	67,109	127,853	170,392	174,075
	2014	1,047,384	482,259	65,167	132,519	178,336	189,102
Wales	2013	35,344	25,000	250	4,026	1,781	4,288
	2014	34,143	23,236	281	4,197	1,804	4,625
Scotland	2013	113,503	34,331	19,881	9,032	2,902	47,358
	2014	109,065	25,906	19,182	9,599	3,138	51,240
Northern Ireland	2013	17,819	9,077	146	4,568	1,178	2,850
	2014	18,490	9,906	170	4,047	893	3,474
UK total	2013	1,169,747	532,059	87,386	145,479	176,254	228,569
	2014	1,209,082	541,308	84,801	150,362	184,171	248440
Share of total UK engineering enterprises turnover	2013		45.5%	7.5%	12.4%	15.1%	19.5%
	2014		44.8%	7.0%	12.4%	15.2%	20.5%

Source: ONS/IDBR

Looking at specific engineering sub-groups, Table 2.12 shows that 44.8% of all engineering enterprise turnover came from the manufacturing sector. Mining and quarrying accounted for the smallest proportion of turnover (7.7%). All other industrial groups saw the largest increase in the share of turnover generated, growing by 1.0% from 19.5% to 20.5%.

2.4 Economic contribution of the engineering sector

Engineering is of vital importance to the UK economy through its contribution to Gross Value Added (GVA)[207] and Gross Domestic Product (GDP)[208] and the number of businesses and jobs it supports. Engineering sectors produce the majority of the nation's exports and play an essential role in supporting the UK's international competitiveness by investing in research & development and innovation – a vital part of sustaining the UK's long-term economic performance.

To quantify this economic impact, EngineeringUK commissioned research[209] from Cebr, which found that:

- Engineering sectors[210] are vital to the UK's economy, contributing an estimated £455.6 billion to GDP[211] in 2014: 27.1% of the £1,683 billion total UK GDP.[212]
- By 2022, this contribution is expected to increase to £608.1 billion in GDP[213] (based on EngineeringUK's potential employment projections and growth in output per employee averaging 3% each year).
- By 2022, forecasters predict 257,100 vacancies in engineering companies.[214] If filled, these will produce an estimated £27.0 billion annual GDP.[215] This is more than the entire cost of building Crossrail[216] and equivalent to the cost of building 1,800 secondary schools[217] or 110 new hospitals.[218]
- If filled, the new engineering roles will generate significant output across all of the country's nations and English regions, including £8.3 billion in London and £7.1 billion in the South East (Table 2.13).

207 GVA or gross value added is a measure of the value from production in the national accounts and can be thought of as the value of industrial output less intermediate consumption. That is, the value of what is produced less the value of the intermediate goods and services used as inputs to produce it. GVA is also commonly known as income from production and is distributed in three directions – to employees, to shareholders and to government. GVA is linked as a measurement to GDP – both being a measure of economic output. That relationship is (GVA + Taxes on products – Subsidies on products = GDP). Because taxes and subsidies on individual product categories are only available at the whole economy level (rather than at the sectoral or regional level), GVA tends to be used for measuring things like gross regional domestic product and measures of economic output of entities that are smaller than the whole economy, such as the engineering sectors. **208** Gross domestic product is an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs). **209** The contribution of engineering to the UK economy, Cebr, October 2014 http://www.engineeringuk.com/_resources/documents/Oct%202014%20Cebr%20-%20The%20contribution%20of%20engineering%20to%20the%20UK%20economy.pdf **210** Defined by EngineeringUK's Engineering Footprint – please see Annex for full details **211** Gross domestic product (GDP) is a measure of economic activity which captures the value of goods and services that the UK produces during a given period **212** Cebr projection for 2014 from UK MOD, Cebr's proprietary model of the UK economy **213** The contribution of engineering to the UK economy – the multiplier impacts, Cebr, January 2015, p7 http://www.engineeringuk.com/_resources/documents/Jan%202015%20Cebr%20-%20The%20contribution%20of%20engineering%20to%20the%20UK%20economy%20-%20the%20multiplier%20impacts.pdf **214** See section 15.5.1 for details **215** In 2022 £s **216** Cost to build Crossrail: £14.8 billion – http://www.crossrail.co.uk/about-us/funding **217** £12.67 million per school outside London – Education Funding Agency, Targeted Basic Need Programme, 2014 **218** Based on £193.26 million example cost to build a hospital – Department of Health, Healthcare Premises Cost Guides, 2010

Table 2.13: Expansion demand for new engineering roles and their GDP contribution (2022)

Regions	Expansion demand '000s	2022 GDP forecast £ million
London	59	8,288
South East	67	7,120
East of England	29	2,767
South West	25	2,209
North West	20	1,745
Scotland	18	1,667
East Midlands	14	1,168
West Midlands	7	595
Yorkshire and The Humber	6	533
Wales	5	367
North East	3	268
Northern Ireland	3	255
UK	**257**	**26,983**

Source: Annual Business Survey, UK Commission for Employment and Skills, Business Register and Employment Survey, ONS, Cebr analysis

Another way of looking at the economic impact of the engineering sector is to measure the multiplier impact of engineering on the rest of the economy. Accordingly, EngineeringUK commissioned Cebr to study these multiplier effects.

The Cebr report key findings were:[219]

- For every £1 in GVA generated in engineering sectors, a further £1.45 is generated elsewhere in the UK economy. This creates a GVA multiplier of 2.45 which, once applied (and taking into account indirect and induced multiplier impacts), provides an estimated total GVA of engineering sectors in 2014 of £995.7 billion. This is equivalent to 66% of UK GVA and represents a GDP contribution of approximately £1,116.8 billion.
- Once direct, indirect and induced multiplier impacts of the engineering sectors are accounted for, the industry is estimated to have supported an aggregate 14.5 million full time equivalent (FTE) jobs in 2014: 55% of UK employment. Everyone FTE employed in engineering sectors is estimated to support a further 1.74 FTEs elsewhere in the economy – a multiplier of 2.74.
- This means that every new engineering vacancy filled can be expected to support 1.7 new jobs throughout the UK economy.

Table 2.14: Tax contributions of engineering sectors, £ billions for tax year (2013/14)

Taxation	Engineering sectors
Taxes on income	66.3
VAT	35.0
Corporation tax	16.5
Total	**117.8**

Source: ONS, HMRC, EngineeringUK, Cebr

Closely linked to engineering's effects on GVA and employment is its impact on tax contributions. These come in various forms, including income tax, national insurance contributions, corporation tax and VAT. The estimated tax contributions of engineering sectors for the latest complete tax year (2013/14) are detailed in Table 2.14.[220] The largest tax contribution made by engineering sectors is through taxes on income, estimated at £66.3 billion in 2013/14. This is followed by VAT, at £35.0 billion and corporation tax, estimated at £16.5 billion. The total tax contribution made by engineering sectors, of £117.8 billion, is equivalent to 24% of total HMRC receipts over the same period.

219 The contribution of engineering to the UK economy – the multiplier impacts, Cebr, January 2015 http://www.engineeringuk.com/_resources/documents/Jan%202015%20Cebr%20-%20The%20contribution%20of%20engineering%20to%20the%20UK%20economy%20-%20the%20multiplier%20impacts.pdf 220 These estimates were developed using official data obtained from HMRC (for corporation tax and income tax and national insurance rates), in combination with ONS national accounts data (for VAT) and the annual survey of employment and earnings (for taxes on employment income).

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Part 1 – Engineering in Context
3.0 UK engineering research and innovation

"The shifting and uncertain global economic climate has resulted in the UK having to face greater competition in research and innovation."[221]

Scientific, engineering and technological research and development will play a critical dual role on the global stage. Economically, they will help countries boost their productivity and competitiveness. And ethically, they are vital in addressing the on-going global challenges of climate change and creating a low carbon economy: ensuring access to clean water, providing adequate food supply and preparing for the growing and ageing population.

The UK is well-placed to play its part. We punch above our weight as a research nation. While representing just 0.9% of global population, 3.2% of R&D expenditure, and 4.1% of researchers, we account for 9.5% of downloads, 11.6% of citations and 15.9% of the world's most highly-cited articles (second only to the United States).[222] The UK also has 4 in the top 10 universities in the world and 29 in the top 200,[223] and has produced 85 Nobel prizes.

When it comes to citations (the number of citations of an article being a measure of its quality and the significance of the work),[224] the UK ranks within the top 3 in the G8 or EU 27 across a number of key indicators (Section 3.4).

However, we cannot rest on our laurels. We lag behind our international competitors when it comes to spending on research and development. Businesses, universities and the government together spend around 1.6% of GDP on R&D. This is a long way short of the 2.8% spent in the US and Germany, 2.2% in France, and an agreed European target of 3%.[225]

Investment in R&D does pay. Economic Insight conducted a study into the relationship between public and private investment into science, research and innovation. The study found that at 2012 funding levels (£8.1 billion from the public sector and £19.0 billion from the private sector), a 1% increase in public expenditure on R&D led to between a 0.48% and 0.68% increase in private expenditure on R&D. This is equivalent to a £1 increase in public expenditure leading to a £1.13-£1.60 increase in private expenditure – or a midpoint of £1.36.[226]

Surely this is compelling evidence for viewing R&D as an investment rather than a cost?

Finally, although time will tell, it is reassuring to record that the government has committed £5.9 billion capital spend[227] until 2021 to support UK scientific excellence.

3.1 Importance of research and innovation

The UK's long-standing strength in science and engineering can cement economic recovery and create prosperity for all. Research and innovation in the public and private sectors yield economic and societal benefits. It generates new products for market, including medicines and life-improving technologies. It boosts productivity through more efficient machinery and processes. It creates high-value jobs. And it attracts inward investment to the UK. But these myriad benefits can only be realised with government support through strategic long-term planning and investment.[228]

The government has demonstrated that it understands this through the Science and Innovation Strategy[229] and by putting science at the heart of its long term economic plan.[230] The £5.9 billion capital spend[231] allocated to supporting UK scientific excellence up to 2012 has two key spending strands:

- £3 billion to support individual capital projects and institutional capital to maintain the excellence of laboratories at universities and research institutes

221 Strategic Plan 2015, Engineering and Physical Sciences Research Council, November 2014 **222** Elsevier (2013). 'International Comparative Performance of the UK Research Base – 2013'. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263729/bis-13-1297-international-comparative-performance-of-the-UK-research-base-2013.pdf **223** QS World University Rankings, 2014-15 **224** Insights from international benchmarking of the UK science and innovation system, A report by Tera Allas, BIS Analysis Paper Number 03, Annexes, January 2014, p64 **225** http://www.nesta.org.uk/blog/summer-budget-what-fuelling-northern-powerhouse#sthash.qlGbJseH.dpuf 8 July 2015 **226** What is the relationship between public and private investment in R&D? Economic Insight, April 2014, p6-8 **227** https://www.gov.uk/government/news/government-unveils-6-billion-package-for-uk-science-and-innovation 17 December 2014 **228** CaSE submission to HM Treasury, 5 June 2015 **229** https://www.gov.uk/government/publications/our-plan-for-growth-science-and-innovation **230** https://www.conservatives.com/Manifesto **231** https://www.gov.uk/government/news/government-unveils-6-billion-package-for-uk-science-and-innovation 17 December 2014

- £2.9 billion towards large capital projects to support scientific 'Grand Challenges'

There is general agreement that short-term bursts of economic growth may be achieved through increases in the physical capital stock. However, long-term sustainable growth, particularly in developed economies, rests ultimately on expanding the frontiers of knowledge alongside our physical capabilities.[232]

For these reasons, knowledge-based capital has become a key driver of economic growth in advanced economies and increasingly the largest form of business investment.[233] Indeed, the OECD describes economies that display a trend towards greater dependence on knowledge, information and high-level skills, as knowledge-based economies.[234 235]

The value of innovation for national economic growth, therefore, is well established. However, our understanding of how and why firms engage in such productivity-enhancing activities has also improved.[236] It is unsurprising that firms that persistently invest in R&D have higher productivity (13% higher than those with no R&D spending and 9% more than firms who occasionally invest in R&D), better value added per employee, and more exports.[237 238 239] But what is less well recognised is that while investment in innovation bears inherent risk, firms with higher innovation intensity grow twice as fast as non-innovative firms,[240] fare better during periods of economic turmoil[241] and they are more likely to still be active after eight years.[242]

Science and innovation are part of a unified knowledge system.[243] Britain's public, private and voluntary sector research and technology organisations together employed 57,200 people in 2012/13 and supported £7.6 billion in gross value added contributions to GDP.[244]

Innovation was responsible for half of all UK labour productivity growth between 2000 and 2008, with 32% of that attributable to changes in technology resulting from science and engineering.[245] Productivity growth is also essential to raise wages and living standards.

There is also clear evidence that investment in science and innovation yields high returns. Private rates of return on R&D investment are estimated at 20-30%, with social rates of return two to three times larger.[246 247] However, not all research and innovation activity should be motivated by an economic outcome alone, as a focus on purely economic returns significantly understates the true value to society of investing in science, innovation and skills.[248]

Finally, the CBI has highlighted the huge potential of R&D. It states that by increasing public and private R&D spending and tackling the STEM skills shortage to improve UK business supply chains, we could boost the manufacturing sector by 500,000 jobs and add £30 billion to the UK economy by 2025.[249]

3.2 Government intentions

The UK's ability to capitalise on its cutting-edge science base will be critical to its future prosperity and societal wellbeing. There are big opportunities (such as the burgeoning potential of genomics) but also big challenges (such as antimicrobial resistance). The UK must rise to these challenges by supporting innovation and transforming scientific advances into new products and services. This will create new jobs and innovative businesses, and allow the UK to take the lead in new markets.[250]

The government is therefore continuing to strengthen its partnerships between the public and private sector through the **industrial strategy**[251] and the **eight great technologies**[252 253] – initiatives that continue to support science and innovation, and our growth ambitions.[254] In addition, the government's new framework for raising productivity, captured in the treasury's report *Fixing the foundations: Creating a more prosperous nation,*[255] sensibly makes the link between innovation and productivity explicit. The report highlights that the government's framework for raising productivity is built around two pillars: encouraging long-term investment in economic capital – including infrastructure, skills and knowledge – and promoting a dynamic economy that encourages innovation and helps resources flow to their most productive use. Both of these 'pillars' are themes that run throughout this report.

It should be noted that the coalition government's commitment to science and innovation has been relaunched and rebadged by the new government as One Nation Science. One Nation Science is bold and ambitious, setting a clear goal: for all parts of the UK to be the best place in Europe to innovate, patent new ideas and set up and expand a business.

The previously-mentioned £5.9 billion investment (part of the government's Science and Innovation Strategy) is the major plank of investment and support to 2021, and sets the key principles that will underpin science and innovation policy during the years ahead. The granular details of the Science and Innovation Strategy include:[256]

- £3 billion to support individual capital projects and institutional capital to maintain the excellence of laboratories at universities and research institutes
- £2.9 billion towards large capital projects to support scientific 'Grand Challenges', including a £30 million UK commitment to 'XFEL' – an international free electron laser project – and £20 million to create an 'Inspiring Science Capital Fund' to get the public more engaged in science. Pre-committed projects such as Polar Ship and Square Kilometre Array will also benefit from additional investment
- Up to £235 million for a 'Sir Henry Royce Institute for Advanced Materials' based in Manchester
- £95 million for European Space Agency programmes, including taking the lead in the next European Rover mission to Mars
- £61 million for government-backed High Value Manufacturing Catapult and an additional £28 million for a new National Formulation Centre within the Catapult to drive innovation and develop the next generation of technology products

232 Our Plan for Growth: Science and Innovation Evidence Paper, Department for Business, Innovation and Skills, December 2014, p3 **233** Goodridge, Haskel and Wallis (2014). 'UK investment in intangible assets'. Available at: http://www.nesta.org.uk/sites/default/files/1402_working_paper_-_uk_investment_in_intangible_assets_report_for_nesta.pdf **234** Organisation for Economic Cooperation and Development (2005). 'The Measurement of Scientific and Technological Activities: Guidelines for Collecting and Interpreting Innovation Data: Oslo Manual, Third Edition'. Prepared by the Working Party of National Experts on Scientific and Technology Indicators. OECD, Paris, para. 71. **235** Organisation for Economic Cooperation and Development (2013). 'Supporting Investment in Knowledge Capital, Growth and Innovation'. OECD Publishing. Available at: http://dx.doi.org/10.1787/9789264193307-en **236** Our Plan for Growth: Science and Innovation Evidence Paper, Department for Business, Innovation and Skills, December 2014, p17 **237** Cefis, E., Ciccarelli, M., 'Profit differentials and innovation', Economics of innovation and new technologies 14, Routledge, 2005 **238** Cefis, E., Orsenigo, L., 'The persistence of innovative activities: A cross-countries and cross-sectors comparative analysis', Research Policy, 2001 **239** Lööf et al, 'R&D Strategy and Firm Performance: What is the Long-Run Impact of Persistent R&D?' in Innovation & Growth. From R&D Strategies of Innovating Firms to Economy-Wide Technological Change. Oxford University Press, 2012 **240** The vital 6 per cent how high-growth innovative businesses generate prosperity and jobs, Nesta, 2009. Available at: http://www.nesta.org.uk/sites/default/files/vital-six-per-cent.pdf **241** Birkbeck (2014). Innovation, skills and performance in the downturn. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287901/bis-14-652-innovation-skills-and-performance-in-the-downturn.pdf **242** Enterprise Research Centre (2014). 'Innovation, Innovation Strategy and Survival'. Research Paper No 17. Available at: http://enterpriseresearch.ac.uk/publications/innovation-innovation-strategy-survival/ **243** Our Plan for Growth: Science and Innovation Evidence Paper, Department for Business, Innovation and Skills, December 2014, p19 **244** Oxford Economics (2014). 'The impact of the innovation, research and technology sector on the UK economy'. Available at: http://www.airto.co.uk/docs/AIRTO%20-%20Oxford%20Economics%202014.pdf **245** Department for Business, Innovation and Skills, Estimating the effect of UK direct public support for innovation, 2014 **246** Frontier Economics (2014). 'Rates of return to investment in science and innovation'. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/333006/bis-14-990-rates-of-return-to-investment-in-science-and-innovation-revised-final-report.pdf **247** Wellcome (2008). Medical Research: What's it worth? Estimating the economic benefits from medical research in the UK. Available at: http://www.wellcome.ac.uk/stellent/groups/corporatesite/@sitestudioobjects/documents/web_document/wtx052110.pdf **248** Griffith, R., Redding, S. & Van Reenan, J, R&D and Absorptive Capacity: Theory and Empirical Evidence. Scandinavian Journal of Economics, 105, 99-118, 2003 **249** Confederation of British Industry, Pulling together, 2014 **250** Our plan for growth: science and innovation, Department for Business, Innovation and Skills, December 2014, p3 **251** https://www.gov.uk/government/collections/industrial-strategy-government-and-industry-in-partnership **252** https://www.gov.uk/government/speeches/eight-great-technologies **253** https://www.gov.uk/government/publications/eight-great-technologies-infographics **254** *Ibid*, p3 **255** https://www.gov.uk/government/publications/fixing-the-foundations-creating-a-more-prosperous-nation **256** https://www.gov.uk/government/news/government-unveils-6-billion-package-for-uk-science-and-innovation

- A new offer of up to £10,000 of income-contingent loans for postgraduate taught masters degrees

This commitment to the UK science and innovation infrastructure is welcome. However, we should never forget that our science and innovation can only be as good as the people that it can attract, educate, train and retain.

Accordingly, the Science and Innovation Strategy sets out a range of measures that will develop and support the brightest minds through the pipeline from primary and secondary school, further and vocational education, undergraduate and postgraduate study, and training into the workplace.[257]

The range of measures aimed at nurturing future generation of scientific talent are:

Schools

Taking action to increase the quantity and quality of STEM teachers through £67 million of new programmes. This will train up to 17,500 maths and physics teachers over the next parliament, on top of existing plans: adding to the skills of up to 15,000 existing non-specialist teachers and recruiting up to 2,500 additional specialist maths and physics teachers.

Vocational education

Delivering more Higher Apprenticeships at the levels and in the sectors where employers believe the need is greatest. At the same time, ensuring that the right provision is in place to deliver the training that these apprentices and other students will need by establishing National Colleges in key STEM sectors such as digital skills, wind energy and advanced manufacturing.

Higher education

Supporting those who wish to attain a postgraduate qualification by introducing a new offer of income-contingent loans for those aged under 30 wishing to undertake a postgraduate taught masters in any subject. These loans, of up to £10,000, will be available from 2016 to 2017 and will be repaid concurrently with undergraduate loans. In addition, funding will be provided to HEFCE to work with the engineering profession to develop and pilot engineering conversion courses for non-engineering graduates.

Workplace

A dedicated platform will be developed to help female STEM graduates return to jobs in industry following career breaks, and to provide them with advice and information about the support on offer.

3.2.1 Government interventions

Catapults[258] are a conspicuous and established vehicle for driving innovation: not-for-profit, independent, physical centres that connect businesses with the UK's research and academic communities.

The original concept of Catapults was based upon the work of entrepreneur Hermann Hauser, who produced an influential report, *The Current and Future Role of Technology & Innovation Centres in the UK*.[259] This report identified best practice from around the world and made a robust case for long-term UK investment in a network of technology and innovation centres which would, "deliver a step change in the UK's ability to commercialise its research."

Each Catapult centre specialises in a different area of technology, but all offer a space with the facilities and expertise to enable businesses and researchers to collaboratively solve key problems and develop new products and services on a commercial scale.

Three years since the first Catapult (High Value Manufacturing) was opened in October 2011, the government commissioned Dr Hauser to review the future shape and ambition of the programme.[260] Two of his nine recommendations are worthy of note:

- Innovate UK should grow the network of Catapults through a clear and transparent process, based on the current criteria, at no more than 1-2 centres per year, with a view to having 30 Catapults by 2030 with total core funding for the network of £400 million per annum.
- Each Catapult should work with Innovate UK to develop more effective SME engagement strategies. Approaches should include working with local authorities and business groups to reach potential high growth SMEs and important clusters of activity in regions across the UK.

There are currently 10 Catapults up and running in the UK (Table 3.1), with total public and private investment exceeding £1.4 billion over their first five years of operation. Additional capital facilities are being delivered over the next two to three years in response to strategic investment by the government.

A new national agency, Innovate UK, is taking over the role of accelerating economic growth by stimulating and supporting business-led innovation from the Technology Strategy Board. Innovate UK has devised a simple schematic (Figure 3.1) to show how the two key government innovation strands – the industrial strategy and the eight great technologies – overlap with each other and with Innovate's priority investment areas.[261]

Table 3.1: UK Catapults

Cell therapy	based at Guy's Hospital, London
Digital	based in King's Cross, London
Energy systems	based in Birmingham business park
Future cities	based in Borough, London
High value manufacturing (a network of seven centres)	Advanced Forming Research Centre based in University of Strathclyde
	Advanced Manufacturing Research Centre based in The University of Sheffield
	The Centre for Process Innovation based in Wilton
	Manufacturing Technology Centre based in Coventry
	National Composites Centre based in Bristol
	Nuclear AMRC based in University of Sheffield
	WMG Centre based in University of Warwick
Offshore renewable energy	Wind, wave and tidal power – based in Glasgow
Precision medicine	based in Cambridge with regional centres of excellence in Belfast, Cardiff, Glasgow, Leeds Manchester and Oxford
Satellite applications	based at Harwell Science and Innovation Campus
Transport systems	based in Milton Keynes
Medicines technologies	based in Alderley Park, Cheshire

Source: Innovate UK

257 Our plan for growth: science and innovation, Department for Business, Innovation and Skills, December 2014, p6 258 https://www.catapult.org.uk/# 259 http://webarchive.nationalarchives.gov.uk/20121212135622/http:/www.bis.gov.uk/assets/biscore/innovation/docs/10-843-role-of-technology-innovation-centres-hauser-review 260 Review of the Catapult network, Recommendations on the future shape, scope and ambition of the programme, Dr Hermann Hauser, November 2014, p6 261 Mapping Local Comparative Advantages in Innovation, Framework and indicators, Department for Business, Innovation and Skills, July 2015, p59

Figure 3.1: Innovate UK's priority investment areas versus the eight great technologies and industrial strategy sectors

Innovate UK's priority areas	Eight great technologies	Industrial strategy sectors
Advanced materials	Advanced materials	
Agriculture & food	Agri-science	Agricultural technologies
Biosciences	Synthetic biology	
Built environment		Construction
Digital economy	Big Data	Information economy, International education (education exports), professional and business services
Electronics, sensors and photonics	Robotics and autonomous systems	
Emerging technologies		
Energy	Energy storage	Nuclear, offshore wind, oil and gas
Health and care	Regenerative medicine	Life sciences
Information and communications technology		
Resource efficiency		
Space	Satellites	
Transport		Automotive, aerospace

Source: Technology Strategy Board (2014)

3.2.2 Government spend on science, engineering and technology

The UK government spending on science, engineering and technology by department over the past 11 years (2002-2013) is presented in Table 3.2.[262] The key trends show that:

- In 2013, £10.9 billion was spent on science, engineering and technology (SET) by the UK government, an increase of 9% in current prices compared with 2012. Allowing for inflation (in constant prices), this was a 7% increase compared with 2012, and reversed the downward trend in SET expenditure since 2009.
- The UK Research Councils contributed the most to expenditure on SET in 2013, at £3.6 billion – 33% of all expenditure on SET.
- Between 2002 and 2013, defence expenditure on SET decreased by £2.1 billion in constant prices to £1.5 billion. Over the same period there was an increase in Research Councils' expenditure on SET of £1.0 billion.
- The 2013 SET estimate of £10.9 billion consists of expenditure on research and development (R&D) of £9.8 billion, indicative UK contributions to EU R&D expenditure of £0.8 billion, and a further £0.3 billion on knowledge transfer.

Table 3.2: UK Government net expenditure on science, engineering and technology (SET) by department: (2002-2013)

Current prices												**£ million**
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Research Councils												
Total	**1,947**	**2,259**	**2,408**	**2,871**	**3,014**	**2,742**	**3,024**	**3,196**	**3,280**	**3,286**	**3,201**	**3,550**
Higher Education Funding Councils (HEFCs):												
Total	**1,626**	**1,665**	**1,804**	**1,928**	**2,085**	**2,252**	**2,247**	**2,403**	**2,328[r]**	**2,285[r]**	**2,212**	**2,328**
Civil Departments												
Total	**2,043**	**2,140**	**1,866**	**1,965**	**1,918**	**1,896**	**2,073**	**2,236**	**2,261[r]**	**2,352[r]**	**2,392**	**2,748**
Ministry of Defence (MoD) of which:												
Research	516	524	639	598	632	635	584	575	532	553	565	586
Development	2,218	1,609	1,552	1,645	1,492	1,505	1,406	117	1,159	953	895	931
Total	**2,734**	**2,133**	**2,191**	**2,243**	**2,124**	**2,139**	**1,991**	**1,752**	**1,693**	**1,306**	**1,460**	**1,516**
Total Set	**8,351**	**8,196**	**8,270**	**9,008**	**9,141**	**2,029**	**9,334**	**9,586**	**9,461[r]**	**9,228[r]**	**9,226**	**10,142**
Indicative UK contributions to EU R&D expenditure	440	390	325	365	374	374	593	668	647	661[r]	718	756
GRAND TOTAL	**8,791**	**8,586**	**8,595**	**9,373**	**9,515**	**9,403**	**9,927**	**10,256**	**10,108[r]**	**9,889[r]**	**9,984**	**10,898**

Source: Office for National Statistics
r = revised data

262 Mapping Local Comparative Advantages in Innovation, Framework and indicators, Department for Business, Innovation and Skills, July 2015, p59

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3.3 Role of LEPs in driving innovation

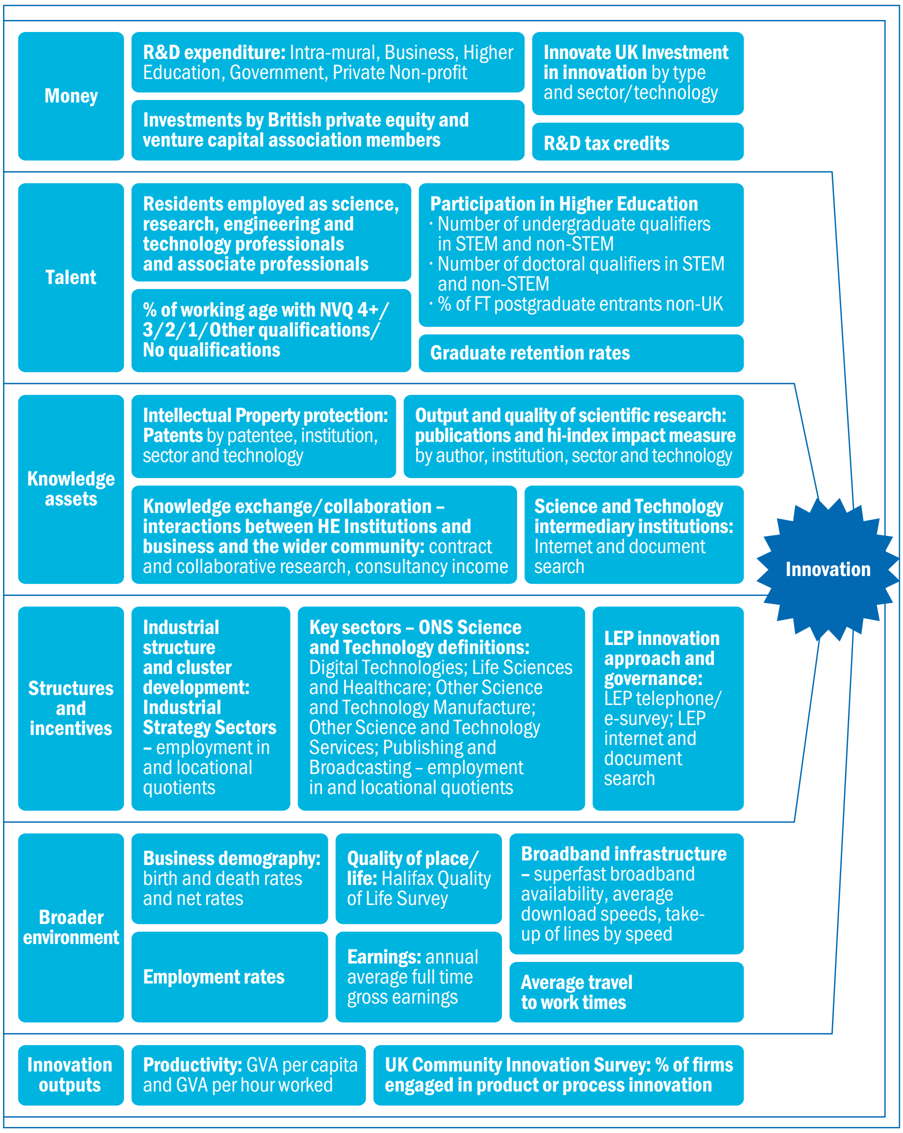
Last year we rightly allocated Local Enterprise Partnerships (LEPs) a sub-section in their own right. This was because they were becoming key players in steering support for innovation at the local level (as well as focusing on education and skills for those Not in Education, Employment or Training).[263]

Since then, BIS has been working with LEPs to improve the effectiveness of local innovation systems through growth hubs and local strategies. LEPs have been the subject of recommendations in the Witty Review,[264] which called for them to build closer relationships with universities, to drive growth by focusing on the competitive strengths of our local economies. Now, the focus has moved to providing support to LEPs to play to their strengths and to access appropriate funding streams.

In its report *Mapping Local Comparative Advantages in Innovation, Framework and indicators*, BIS has provided a consistent and comprehensive body of evidence of comparative innovation strengths in the 39 LEP areas. It is hoped this will help LEPs and their partners to marshal their innovation assets to best effect, using European Structural Funds and other funding streams. Their intention is that this data will enable individual LEPs to identify where there is scope for joint working with other LEPs, BIS, other government departments and national agencies. The evidence should also help the LEPs and their partners to play to their respective innovation strengths, situate them in a wider regional and national context and maximise comparative advantage. That should in turn lead to less duplication and unproductive competition between institutions and regions.[265]

In summary, this comprehensive innovation-related data was broken down into 23 headline indicators[266] which, in turn, were allocated across an established six-part framework developed by Allas.[267] There is, however, much more information to be had: the full report and appendices (which run to nearly 500 pages), can be accessed online.[268]

Figure 3.2 Innovation framework: elements and headline indicators



Source: BIS

For the purpose of this sub-section, the 'essence' of their analysis is best displayed graphically. Figure 3.1 depicts the elements and indicators of the innovation framework, and shows that underneath each of these key headline innovation indicators, there lies detailed comparative individual LEP data.

263 Innovation Report 2014, Innovation, Research and Growth, Department for Business Innovation and Skills, March 2014, p14 **264** Witty Review, Encouraging a British invention revolution: Sir Andrew Witty's review of universities and growth, 2013. Accessible at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249720/bis-13-1241-encouraging-a-britishinvention-revolution-andrew-witty-review-R1.pdf **265** Mapping Local Comparative Advantages in Innovation, Framework and indicators, Department for Business, Innovation and Skills, July 2015, p6 **266** Mapping Local Comparative Advantages in Innovation, Framework and indicators, Department for Business, Innovation and Skills, July 2015, p7 **267** Insights from international benchmarking of the UK science and innovation system, BIS Analysis Paper Number 03, January 2014 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277090/bis-14-544-insights-from-international-benchmarking-of-the-UK-science-and-innovation-system-bis-analysis-paper-03.pdf **268** https://www.gov.uk/government/publications/local-enterprise-partnerships-evidence-on-local-innovation-strengths

3.4 UK Research Excellence Framework (REF)

Finally, after several years of referencing the inception, then the introduction of the Research Excellent Framework (REF), we are able to present the first findings.

The REF 2014[269 270] was carried out by the four UK higher education funding bodies. They have used the results to distribute research funding to universities from 2015/16 onwards[271] on the basis of quality.

3.4.1 REF process and key facts

154 UK institutions made submissions in 36 subject-based units of assessment (UOAs). The submissions were assessed by panels of experts, who produced an overall quality profile for each submission (Figure 3.3). Each overall quality profile shows the proportion of research activity judged by the panels to have met each of the four starred quality levels defined below, in steps of 1%.

The overall quality profile awarded to each submission is derived from a sub-profile for each of three elements of the assessment, which are weighted as follows:

1. The quality of research outputs: this counts for 65% of the assessment.
2. The impact of research beyond academia: this counts for 20% of the assessment. Impact is a new feature in the REF 2014.
3. The research environment: this counts for 15% of the overall results.

Overall, 154 higher education institutions took part in the REF[272] and made 1,911 submissions, including:

- 52,061 FTE academic staff
- 191,150 research outputs
- 6,975 impact case studies

Submissions were reviewed by 36 expert sub-panels and overseen by four main panels, comprising 898 academic members and 259 research users. (Full details of the 4 Main Panels and the 36 sub-panels are on the REF 2014 web-site.)[273] Overall quality was judged, on average across all submissions, to be:

- 30% world-leading (4*)
- 46% internationally excellent (3*)
- 20% internationally recognised (2*)
- 3% nationally recognised (1*)

Figure 3.3: REF quality ratings

4*	Quality that is world-leading in terms of originality, significance and rigour
3*	Quality that is internationally excellent in terms of originality and rigour but which falls short of the highest standards of excellence
2*	Quality that is recognised internationally in terms of originality, significance and rigour
1*	Quality that is recognised nationally in terms of originality, significance and rigour
Unclassified	Quality that falls below the standard of nationally recognised work. Or work which does not meet the published definition of research for the purposes of this assessment

Source: REF

3.4.2 Overall quality profiles for Main Panel B

Table 3.3 shows the overall results of the assessment for Panel B – which includes the five Units of Assessment (UoA) related to engineering research. The table shows the average overall quality profile for each UoA, and for the main panel as a whole.[274] The average is calculated by weighting each submission in the UoA (or main panel) by the number of Category A staff FTE in each submission.

Table 3.3: Overall quality profiles (category A FTE-weighted averages)

U04	Name	Average percentage of research activity judged to meet the standard for:				
		4*	3*	2*	1*	U
	Main Panel B	**26**	**57**	**15**	**2**	**0**
7	Earth systems and environmental science	24	59	15	2	0
8	Chemistry	28	63	9	0	0
9	Physics	28	60	11	1	0
10	Mathematical sciences	29	55	15	1	0
11	Computer science and informatics	26	44	24	5	1
12	Aeronautical, mechanical, chemical and manufacturing engineering	25	57	17	1	0
13	Electrical and electronic engineering, metallurgy and materials	25	62	11	2	0
14	Civil and construction engineering	24	56	16	3	1
15	General engineering	26	56	16	2	0

Source: REF

269 http://www.ref.ac.uk/results/intro/ **270** The 2014 Research Excellence Framework (REF) is a peer assessment of the quality of UK universities' research in all disciplines. It replaces the Research Assessment Exercise (RAE), last conducted in 2008. **271** http://www.hefce.ac.uk/pubs/year/2015/201505/ **272** Research Excellence Framework 2014: The results, REF 01.2014, December 2014, **273** http://www.ref.ac.uk/panels/ Submissions to the REF were made in 36 units of assessment. An expert sub-panel for each unit of assessment assessed each submission, working under the leadership and guidance of four main panels. **274** Research Excellence Framework 2014: Overview report by Main Panel B and Sub-panels 7 to 15, January 2015, p4

Following this, Technopolis examined the engineering UoA within the REF2014 in detail in its report. Technopolis found that **70% of all research outputs submitted by the UoAs relating to engineering research were classified as 'world leading' (4*) or 'internationally excellent' (3*)**. This represents an increase of 9 percentage points on RAE2008. Moreover, the overall quality profile classified as 'world leading' or 'internationally excellent' increased from 55% (RAE2008) to 68%.[275]

The five UoAs relating to engineering research are:

- Civil and construction engineering
- Computer science and informatics
- Electrical and electronic engineering, metallurgy and materials
- General engineering
- Aeronautical, mechanical, chemical and manufacturing engineering

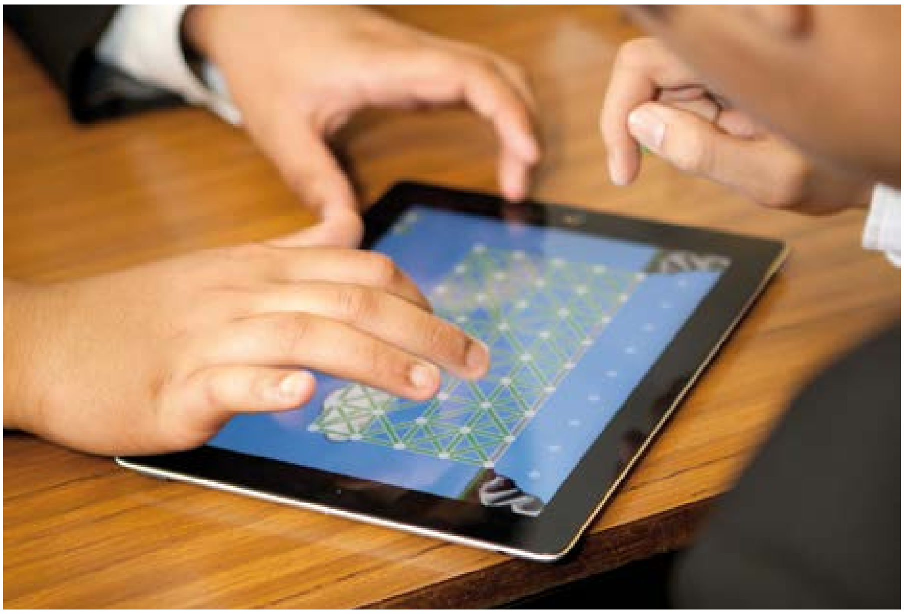
3.5 International citations – UK and comparator countries

Published biennially, the most recent International Comparative Performance of the UK Research Base report[276] is the same as that reported last year. Nevertheless, it shows that despite the UK having far fewer researchers than larger countries such as the US and China, it is far more efficient in terms of output per researcher.

To demonstrate this assertion, we have abstracted four key findings that relate to citations. (We have used this measure because it is widely accepted that *the number of citations of an article is a measure of its quality and the significance of the work.*)[277]

The four international comparators show that:

- In world share of citations, the UK ranks third in the G8 and is first in the EU 27[278]
- In world share of citations for UK **engineering**, the UK ranks third in the G8 and second in EU 27[279]
- In the number of citations per billion dollars GDP, the UK ranks first in the G8, showing excellent value for money[280]



- In the number of citations (academic sector) per million dollars spent in Higher Education Research and Development (HERD), the UK again shows excellent value for money, ranking first in the G8[281]

In particular, Universities UK endorses the importance of the number of citations (academic sector) per million dollars spent in HERD, in its report on the economic role of universities.[282]

The report asserts that universities play an important part in supporting businesses to drive product, process and service innovation, highlighting that this innovation is a key driver of UK growth and plays a critical role in increasing private sector productivity.[283]

The reports summarises how innovation is enabled and supported by universities:

- Through a range of knowledge exchange activities with businesses, such as long-term collaborative research programmes, consultancy and bespoke training. This has been shown to significantly improve business investment in R&D, business performance on process and product innovation, the sale of novel products and the use of technical information.[284]
- By commercialising innovative ideas. This includes taking a proactive role in the commercialisation of universities' research through investment in academic and graduate spinoffs, and backing ventures that can add value and complementary expertise to their internal R&D facilities.
- Through helping to facilitate innovation indirectly, by providing space for innovative firms to interact closely and assisting the development of networks.
- By promoting entrepreneurial talent through education and entrepreneurship support services. This helps graduates and local residents gain the confidence, skills and tools needed to start their own business.

275 Assessing the economic returns of engineering research and postgraduate training in the UK, Final report, technopolis |group|, March 2015, p14 **276** International Comparative Performance of the UK Research Base – 2013 **277** Insights from international benchmarking of the UK science and innovation system, A report by Tera Allas, BIS Analysis Paper Number 03, Annexes, January 2014, p64 **278** International Comparative Performance of the UK Research Base – 2013, A report prepared by Elsevier for the UK's Department for Business, Innovation and Skills (BIS), November 2013,Appendix F – supplementary data, p55 **279** *ibid*, p62 **280** *ibid*, p105 **281** *ibid*, p109 **282** The Economic Role of UK Universities, UniversitiesUK, June 2013, p3 **283** *Ibid*, p3 **284** Department for Business, Innovation and Skills (2014) Estimating the effect of UK direct public support for Innovation https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/369650/bis-14-1168-estimating-the-effect-of-uk-direct-public-support-for-innovation-bis-analysis-paper-number-04.pdf

Part 1 – Engineering in Context
4.0 Demographics

We strongly believe that interventions such as employer engagement activities can help us to produce more engineers and meet projected demand. However, natural variations in population will have a strong bearing on strategies designed to bolster the supply of workers in any field. For example, the number of 18-year-olds in the UK will fall by 8.7% from 802,033 in 2012 to 732,166 in 2022, substantially reducing the size of the cohort joining the workforce or entering higher education.

This chapter presents background figures and trends relating to population change, education, workforce and economy. There will be significant population changes among the supply pool for higher education and the workforce, with the number of 21-year-olds experiencing a 14.0% drop from 875,604 in 2012 to 753,024 in 2022. In relation to GCSEs and their equivalents, the number of 16-year-olds has already fallen from 769,344 in 2012 to 744,771 in 2015. It will reach a low of 687,616 in 2018 before recovering to 765,921 in 2022.

There are 3,794,451 pupils in 4,158 state-maintained secondary schools in the UK – an average of 913 pupils per school. Of those in England, the percentage eligible for free school meals (FSM) ranges from a low of 9.2% in the South East to a high of 19.6% in London, against a national average of 13.9%. Wales (15.8%), Scotland (15%) and Northern Ireland (26.1%) all have higher proportions of secondary school pupils eligible for FSM than England.

There are 382 further education colleges in the UK, educating 3,100,000 people every year. There were also 2,299,355 students attending 163 higher education institutions in the UK in 2013/14: an average of 14,106 students per institution. The percentage of English 18- to 19-year-olds participating in higher education increased by around a fifth (19.1%) between 2002/03 (32.0%) and 2011/12 (38.1%). Of the UK nations, only Wales (34.3%) had a lower participation rate than England (38.1%), while Scotland (45.1%) and Northern Ireland (39.8%) were both significantly higher.

In 2014, there were 5,375,793 employees in engineering enterprises, of whom two thirds (3,631,636) worked as an engineer or technician.[285] That leaves 1,744,157 other employees in engineering enterprises (such as administrative, business and financial workers). There were 4,973,160 engineers and technicians in the total workforce, of which a quarter (1,341,524) were working in the wider economy.

In 2014, engineering sectors contributed some £456 billion to the UK GDP – 27.1% of the UK total (Table 4.18). Of the UK nations, Northern Ireland had the smallest engineering sector as a proportion of national GDP, contributing around £8 billion – 22.1% of the national total. The engineering sectors of Wales (£17 billion or 28.4%) and Scotland (£51 billion or 38.7%) both contributed a greater percentage of GDP to their nations' totals than England.

The UK demand for new engineering roles (both newly created and replacement for those moving on or retiring) will be 2,561,000 by 2022.

4.1 Population trends[286]

The size of the population is one of the most important factors affecting the pipeline of students who can study for STEM qualifications and, ultimately, enter the workforce with engineering skills. Any strategic targets for STEM engagements, education provision, qualification attainment and business expansion must take into account the simple fact that the population and key age cohorts undergo significant changes from year-to-year.

Table 4.1 shows that population variations are due to have a significant effect on the numbers of people at key points in education and work. The cohort of 14-year-olds is set for a sudden drop, from 748,443 in 2012 to 694,006 in 2017 (-7.3%), before surging to 804,565 in 2022 – an increase of 15.9% in just five years (2017-2022).

285 Defined by EngineeringUK using the Office for National Statistics' system of Standard Industrial Classification (SIC) and Standard Occupational Classification (SOC) codes **286** The following national and regional population projections are based on the Office for National Statistics' principal projection rather than the balanced long term migration projection used in Engineering UK 2015: The state of engineering

The number of 16-year-olds will fall by 8.4% from 769,344 in 2012 to just 705,094 in 2017, before recovering to 765,921 five years later (an 8.6% rise between 2017 and 2022) and increasing dramatically from there. The number of 18-year-olds will drop from 802,033 in 2012 to 755,732 in 2017 and 732,166 in 2022, an 8.7% fall in just 10 years. However, this will be followed by the same upward trend seen with other ages. This means that the pool of young people available to progress into higher or vocational education will be reduced in the short-to-medium term.

The numbers of both 21- and 65-year-olds will reduce massively over the short-to-medium term, with the number of 21-year-olds experiencing a drop of 14.0% from 875,604 in 2012 to 753,024 in 2022. These fluctuations are all within the context of a population that will actually be increasing steadily by one to two million every five years. Starting from 63,705,030 in 2012, it will rise by 6.7% to 67,968,970 in 2022, and then to 73,272,290 in 2037 – a 15% increase over 25 years.

Table 4.1: National population projections by ages 7-21 and 65 (2012-2037) – UK

Age	2012	2017	2022	2027	2032	2037	10-year percentage change (2012-2022)	25-year percentage change (2012-2037)
					Overall			
7	722,490	799,734	817,915	823,846	815,099	805,758	13.2%	11.5%
8	709,598	792,373	815,944	825,445	818,335	807,973	15.0%	13.9%
9	688,954	799,672	808,914	826,125	821,415	810,700	17.4%	17.7%
10	677,889	773,308	828,549	825,854	824,172	813,713	22.2%	20.0%
11	696,455	757,392	818,955	824,667	826,627	816,883	17.6%	17.3%
12	715,291	727,693	804,797	822,845	828,793	820,061	12.5%	14.6%
13	738,287	714,724	797,346	820,795	830,315	823,219	8.0%	11.5%
14	748,443	694,006	804,565	813,708	830,935	826,243	7.5%	10.4%
15	769,826	684,055	779,334	834,479	831,813	830,151	1.2%	7.8%
16	769,344	705,094	765,921	827,385	833,130	835,110	-0.4%	8.5%
17	771,320	727,057	739,406	816,410	834,492	840,464	-4.1%	9.0%
18	802,033	755,732	732,166	814,699	838,183	847,731	-8.7%	5.7%
19	814,027	776,520	722,044	832,500	841,693	858,951	-11.3%	5.5%
20	848,818	808,901	722,953	818,144	873,311	870,699	-14.8%	2.6%
21	875,604	817,661	753,024	813,818	875,297	881,102	-14.0%	0.6%
65	839,956	669,509	728,286	840,328	874,159	828,117	-13.3%	-1.4%
All ages	63,705,030	65,824,545	67,968,970	69,954,634	71,712,619	73,272,290	6.7%	15.0%
					Male			
7	369,723	408,988	419,077	422,127	417,659	412,886	13.3%	11.7%
8	363,362	405,173	418,028	422,911	419,283	413,987	15.0%	13.9%
9	353,097	409,284	414,393	423,223	420,824	415,347	17.4%	17.6%
10	347,227	396,152	424,715	423,112	422,262	416,918	22.3%	20.1%
11	355,751	387,375	419,599	422,600	423,615	418,638	17.9%	17.7%
12	366,799	372,531	411,728	421,750	424,810	420,349	12.2%	14.6%
13	378,172	366,253	407,995	420,788	425,683	422,062	7.9%	11.6%
14	383,373	356,110	412,220	417,281	426,120	423,731	7.5%	10.5%
15	394,408	350,943	399,800	428,318	426,732	425,892	1.4%	8.0%
16	396,751	360,836	392,408	424,586	427,605	428,631	-1.1%	8.0%
17	396,141	373,570	379,279	418,430	428,470	431,544	-4.3%	8.9%
18	411,313	387,706	375,790	417,489	430,303	435,214	-8.6%	5.8%
19	414,613	397,774	370,469	426,530	431,623	440,480	-10.6%	6.2%
20	428,410	413,934	370,305	419,119	447,649	446,100	-13.6%	4.1%
21	446,484	420,776	384,538	416,099	448,288	451,346	-13.9%	1.1%
65	410,882	326,030	354,997	409,668	426,190	402,990	-13.6%	-1.9%
All ages	31,315,072	32,482,184	33,638,837	34,698,845	35,634,611	36,469,940	7.4%	16.5%

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Table 4.1: National population projections by ages 7-21 and 65 (2012-2037) – UK – continued

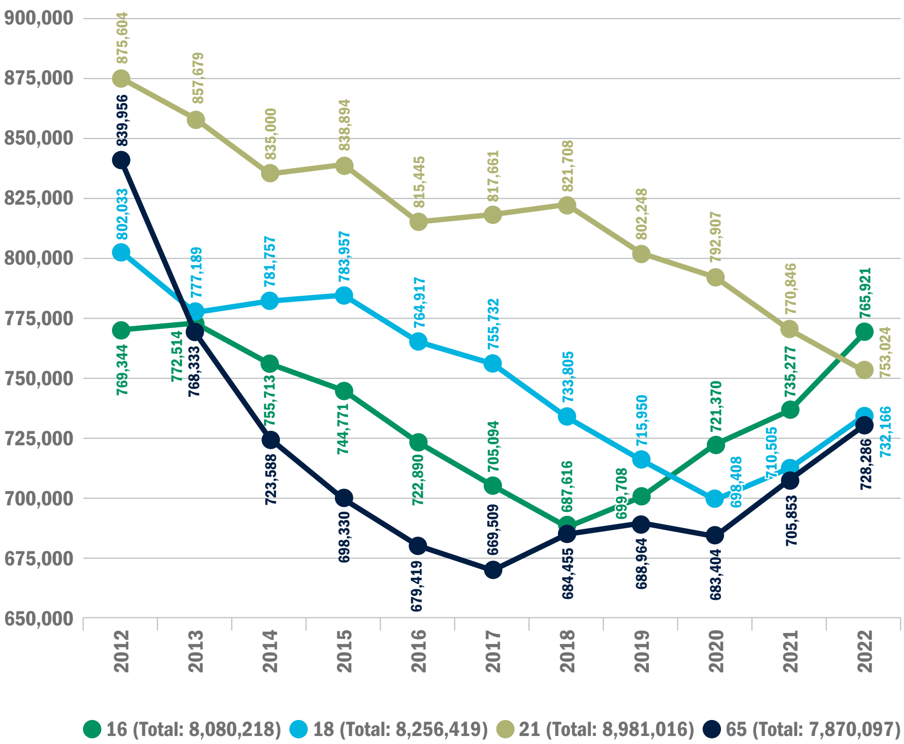
Age	2012	2017	2022	2027	2032	2037	10-year percentage change (2012-2022)	25-year percentage change (2012-2037)
	Female							
7	352,767	390,746	398,838	401,719	397,440	392,872	13.1%	11.4%
8	346,236	387,200	397,916	402,534	399,052	393,986	14.9%	13.8%
9	335,857	390,388	394,521	402,902	400,591	395,353	17.5%	17.7%
10	330,662	377,156	403,834	402,742	401,910	396,795	22.1%	20.0%
11	340,704	370,017	399,356	402,067	403,012	398,245	17.2%	16.9%
12	348,492	355,162	393,069	401,095	403,983	399,712	12.8%	14.7%
13	360,115	348,471	389,351	400,007	404,632	401,157	8.1%	11.4%
14	365,070	337,896	392,345	396,427	404,815	402,512	7.5%	10.3%
15	375,418	333,112	379,534	406,161	405,081	404,259	1.1%	7.7%
16	372,593	344,258	373,513	402,799	405,525	406,479	0.2%	9.1%
17	375,179	353,487	360,127	397,980	406,022	408,920	-4.0%	9.0%
18	390,720	368,026	356,376	397,210	407,880	412,517	-8.8%	5.6%
19	399,414	378,746	351,575	405,970	410,070	418,471	-12.0%	4.8%
20	420,408	3 94,967	352,648	399,025	425,662	424,599	-16.1%	1.0%
21	429,120	396,885	368,486	397,719	427,009	429,756	-14.1%	0.1%
65	429,074	343,479	373,289	430,660	447,969	425,127	-13.0%	-0.9%
All ages	32,389,958	33,342,361	34,330,133	35,255,789	36,078,008	36,802,350	6.0%	13.6%

Source: Office for National Statistics[287]

Figure 4.1 illustrates the significant fluctuations in the numbers of people aged 16, 18, 21 and 65 over the next 10 years.

A key point is that the number of 16-year-olds has already fallen from 769,344 in 2012 to 744,771 in 2015, and will reach a low of 687,616 in 2018 before recovering to 765,921 in 2022. These fluctuations will have a large impact on the number of potential pupils with STEM GCSEs, A levels and degrees.

Figure 4.1: National population projections by ages 16, 18, 21 and 65 (2012-2022) – UK



Source: Office for National Statistics[288 289 290]

287 National Population Projections, 2012-based projections, Office for National Statistics, November 2013, Table A3-1, Principal Projection – UK Population Single Year of Age, 2012-based; http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2012-based-projections/rft-table-a3-1-principal-projection---uk-population-single-year-of-age.xls 288 2012 and 2015-2022 source: National Population Projections, 2012-based projections, Office for National Statistics, November 2013, Table A3-1, Principal Projection – UK Population Single Year of Age, 2012-based; http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2012-based-projections/rft-table-a3-1-principal-projection---uk-population-single-year-of-age.xls 289 2013 source: Population Estimates by Age and Sex: Revised Population Estimates for UK, England and Wales, Scotland and Northern Ireland, Mid-2013, Office for National Statistics, June 2015, Workbook: MYE2_population_by_sex_and_age_for_local_authorities_UK.xls; http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/mid-2014/rft---mid-2013-uk-population-estimates.zip 290 2014 source: Population Estimates by Age and Sex: Population Estimates for UK, England and Wales, Scotland and Northern Ireland, Mid-2014, Office for National Statistics, June 2015, Workbook: MYE2_population_by_sex_and_age_for_local_authorities_UK.xls;

Research[291 292 293] suggests that the 11- to 14-year-old age group is both the most likely point at which young people can lose interest in STEM,[294] and at which interventions can have the greatest effect. Indeed, influencing young people before they choose the subjects they will study at GCSE and equivalent is the basis of most STEM intervention programmes, including The Big Bang and Tomorrow's Engineers.

Tables 4.2 to 4.5 show the projected numbers of young people aged 11, 12, 13 and 14 by UK nations and English regions. Key Stage 3 is often referred to as comprising 11- to 14-year-olds. However, only some 11-year-olds are in secondary school, with only three school years (Years 7 to 9) included in KS3, while there are four in the 11 to 14 age group. The ages are therefore presented separately and can be totalled as required. The numbers vary significantly by region, with the North East having the lowest of all English regions across all years. In 2015, the South East had around four times the number of young people aged 11, 12, 13 and 14 as the North East. Only Northern Ireland has fewer.

Table 4.2: Projected population of 11-year-olds by nation and English region (2012-2022) – UK

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10-year percentage change (2012-2022)
England		586,219	574,278	588,343	602,850	614,684	643,106	657,206	679,500	673,567	683,408	694,279	18.4%
	North East	26,909	26,230	26,765	27,309	27,889	29,476	29,301	30,387	29,869	30,607	31,018	15.3%
	North West	77,497	76,058	76,734	78,759	80,809	84,187	85,230	87,856	86,461	87,551	88,840	14.6%
	Yorkshire and The Humber	57,897	57,381	58,131	59,785	60,997	63,711	64,330	66,109	66,222	66,841	66,686	15.2%
	East Midlands	49,621	48,356	49,347	50,886	51,320	54,109	55,003	57,159	56,297	57,057	58,188	17.3%
	West Midlands	64,367	63,184	64,516	66,295	67,765	69,624	70,599	73,002	72,377	72,289	73,711	14.5%
	East of England	65,905	64,353	65,433	68,078	68,688	71,813	73,758	77,112	76,938	78,218	79,434	20.5%
	London	90,647	89,668	93,724	94,077	97,942	102,777	106,435	109,554	108,668	110,241	112,231	23.8%
	South East	98,074	95,312	98,109	101,235	101,874	107,488	110,677	114,355	113,419	116,092	117,913	20.2%
	South West	55,302	53,736	55,584	56,426	57,400	59,922	61,874	63,964	63,316	64,513	66,258	19.8%
Wales		33,285	32,046	32,176	32,690	33,659	34,865	35,401	36,752	36,059	36,504	37,390	12.3%
Scotland		54,785	52,706	53,042	54,548	55,603	56,076	57,298	59,705	60,004	58,456	61,432	12.1%
Northern Ireland		22,166	21,974	21,951	22,456	22,727	23,345	24,487	25,803	25,845	25,483	25,854	16.6%
UK		696,455	681,004	695,512	712,544	726,673	757,392	774,392	801,760	795,475	803,851	818,955	17.6%

Source: Office for National Statistics[295 296 297 298 299 300 301 302]

291 See STEM Careers Awareness Timelines: Attitudes and ambitions towards science, technology, engineering and maths (STEM at Key Stage 3), International Centre for Guidance Studies, 2009; http://www.derby.ac.uk/media/derbyacuk/contentassets/documents/ehs/icegs/STEM-Careers-Awareness-Timelines-final-version.pdf **292** AP8: STEM Careers Awareness Timelines – STEM subjects and jobs: A longitudinal perspective of attitudes among Key Stage 3 students, 2008 – 2010, International Centre for Guidance Studies, 2011; https://www.nationalstemcentre.org.uk/res/documents/page/STEM-Attitudes-and-Ambitions-Survey-KS3-Phase2-Report-2011.pdf **293** Good Timing: Implementing STEM careers strategy in secondary schools, Centre for Education and Industry, International Centre for Guidance Studies and Isinglass Consultancy Ltd, November 2011; http://www.nationalstemcentre.org.uk/res/documents/page/Good_Timing_report_November2011.pdf **294** Student attitudes, engagement and participation in STEM subjects, The University of York, October 2013, p24; https://royalsociety.org/~/media/education/policy/vision/reports/ev-3-vision-research-reports-20140624.pdf **295** 2012 and 2015-2012 UK source: National Population Projections, 2012-based projections, Office for National Statistics, November 2013, Table: A3-1, Principal Projection – UK Population Single Year of Age, 2012-based; http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2012-based-projections/rft-table-a3-1-principal-projection---uk-population-single-year-of-age.xls **296** 2012 and 2015-2012 England source: National Population Projections, 2012-based projections, Office for National Statistics, November 2013, Table A3-4, Principal Projection – England Population Single Year of Age, 2012-based; http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2012-based-projections/rft-table-a3-4-principal-projection---england-population-single-year-of-age.xls **297** 2012 and 2015-2012 Wales source: National Population Projections, 2012-based projections, Office for National Statistics, November 2013, Table A3-5, Principal Projection – Wales Population Single Year of Age, 2012-based; http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2012-based-projections/rft-table-a3-5-principal-projection---wales-population-single-year-of-age.xls **298** 2012 and 2015-2012 Scotland source: National Population Projections, 2012-based projections, Office for National Statistics, November 2013, Table A3-6, Principal Projection – Scotland Population Single Year of Age, 2012-based; http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2012-based-projections/rft-table-a3-6-principal-projection---scotland-population-single-year-of-age.xls **299** 2012 and 2015-2012 Northern Ireland source: National Population Projections, 2012-based projections, Office for National Statistics, November 2013, Table A3-7, Principal Projection – Northern Ireland Population Single Year of Age, 2012-based; http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2012-based-projections/rft-table-a3-7-principal-projection---northern-ireland-population-single-year-of-age.xls **300** 2012 and 2015-2022 English region source: Subnational Population Projections, 2012-based projections: Z1: 2012-based Subnational Population Projections. Local Authorities in England, mid-2012 to mid-2037, Office for National Statistics, Table: 2012 SNPP Population persons, May 2014; http://www.ons.gov.uk/ons/rel/snpp/sub-national-population-projections/2012-based-projections/rft-open-population-las.zip **301** 2013 UK, devolved nation and English region source: Population Estimates by Age and Sex: Revised Population Estimates for UK, England and Wales, Scotland and Northern Ireland, Mid-2013, Office for National Statistics, June 2015, Workbook: MYE2_population_by_sex_and_age_for_local_authorities_UK.xls; http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/mid-2014/rft---mid-2013-uk-population-estimates.zip **302** 2014 UK, devolved nation and English region source: Population Estimates by Age and Sex: Population Estimates for UK, England and Wales, Scotland and Northern Ireland, Mid-2014, Office for National Statistics, June 2015, Workbook: MYE2_population_by_sex_and_age_for_local_authorities_UK.xls; http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/mid-2014/rft---mid-2014-uk-population-estimates.zip

Table 4.3: Projected population of 12-year-olds by nation and English region (2012-2022) – UK

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10-year percentage change (2012-2022)
England		601,871	589,178	577,811	585,070	603,942	615,610	644,068	658,049	680,343	674,412	684,253	13.7%
	North East	27,960	26,960	26,314	26,669	27,325	27,901	29,485	29,313	30,398	29,882	30,616	9.5%
	North West	79,585	77,792	76,316	76,449	78,825	80,858	84,242	85,279	87,907	86,517	87,609	10.1%
	Yorkshire and The Humber	59,418	58,050	57,664	57,748	59,809	61,008	63,726	64,340	66,122	66,229	66,850	12.5%
	East Midlands	51,445	49,973	48,656	49,244	51,114	51,547	54,339	55,234	57,392	56,535	57,297	11.4%
	West Midlands	66,385	64,639	63,569	64,184	66,385	67,842	69,714	70,685	73,088	72,460	72,382	9.0%
	East of England	67,425	66,343	64,878	65,424	68,378	68,989	72,130	74,073	77,424	77,242	78,524	16.5%
	London	90,972	90,639	89,795	91,328	93,404	97,151	101,939	105,499	108,589	107,712	109,267	20.1%
	South East	100,765	99,009	96,259	98,114	101,805	102,448	108,081	111,267	114,959	114,022	116,693	15.8%
	South West	57,916	55,773	54,360	55,911	56,898	57,866	60,411	62,359	64,464	63,814	65,014	12.3%
Wales		34,192	33,389	32,175	31,981	32,717	33,686	34,892	35,428	36,779	36,086	36,531	6.8%
Scotland		56,171	54,857	52,773	52,837	54,574	55,631	56,106	57,330	59,737	60,036	58,488	4.1%
Northern Ireland		23,057	22,192	22,058	21,955	22,494	22,766	23,386	24,529	25,845	25,887	25,525	10.7%
UK		715,291	699,616	684,817	691,843	713,727	727,693	758,452	775,336	802,704	796,421	804,797	12.5%

Source: Office for National Statistics[303]

Table 4.4: Projected population of 13-year-olds by nation and English region (2012-2022) – UK

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10-year percentage change (2012-2022)
England		620,278	604,563	592,716	573,914	586,144	604,852	616,558	644,898	658,879	681,173	675,244	8.9%
	North East	28,871	27,996	27,070	26,160	26,678	27,330	27,907	29,484	29,317	30,401	29,887	3.5%
	North West	82,739	79,797	78,061	75,924	76,518	78,879	80,911	84,290	85,329	87,958	86,572	4.6%
	Yorkshire and The Humber	61,737	59,620	58,207	57,235	57,740	59,789	60,988	63,700	64,314	66,099	66,200	7.2%
	East Midlands	53,917	51,711	50,275	48,613	49,448	51,312	51,756	54,539	55,443	57,602	56,750	5.3%
	West Midlands	67,790	66,649	64,993	63,121	64,267	66,454	67,914	69,788	70,763	73,166	72,537	7.0%
	East of England	69,622	67,783	66,804	64,723	65,722	68,653	69,283	72,425	74,376	77,724	77,535	11.4%
	London	91,233	91,263	91,186	87,636	90,874	92,881	96,589	101,291	104,805	107,870	107,000	17.3%
	South East	104,064	101,314	99,744	95,967	98,566	102,230	102,908	108,527	111,723	115,426	114,487	10.0%
	South West	60,305	58,430	56,376	54,534	56,332	57,323	58,301	60,855	62,809	64,927	64,275	6.6%
Wales		35,560	34,322	33,498	32,019	32,001	32,737	33,706	34,912	35,448	36,799	36,106	1.5%
Scotland		58,383	56,241	54,991	52,724	52,871	54,611	55,669	56,147	57,371	59,778	60,077	2.9%
Northern Ireland		24,066	23,096	22,297	22,053	21,985	22,524	22,797	23,418	24,561	25,877	25,919	7.7%
UK		738,287	718,222	703,502	680,710	693,001	714,724	728,730	759,375	776,259	803,627	797,346	8.0%

Source: Office for National Statistics[304]

303 For sources see Table 4.2 304 For sources see Table 4.2

Table 4.5: Projected population of 14-year-olds by nation and English region (2012-2022) – UK

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10-year percentage change (2012-2022)
England		628,130	623,246	608,240	588,733	574,955	587,043	605,784	617,386	645,726	659,707	682,001	8.6%
	North East	29,691	28,906	28,087	26,929	26,172	26,686	27,339	27,914	29,487	29,326	30,409	2.4%
	North West	83,597	82,916	80,158	77,658	76,014	76,602	78,966	80,986	84,370	85,412	88,045	5.3%
	Yorkshire and The Humber	62,392	61,839	59,783	57,904	57,264	57,765	59,818	61,008	63,722	64,338	66,128	6.0%
	East Midlands	53,993	54,370	52,127	50,194	48,811	49,639	51,513	51,959	54,741	55,656	57,815	7.1%
	West Midlands	69,789	68,144	66,964	64,613	63,242	64,380	66,567	68,021	69,909	70,888	73,292	5.0%
	East of England	70,606	69,836	68,069	66,665	64,977	65,979	68,904	69,539	72,693	74,652	77,994	10.5%
	London	91,516	91,445	91,692	88,853	87,144	90,290	92,288	95,905	100,559	104,022	107,062	17.0%
	South East	105,212	104,751	102,038	99,263	96,282	98,862	102,533	103,220	108,833	112,039	115,744	10.0%
	South West	61,334	61,039	59,322	56,655	55,050	56,840	57,856	58,835	61,411	63,374	65,512	6.8%
Wales		36,258	35,636	34,474	33,350	32,032	32,014	32,750	33,719	34,925	35,461	36,812	1.5%
Scotland		59,614	58,432	56,376	54,886	52,776	52,927	54,667	55,729	56,207	57,431	59,838	0.4%
Northern Ireland		24,441	24,134	23,162	22,269	22,090	22,022	22,561	22,834	23,455	24,598	25,914	6.0%
UK		748,443	741,448	722,252	699,238	681,853	694,006	715,762	729,668	760,313	777,197	804,565	7.5%

Source: Office for National Statistics[305]

The 38 Local Enterprise Partnerships (LEPs) are now significantly more important as representative bodies for local economic policy than the nine traditional regions. Table 4.6 shows the vastly different population sizes within LEPs. While Cumbria has just 497,900, London has approximately 17 times that, with 8,538,700.

305 For sources see Table 4.2

Table 4.6: Population by Local Enterprise Partnership (LEP) (2014) – England

LEP	Region	
London	London	8,538,700
South East	South East (part East of England)	4,097,300
Leeds City Region	Yorkshire and The Humber	3,004,900
Greater Manchester	North West	2,732,900
Derby, Derbyshire, Nottingham and Nottinghamshire	East Midlands	2,147,900
Greater Birmingham and Solihull	West Midlands	1,983,600
Coast to Capital	South East (part London)	1,978,800
North Eastern	North East	1,952,500
Sheffield City Region	Yorkshire and The Humber (part East Midlands)	1,832,100
South East Midlands	East Midlands (part South East and East of England)	1,781,300
Heart of the South West	South West	1,701,400
Enterprise M3	South East	1,664,700
New Anglia	East of England	1,616,200
Solent	South East	1,578,100
Liverpool City Region	North West	1,517,500
Lancashire	North West	1,472,000
Greater Cambridge & Greater Peterborough	East of England (part East Midlands)	1,408,300
Black Country	West Midlands	1,159,700
Hertfordshire	East of England	1,154,800
York, North Yorkshire and East Riding	Yorkshire and The Humber	1,143,100
Stoke-on-Trent and Staffordshire	West Midlands	1,111,200
West of England	South West	1,104,200
Greater Lincolnshire	East Midlands (part Yorkshire and The Humber)	1,060,600
Leicester and Leicestershire	East Midlands	1,005,600
Humber	Yorkshire and The Humber	923,900
Cheshire and Warrington	North West	912,800
Coventry and Warwickshire	West Midlands	889,000
Thames Valley Berkshire	South East	885,700
Dorset	South West	759,800
Northamptonshire	East Midlands	714,400
Swindon and Wiltshire	South West	698,900
Oxfordshire	South East	672,500
The Marches	West Midlands	666,700
Tees Valley	North East	666,200
Gloucestershire	South West	611,300
Worcestershire	West Midlands	575,400
Cornwall and Isles of Scilly	South West	547,600
Buckinghamshire Thames Valley	South East	521,900
Cumbria	North West	497,900
Total		**59,291,300**

Source: Office for National Statistics[306]

306 Local Enterprise Partnership Profile, Office for National Statistics, Retrieved 11 September 2015; https://www.nomisweb.co.uk/livelinks/8351.xls

4.1.1 Ethnicity

Table 4.7 reveals the ethnic makeup of the UK, its constituent nations and English regions as recorded by the 2011 Census. While white remains by far the major ethnic group in all nations and regions, with 87.2% of the UK population, some regions have a significantly greater percentage of minority ethnic groups than others. The national average is influenced heavily by London, which is considerably more ethnically-diverse than anywhere else. It has a white population of just 59.8%, with significant percentages of Asian or Asian British (18.5%), black, African, Caribbean or black British (13.3%). The West Midlands is next in terms of diversity, with 10.8% Asian or Asian British and 3.3% black, African, Caribbean or black British. This contrasts with Northern Ireland where the respective figures are just 1.1% and 0.2%. The urban nature of the UK's non-white population is highlighted by the Policy Exchange, which states that "just three cities (London, Greater Birmingham and Greater Manchester) account for over 50% of the UK's entire [Black and Minority Ethnic] BME population."[307] The report also claims that "8 million people or 14% of the UK population belong to an ethnic minority", while "the 5 largest distinct minority communities are (in order of size): Indian, Pakistani, black African, black Caribbean and Bangladeshi."[308]

Table 4.7: National and English regional populations by broad ethnic group[309] (2011) – UK

		All	White[310]		Mixed / multiple ethnic group[311]		Asian / Asian British[312]		Black / African / Caribbean / black British[313]		Other ethnic group[314]	
Nation	**Region**		**Number**	**Percentage**	**Number**	**Percentage**	**Number**	**Percentage**	**Number**	**Percentage**	**Number**	**Percentage**
England		53,012,456	45,281,142	85.4%	1,192,879	2.3%	4,143,403	7.8%	1,846,614	3.5%	548,418	1.0%
	North East	2,596,886	2,475,567	95.3%	22,449	0.9%	74,599	2.9%	13,220	0.5%	11,051	0.4%
	North West	7,052,177	6,361,716	90.2%	110,891	1.6%	437,485	6.2%	97,869	1.4%	44,216	0.6%
	Yorkshire and The Humber	5,283,733	4,691,956	88.8%	84,558	1.6%	385,964	7.3%	80,345	1.5%	40,910	0.8%
	East Midlands	4,533,222	4,046,356	89.3%	86,224	1.9%	293,423	6.5%	81,484	1.8%	25,735	0.6%
	West Midlands	5,601,847	4,633,669	82.7%	131,714	2.4%	604,435	10.8%	182,125	3.3%	49,904	0.9%
	East of England	5,846,965	5,310,194	90.8%	112,116	1.9%	278,372	4.8%	117,442	2.0%	28,841	0.5%
	London	8,173,941	4,887,435	59.8%	405,279	5.0%	1,511,546	18.5%	1,088,640	13.3%	281,041	3.4%
	South East	8,634,750	7,827,820	90.7%	167,764	1.9%	452,042	5.2%	136,013	1.6%	51,111	0.6%
	South West	5,288,935	5,046,429	95.4%	71,884	1.4%	105,537	2.0%	49,476	0.9%	15,609	0.3%
Wales		3,063,456	2,928,253	95.6%	31,521	1.0%	70,128	2.3%	18,276	0.6%	15,278	0.5%
Scotland		5,295,403	5,084,407	96.0%	19,815	0.4%	140,678	2.7%	36,178	0.7%	14,325	0.3%
Northern Ireland		1,810,863	1,779,750	98.3%	6,014	0.3%	19,130	1.1%	3,616	0.2%	2,353	0.1%
UK		63,182,178	55,073,552	87.2%	1,250,229	2.0%	4,373,339	6.9%	1,904,684	3.0%	580,374	0.9%

Source: Office for National Statistics[315]

307 A Portrait of Modern Britain, Policy Exchange, 2014, p7; http://www.policyexchange.org.uk/images/publications/a%20portrait%20of%20modern%20britain.pdf **308** A Portrait of Modern Britain, Policy Exchange, 2014, p6 **309** Categories are those used by the ONS at top-line UK harmonised level. For further information see Harmonised Concepts and Questions for Social Data Sources: Primary Principles – Ethnic Group, Office for National Statistics, May 2015; http://www.ons.gov.uk/ons/guide-method/harmonisation/primary-set-of-harmonised-concepts-and-questions/ethnic-group.pdf **310** Includes: England and Wales – 'White: English/Welsh/Scottish/Northern Irish/British', 'White: Irish', 'White: Other White' and 'White: Gypsy or Irish Traveller'; Scotland – 'White: Scottish', 'White: Other British', 'White: Irish', 'White: Polish', 'White: Other White' and 'White: Gypsy/Traveller'; Northern Ireland – 'White' and 'Irish Traveller' **311** Includes: England and Wales – 'Mixed/multiple ethnic group: White and Black Caribbean', 'Mixed/multiple ethnic group: White and Black African', 'Mixed/multiple ethnic group: White and Asian' and 'Mixed/multiple ethnic group: Other Mixed'; Scotland – 'Mixed or multiple ethnic groups'; Northern Ireland – 'Mixed' **312** Includes: England and Wales – 'Asian/Asian British: Indian', Asian/Asian British: Pakistani', 'Asian/Asian British: Bangladeshi', 'Asian/Asian British: Chinese' and 'Asian/Asian British: Other Asian'; Scotland – 'Asian, Asian Scottish or Asian British: Indian, Indian Scottish or Indian British', 'Asian, Asian Scottish or Asian British: Pakistani, Pakistani Scottish or Pakistani British', 'Asian, Asian Scottish or Asian British: Bangladeshi, Bangladeshi Scottish or Bangladeshi British', 'Asian, Asian Scottish or Asian British: Chinese, Chinese Scottish or Chinese British' and 'Asian, Asian Scottish or Asian British: Other Asian'; Northern Ireland – 'Indian', 'Pakistani', 'Bangladeshi', 'Chinese' and 'Other Asian' **313** Includes: England and Wales – 'Black/African/Caribbean/Black British: African', 'Black/African/Caribbean/Black British: Caribbean' and 'Black/African/Caribbean/Black British: Other Black'; Scotland – 'African: African, African Scottish or African British', 'African: Other African', 'Caribbean or Black: Caribbean Scottish or Caribbean British', 'Caribbean or Black: Black, Black Scottish or Black British' and 'Caribbean or Black: Other Caribbean or Black'; Northern Ireland – 'Black African', 'Black Caribbean' and 'Black Other' **314** Includes: England and Wales – 'Other ethnic group: Arab' and 'Other ethnic group: Any other ethnic group'; Scotland – 'Other ethnic groups: Arab, Arab Scottish or Arab British' and 'Other ethnic groups: Other ethnic group'; Northern Ireland – 'Other' **315** 2011 Census, Key Statistics and Quick Statistics for local authorities in the United Kingdom – Part 1, Office for National Statistics, October 2013, Workbook: 2011 Census: KS201UK Ethnic group, local authorities in the United Kingdom, Table: KS201UK_Numbers; http://www.ons.gov.uk/ons/rel/census/2011-census/key-statistics-and-quick-statistics-for-local-authorities-in-the-united-kingdom---part-1/rft-ks201uk.xls

The relatively small percentage of non-white British people is due to increase significantly as "ethnic minorities represent just 5% of the over-60 population, but 25% of the under-5 population" and "by 2051, it is estimated that BME communities will represent between 20–30% of the UK's population."[316]

This is supported by Table 4.8, which shows that, in 2011, the overall number of 10- to 14-year-olds in England (3,080,929) was lower than 15- to 19-year-olds (3,340,265). This was mainly because there were 252,233 fewer white people aged 15 to 19. However, the percentage of mixed/multiple ethnic group, Asian or Asian British and black/African/Caribbean/black British young people is rising. Elsewhere in the UK, however, the proportions are staying broadly the same.

Table 4.8: Population by young age group and broad ethnic group[317] (2011) – UK

England						
	Total population	Percentage of total population	Number of 10- to 14-year-olds	Percentage of 10-14 age group	Number of 15- to 19-year-olds	Percentage of 15-19 age group
All categories: ethnic group	53,012,456	100.0%	3,080,929	100.0%	3,340,265	100.0%
White	45,281,142	85.4%	2,477,722	80.4%	2,729,955	81.7%
Mixed / multiple ethnic group	1,192,879	2.3%	138,048	4.5%	126,931	3.8%
Asian / Asian British	4,143,403	7.8%	286,140	9.3%	301,350	9.0%
Black / African / Caribbean / black British	1,846,614	3.5%	144,439	4.7%	144,245	4.3%
Other ethnic group	548,418	1.0%	34,580	1.1%	37,784	1.1%
Wales						
	Total population	Percentage of total population	Number of 10- to 14-year-olds	Percentage of 10-14 age group	Number of 15- to 19-year-olds	Percentage of 15-19 age group
All categories: ethnic group	3,063,456	100.0%	177,748	100.0%	199,120	100.0%
White	2,928,253	95.6%	167,748	94.4%	188,095	94.5%
Mixed / multiple ethnic group	31,521	1.0%	3,342	1.9%	3,528	1.8%
Asian / Asian British	70,128	2.3%	4,550	2.6%	4,997	2.5%
Black / African / Caribbean / black British	18,276	0.6%	1,210	0.7%	1,403	0.7%
Other ethnic group	15,278	0.5%	898	0.5%	1,097	0.6%
Scotland						
	Total population	Percentage of total population	Number of 10- to 14-year-olds	Percentage of 10-14 age group	Number of 15- to 19-year-olds	Percentage of 15-19 age group
All categories: ethnic group	5,295,403	100.0%	291,615	100.0%	330,826	100.0%
White	5,084,407	96.0%	278,133	95.4%	316,197	95.6%
Mixed / multiple ethnic group	19,815	0.4%	2,022	0.7%	1,888	0.6%
Asian / Asian British	140,678	2.7%	8,542	2.9%	9,634	2.9%
Black / African / Caribbean / black British	36,178	0.7%	2,138	0.7%	2,210	0.7%
Other ethnic group	14,325	0.3%	780	0.3%	897	0.3%
Northern Ireland						
	Total population	Percentage of total population	Number of 10- to 15-year-olds[318]	Percentage of 10-15 age group	Number of 16- to 19-year-olds	Percentage of 16-19 age group
All categories: ethnic group	1,810,863	100.0%	143,654	100.0%	101,621	100.0%
White	1,779,750	98.3%	140,867	98.1%	100,043	98.4%
Mixed / multiple ethnic group	6,014	0.3%	875	0.6%	456	0.4%
Asian / Asian British	19,130	1.1%	1,449	1.0%	884	0.9%
Black / African / Caribbean / black British	3,616	0.2%	296	0.2%	145	0.1%
Other ethnic group	2,353	0.1%	167	0.1%	93	0.1%

Source: Office for National Statistics,[319 320] National Records of Scotland[321] and Northern Ireland Statistics and Research Agency[322]

316 A Portrait of Modern Britain, Policy Exchange, 2014, p6 **317** See Table 4.7 footnotes detailing categories included in each broad ethnic group **318** Age groups differ as they reflect those published by Northern Ireland Statistics and Research Agency **319** England source: 2011 Census: DC2101EW – Ethnic group by sex by age – England, Office for National Statistics: Retrieved from NOMIS [5 August 2015], https://www.nomisweb.co.uk/census/2011/DC2101EW/view/2092957699?rows=c_age&cols=c_ethpuk11 **320** Wales source: 2011 Census: DC2101EW – Ethnic group by sex by age – Wales, Office for National Statistics: Retrieved from NOMIS [5 August 2015], https://www.nomisweb.co.uk/census/2011/DC2101EW/view/2092957700?rows=c_age&cols=c_ethpuk11 **321** Scotland source: Scotland's Census 2011: DC2101SC – Ethnic group by sex by age, National Records of Scotland: Retrieved from Census Data Explorer [5 August 2015]; http://www.scotlandscensus.gov.uk/ods-web/standard-outputs.html **322** Northern Ireland source: Census 2011: Ethnic Group by Age by Sex DC2101NI (administrative geographies), Northern Ireland Statistics and Research Agency: Northern Ireland Neighbourhood Information Service, November 2013, Folder: NI, Workbook: DC2101NI; http://www.ninis2.nisra.gov.uk/Download/Census%202011_Winzip/2011/DC2101NI%20(a).zip

4.2 Education

The trend in targeting STEM engagement activities at schools and colleges according to a variety of categories – such as attainment, free school meals, gender, diversity and location – is becoming increasingly evident. Consequently, access to robust data upon which to act has become ever more important.

4.2.1 Schools

Table 4.9 and Table 4.10 show that there are 3,794,451 pupils in 4,158 state-maintained secondary schools in the UK – an average of 913 pupils per school. In England, there are 3,184,728 pupils in 3,381 state-maintained secondary schools – about 942 per school, which is more than the UK average. This contrasts strongly with the rest of the UK. In Wales, there is an average of 881 students per school, in Scotland it is 787 students per school and in Northern Ireland around 685 students per school.

Including those in Years 12 and 13, the average secondary class size in England, as reported by the Department for Education, is 20[323] – the same figure for Wales.[324 325 326 327]

Table 4.9 also shows the number of state secondary schools by English region. In general, the figures reflect the number of students in each region, although geography also seems to play some part. For example, there is a larger number of schools in the South West (337) than in Yorkshire and the Humber (311), despite a slightly lower number of secondary pupils (311,821 vs 317,671). As expected, there are significantly more schools in the most heavily populated region of the South East (498), compared with those at the other end of the population spectrum, such as the North East (187).

Table 4.9: Primary, secondary and independent schools by nation and English region (2014 or 2015) – UK

Nation	Region	State-funded primary	State-funded secondary	Independent
England (January 2015)		16,766[328]	3,381[329]	2,357
	North East	867	187	41
	North West	2,449	459	260
	Yorkshire and The Humber	1,789	311	137
	East Midlands	1,632	296	158
	West Midlands	1,772	412	209
	East of England	2,000	402	237
	London	1,800	479	555
	South East	2,594	498	536
	South West	1,863	337	224
Wales (January 2015)		1,330[330]	207[331]	66
Scotland (September 2014)[332]		2,048	362	70
Northern Ireland (October 2014)		836[333]	208[314]	14
UK total		20,980	4,158	2,507

Source: Department for Education,[335] StatsWales,[336 337] Scottish Government,[338] Scottish Council of Independent Schools[339] and Department of Education Northern Ireland[340]

323 Schools, pupils and their characteristics: January 2015 – National tables: SFR16/2015, Department for Education, June 2015, Table 6b; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/433685/SFR16_2015_national_tables.xlsx **324** Calculation based on data from the tables in footnote 325 and 326 **325** Years 7-11 classes source: Pupil Level Annual School Census (PLASC): January 2015, StatsWales [Welsh Government], July 2015, Table: Classes in primary, middle and secondary schools by local authority, region and year group; https://statswales.wales.gov.uk/Catalogue/Education-and-Skills/Schools-and-Teachers/Schools-Census/Pupil-Level-Annual-School-Census/Classes/classesinprimarymiddlesecondaryschools-by-localauthorityregion-yeargroup **326** Years 7-11 pupils source: Pupil Level Annual School Census (PLASC): January 2015, StatsWales [Welsh Government], July 2015, Table: Number of pupils in primary, middle and secondary school classes by local authority, region and year group; https://statswales.wales.gov.uk/Catalogue/Education-and-Skills/Schools-and-Teachers/Schools-Census/Pupil-Level-Annual-School-Census/Classes/numberofpupilsinprimarymiddlesecondaryschoolclasses-by-localauthorityregion-yeargroup **327** Secondary class sizes for Northern Ireland and Scotland are not publicly available **328** Excludes special schools (including general hospital schools) and pupil referral units (including alternative provision academies and free schools). Includes middle/all through schools as deemed and all primary academies, including free schools **329** Excludes special schools (including general hospital schools) and pupil referral units (including alternative provision academies and free schools). Includes middle/all through schools as deemed, city technology colleges and all secondary academies, including free schools, university technical colleges and studio schools **330** Excludes nurseries, special schools and 6 'all-through' middle schools. Includes infant schools without nursery provision, infant schools with nursery provision, junior schools, primary schools (infant and junior) and primary schools (nursery, infant and junior) **331** Excludes special schools and 6 'all-through' middle schools. Includes secondary schools without post-16 provision and secondary schools with post-16 provision **332** Excludes special schools **333** Excludes nurseries, special schools and hospital schools. Includes grammar school prep departments **334** Excludes nurseries, special schools and hospital schools. Includes grammar schools **335** England source: Schools, pupils and their characteristics: January 2015 – Local authority and regional tables: SFR16/2015, Department for Education, June 2015, Table 7a; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/445755/SFR16_2015_LA_tables.xlsx **336** Wales state source: Pupil Level Annual School Census (PLASC): January 2015, StatsWales [Welsh Government], July 2015, Table: Schools by local authority, region and type of school; https://statswales.wales.gov.uk/Catalogue/Education-and-Skills/Schools-and-Teachers/Schools-Census/Pupil-Level-Annual-School-Census/Schools/schools-by-localauthorityregion-type **337** Wales independent source: Pupil Level Annual School Census (PLASC): January 2015, StatsWales [Welsh Government], July 2015, Table: Schools by local authority, region and year; https://statswales.wales.gov.uk/Catalogue/Education-and-Skills/Schools-and-Teachers/Schools-Census/Independent-Schools/Schools/schools-by-localauthorityregion-year **338** Scotland state source: Pupil census [September] 2014 supplementary data: Pupils in Scotland 2014, Scottish Government, February 2015, Table 1.1: Schools and pupils, by school sector, 1998-2014; http://www.gov.scot/Resource/0047/00471990.xls **339** Scotland independent source: Pupil Numbers: Pupil numbers and demographic trends [September 2014), Scottish Council of Independent Schools, September 2014 [Accessed 12 September 2015]; http://www.scis.org.uk/facts-and-statistics/pupil-numbers **340** Northern Ireland source: School Census [October 2014]: Northern Ireland summary data – Schools and pupils in Northern Ireland 1991/92 to 2014/15, Department of Education Northern Ireland, February 2015, Table: Schools; http://www.deni.gov.uk/enrolment_time_series_1415-3.xlsx

Table 4.10: Primary and secondary pupils by nation and English region (2014 or 2015) – UK

Nation	Region	State-funded primary	State-funded secondary	Independent
England (January 2015)		4,510,308[341]	3,184,728[342]	582,866
	North East	216,293	155,862	10,809
	North West	623,546	412,929	46,390
	Yorkshire and The Humber	476,414	317,671	32,038
	East Midlands	383,003	278,704	31,123
	West Midlands	500,158	354,735	43,820
	East of England	489,829	370,830	66,883
	London	730,568	483,795	146,341
	South East	693,964	498,381	149,629
	South West	396,533	311,821	55,833
Wales (January 2015)		273,400[343]	182,408[344]	8,991
Scotland (September 2014)[345]		385,212[346]	284,762[347]	30,687
Northern Ireland (October 2014)		175,042[348]	142,553[349]	642
UK total		5,343,962	3,794,451	623,186

Source: Department for Education,[350] StatsWales,[351 352] Scottish Government,[353] Scottish Council of Independent Schools[354] and Department of Education Northern Ireland[355]

Table 4.11 shows the number of full-time equivalent (FTE) primary and secondary teachers by nation. In England, the number of primary pupils per teacher is 21, in Wales the figure is 22,[356] in Scotland it is 17, and in Northern Ireland there are 21 primary pupils to each teacher. The UK average is 21.

The number of secondary pupils per teacher is significantly lower than the primary figures (given more subject-specific teachers). In England, there are 15 secondary pupils per teacher, in Wales there are 16, in Scotland 12, and in Northern Ireland 15. The UK average is 14.

Table 4.11: Full-time equivalent (FTE) primary and secondary teachers by nation (2014 or 2015) – UK

	Primary	Secondary
England (November 2014)[357]	215,500	218,200
Wales (January 2015)	12,534[358]	11,442[359]
Scotland (September 2014)[360]	23,029	23,439
Northern Ireland (November 2014)	8,252[361]	9,382[362]
UK total	259,315	262,463

Source: Department for Education,[363 364] StatsWales,[365] Scottish Government,[366] and Department of Education Northern Ireland[367]

341 Excludes pupils in special schools (including general hospital schools and special academies) and pupil referral units (including alternative provision academies and free schools). Includes pupils in nursery classes and middle/all through schools as deemed (including above Year 6) and all primary academies, including free schools **342** Excludes pupils in special schools (including general hospital schools and special academies) and pupil referral units (including alternative provision academies and free schools). Includes pupils in middle/all through schools as deemed (including those below Year 7), city technology colleges and all secondary academies, including free schools, university technical colleges and studio schools **343** Excludes pupils in special schools and 4,376 in 'all-through' middle schools. Includes those in nursery classes and above Year 6 in primary schools detailed in Table 4.9 **344** Excludes pupils in special schools and 4,376 in 'all-through' middle schools **345** Excludes pupils in special schools **346** Includes pupils in P1-P7 only **347** Includes pupils in S1-S6 only **348** Excludes pupils in special schools and hospital schools. Includes those in nursery classes and grammar school prep departments and those in both mainstream classes and in special units **349** Excludes pupils in special schools and hospital schools. Includes those in grammar schools and those in both mainstream classes and in special units **350** England source: Schools, pupils and their characteristics: January 2015 – Local authority and regional tables: SFR16/2015, Department for Education, June 2015, Table 7b; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/445755/SFR16_2015_LA_tables.xlsx **351** Wales state source: Pupil Level Annual School Census (PLASC): January 2015, StatsWales [Welsh Government], July 2015, Table: Pupils by local authority, region and year group; https://statswales.wales.gov.uk/Catalogue/Education-and-Skills/Schools-and-Teachers/Schools-Census/Pupil-Level-Annual-School-Census/Pupils/pupils-by-localauthorityregion-yeargroup **352** Wales independent source: Pupil Level Annual School Census (PLASC): January 2015, StatsWales [Welsh Government], July 2015, Table: Number of pupils by local authority, region and age group, July 2015; https://statswales.wales.gov.uk/Catalogue/Education-and-Skills/Schools-and-Teachers/Schools-Census/Independent-Schools/Pupils/number-by-localauthorityregion-agegroup **353** Scotland state source: Pupil census [September] 2014 supplementary data – Pupils in Scotland 2014, Scottish Government, February 2015, Table 1.1: Schools and pupils, by school sector, 1998-2014; http://www.gov.scot/Resource/0047/00471990.xls **354** Scotland independent source: Annual Review 2014, Scottish Council of Independent Schools (SCIS), September 2014, p5; http://www.scis.org.uk/assets/Uploads/Publications/SCISAnnualReview2014Web.pdf **355** Northern Ireland source: School Census [October 2014]: Northern Ireland summary data – Schools and pupils in Northern Ireland 1991/92 to 2014/15, Department of Education Northern Ireland, February 2015, Table: Pupils; http://www.deni.gov.uk/enrolment_time_series_1415-3.xlsx **356** This may be affected by the exclusion of 'all-through' middle school teachers and pupils, unlike in England. **357** Excludes teachers in nursery schools but includes those in nursery classes in primary schools. Includes those in primary academies and 'advisory teachers', 'Leading Practitioners' and 'post-threshold' teachers and 'unqualified' teachers **358** Excludes those in nurseries, 298 in 'all-through' middle schools and those in special schools. Includes 26 'Other teachers', 242 ITT Trainees' and 26 'Peripatetic Teachers' **359** Excludes 298 in 'all-through' middle schools and those special schools. Includes 53 'Other teachers', 103 ITT Trainees' and 18 'Peripatetic Teachers' **360** Excludes teachers in special schools **361** Includes teachers in nursery classes and 123 in preparatory departments of grammar schools. Excludes those in special schools and hospital schools **362** Includes post-primary teachers including secondary and grammar. Excludes those in special schools and hospital schools **363** England primary academy and state funded secondary source: School workforce in England: November 2014: Main tables: SFR21/2015, Department for Education, July 2015, Table: Table_2_2014; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440718/Main_tables_SFR21_2015.xlsx **364** England LA maintained primary (excluding nursery schools): Bespoke request from School Workforce Census, Department for Education, July 2015 **365** Wales source: Pupil Level Annual School Census (PLASC): January 2015, StatsWales [Welsh Government], July 2015, Table: Full-time equivalent teachers by local authority, region and category; https://statswales.wales.gov.uk/Catalogue/Education-and-Skills/Schools-and-Teachers/Schools-Census/Pupil-Level-Annual-School-Census/Staff-and-Governors/fteteachers-by-localauthorityregion-category **366** Scotland source: Teacher Census [September] 2014: supplementary data, Scottish Government, March 2015, Table 1.1: Schools, pupils and teachers by school sector, 2009 – 2014; http://www.gov.scot/Resource/0047/00472998.xls **367** Northern Ireland Source: Teacher Numbers [November 2014] – Full-Time Equivalent (FTE) Teachers in Northern Ireland by school type and management type: 2005/06 – 2014/15, Department of Education Northern Ireland, July 2015; http://www.deni.gov.uk/fte_teacher_time_series_mantype_website-3.xls

Table 4.12 shows the number and percentage of pupils eligible for free school meals by nation and English region. Because free school meals are means tested, this is used as a measure of deprivation for most nations. However, the Scottish government extended eligibility to all primary 1-3 pupils in January 2015, meaning that Scottish primary school data can no longer be used in this way.

For England, percentages eligible for FSM in secondary schools range from a low of 9.2% in the South East to 19.6% in London, against a national average of 13.9%. Wales (15.8%), Scotland (15%) and Northern Ireland (26.1%) all have higher percentages of secondary school pupils eligible for FSM than England.

Table 4.12: Number and percentage of pupils eligible for free school meals by nation and English region (2014 or 2015) – UK

		State-funded primary pupils			State-funded secondary pupils		
Nation	**Region**	**Number of pupils known to be eligible for free school meals**	**Number on roll**	**Percentage known to be eligible for and claiming free school meals**	**Number of pupils known to be eligible for and claiming free school meals**	**Number on roll**	**Percentage known to be eligible for and claiming free school meals**
England (January 2015)[368]		705,345[369]	4,510,308	15.6%	442,341	3,184,728	13.9%
	North East	43,024	216,293	19.9%	26,265	155,862	16.9%
	North West	111,561	623,546	17.9%	65,911	412,929	16.0%
	Yorkshire and The Humber	79,590	476,414	16.7%	47,558	317,671	15.0%
	East Midlands	55,476	383,003	14.5%	34,840	278,704	12.5%
	West Midlands	91,918	500,158	18.4%	57,417	354,735	16.2%
	East of England	60,774	489,829	12.4%	37,109	370,830	10.0%
	London	135,653	730,568	18.6%	95,050	483,795	19.6%
	South East	76,730	693,964	11.1%	45,680	498,381	9.2%
	South West	50,619	396,533	12.8%	32,511	311,821	10.4%
Wales (January 2015)		49,184[370]	273,400	18.0%	28,859[371]	182,408	15.8%
Scotland (February/March 2015)[372]		213,199[373]	385,434	55.3%	41,744	278,038	15.0%
Northern Ireland (October 2014)		55,526[374]	175,042	31.8%	37,236[375]	142,553	26.1%

Source: Department for Education,[376] StatsWales,[377] Scottish Government,[378] and Department of Education Northern Ireland[379]

4.2.2 Further education

There are 382 further education colleges in the UK, including 335 in England (Table 4.13). The Association of Colleges (AoC) also states that 3,100,000 people are educated in FE colleges every year and that "834,000 16- to 18-year-olds choose to study in colleges (compared with 438,000 in maintained school and academy sixth forms)" while "an additional 70,000 16- to 18-year-olds undertake an apprenticeship through their local college".[380] It also states that "colleges provide 30% of the students aged under 19 who enter higher education through UCAS" while "144,000 students study higher education in a college".[381]

Table 4.13: Further education colleges by nation (2015) – UK

England		335
	General further education colleges	216
	Sixth form colleges	93
	Land-based colleges	14
	Art, design and performing arts colleges	2
	Specialist designated colleges	10
Scotland		26
Wales		15
Northern Ireland		6
UK total		382

Source: Association of Colleges[382]

368 Number of pupils known to be eligible for and claiming free school meals **369** Includes pupils in nursery classes in primary schools **370** Excludes pupils in special schools and those in 'all-through' middle schools (of which 632 (14.4%) are eligible for free school meals). Includes those in nursery classes and above Year 6 in primary schools detailed in Table 4.9 **371** Excludes pupils in special schools and 'all-through' middle schools **372** Pupils registered for free school meals **373** In the past, statistics from this survey on the percentage of pupils registered for free school meals have been widely used as a measure of school level deprivation. However, as a result of the extension of free school meals eligibility to all children in primary 1-3, launched by the Scottish Government on 5 January 2015, this will no longer be a reliable measure to use. Secondary school data is unaffected by these changes and so it is still possible for this to be used as an indicator of deprivation. However, this has some limitations as the percentage of pupils registered falls throughout secondary. It may also be possible to use primary 4-7 data as an indicator of deprivation, although there is no comparable data on this from previous years **374** Excludes pupils in special schools and hospital schools. Includes those in nursery classes and grammar school prep departments and those in both mainstream classes and in special units **375** Excludes pupils in special schools and hospital schools. Includes those in grammar schools and those in both mainstream classes and in special units **376** England source: Schools, pupils and their characteristics: January 2015 – Underlying data: SFR16/2015, Department for Education, June 2015, Workbook: SFR16_2015_Schools_Pupils_UD; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/434186/SFR16_2015_Underlying_Data.zip **377** Wales source: School census results, 2015 – first release, Knowledge and Analytical Services (Welsh Government), July 2015, p11; http://gov.wales/docs/statistics/2015/150723-school-census-results-2015-en.pdf **378** Scotland source: Healthy Living Survey 2015: Schools meals and PE, supplementary data, Scottish Government, June 2015, Table 1; http://www.gov.scot/Resource/0047/00479378.xlsx **379** Northern Ireland source: School Meals 2014/15, Department of Education Northern Ireland, April 2015, Table 8; http://www.deni.gov.uk/tables_for_school_meals_in_northern_ireland_statistical_release_14.15_-_suppressed.xlsx **380** College Key Facts 2014/15, Association of Colleges, June 2015, p1; https://www.aoc.co.uk/sites/default/files/AOC%20KEY%20FACTS%202014.pdf **381** College Key Facts 2014/15, Association of Colleges, June 2015, p2 **382** Key Further Education Statistics: Number and list of Colleges June 2015, Association of Colleges, June 2015 [Accessed 13 September 2015]; https://www.aoc.co.uk/about-colleges/research-and-stats/key-further-education-statistics

4.2.3 Higher education

Table 4.14 shows that there were 163 higher education institutions in the UK in 2013/14, including 130 in England. There were 2,299,355 students at all levels in these institutions.[383] This equates to an average of 14,106 students per institution.

Meanwhile, Table 4.15 displays the young participation rates in higher education by nation and English region. This comprises the 18-year-old cohort from each year who enter higher education in the same year, or as a 19-year-old the following year. The average for England increased by a fifth between 2002/03 (32.0%) and 2011/12 (38.1%). Of the English regions, the North East consistently had the lowest proportion of young people entering higher education, at 27.2% in 2002/03 and 33.4% in 2011/12. However, this 10-year increase was the third largest, with only London (23.8%) and the North West (26.2%) having a larger percentage change. London has consistently had the largest participation rate – pulling away from the South East – from 38.6% in 2002/03 to 47.8% in 2011/12. In 2011/12, only London (47.8%) and the South East (39.6%) had a higher rate than the England average (38.1%), with the North West (38.1%) matching it. Of the UK nations, England had by far the largest 10-year increase. However, in 2011/12, only Wales (34.3%) had a lower participation rate than England (38.1%), while Scotland (45.1%) and Northern Ireland (39.8%) were both significantly higher.

Table 4.14: Higher education institutions by nation and English region (2013/14) – UK

England		130
	North East	5
	North West	14
	Yorkshire and The Humber	11
	East Midlands	9
	West Midlands	12
	East of England	10
	London	39
	South East	18
	South West	12
Wales		9
Scotland		19
Northern Ireland		5
UK total		163

Source: HESA[384]

Table 4.15: Young participation rates in higher education by nation and English region (2002/03-2011/12) – UK

		18-year-old cohort										
		2002/03	**2003/04**	**2004/05**	**2005/06**	**2006/07**	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12[385]**	**10-year percentage change**
England		32.0%	31.3%	32.0%	32.8%	32.8%	33.9%	35.2%	36.3%	37.6%	38.1%	19.1%
	North East	27.2%	26.4%	27.0%	27.5%	28.3%	29.3%	30.2%	31.7%	33.0%	33.4%	22.8%
	North West	30.2%	29.3%	29.9%	30.7%	31.1%	31.8%	33.5%	35.2%	37.1%	38.1%	26.2%
	Yorkshire and The Humber	28.0%	27.7%	28.1%	28.6%	29.1%	29.8%	30.5%	31.8%	32.8%	33.9%	21.1%
	East Midlands	30.3%	29.4%	30.5%	31.1%	30.6%	31.8%	33.0%	33.6%	34.4%	34.5%	13.9%
	West Midlands	30.5%	29.9%	30.4%	31.0%	31.1%	31.6%	33.2%	34.3%	35.1%	36.3%	19.0%
	East of England	31.5%	30.9%	31.1%	31.8%	32.0%	33.6%	35.2%	36.2%	37.1%	37.6%	19.4%
	London	38.6%	38.1%	39.6%	40.8%	41.7%	42.7%	44.4%	45.7%	47.3%	47.8%	23.8%
	South East	35.2%	34.3%	35.0%	35.9%	35.1%	36.3%	37.4%	38.3%	39.5%	39.6%	12.5%
	South West	31.7%	30.5%	31.4%	31.4%	30.8%	32.0%	33.0%	33.4%	34.8%	34.9%	10.1%
Wales		32.0%	30.9%	30.8%	30.3%	30.9%	31.1%	32.7%	33.4%	33.1%	34.3%	7.2%
Scotland		41.7%	40.0%	39.2%	38.6%	39.5%	39.2%	40.1%	41.6%	43.1%	45.1%	8.2%
Northern Ireland		36.5%	35.5%	36.5%	38.1%	37.2%	37.9%	37.2%	40.2%	39.3%	39.8%	9.0%

Source: Higher Education Funding Council for England[386]

383 Students in Higher Education 2013/14, Higher Education Statistics Agency, February 2015, Table A; https://www.hesa.ac.uk/images/stories/hesa/pubs_intro_graphics/STUDENT_1314/student_1314_table_A.xlsx **384** In-house analysis of Students in Higher Education 2013/14, Higher Education Statistics Agency, February 2015, Table 1 – HE students by HE provider, level of study, mode of study and domicile 2013/14; https://hesa.ac.uk/dox/dataTables/studentsAndQualifiers/download/Institution1314.xlsx **385** Provisional figures **386** Trends in young participation in higher education, Higher Education Funding Council for England, October 2013, p7, p21; http://www.hefce.ac.uk/media/hefce/content/pubs/2013/201328/HEFCE_2013_28.pdf. Underlying data provided by hefce

Table 4.16 reveals that of all LEPs, the Liverpool City Region (83.4%) retained the highest percentage of graduates who studied at a higher education institution in that LEP six months after graduation. It also had the third-lowest percentage of graduates who relocated to London (4.7%). London (81.7%) had the fourth-highest retention rate while Hertfordshire had both the lowest retention rate (50.2%) and the highest proportion relocating to London (31.6%).

Table 4.16: Graduate retention and relocation to London rates[387] by Local Enterprise Partnership (LEP) (2012/13) – England

LEP[388]	Region	Percentage retained in region (where known)	Percentage who relocated to London
Liverpool City Region	North West	83.4%	4.7%
Black Country	West Midlands	82.5%	4.2%
Greater Manchester	North West	81.7%	5.0%
London	London	81.7%	-
Lancashire	North West	80.5%	4.8%
North Eastern	North East	79.9%	4.9%
Tees Valley	North East	77.8%	4.5%
Greater Birmingham and Solihull	West Midlands	75.6%	6.7%
Cornwall and the Isles of Scilly	South West	74.9%	9.6%
Leeds City Region	Yorkshire and The Humber	74.9%	6.5%
Humber	Yorkshire and The Humber	72.8%	5.8%
Cumbria	North West	72.8%	5.4%
West of England	South West	72.7%	10.6%
Heart of the South West	South West	71.6%	11.1%
Stoke-on-Trent and Staffordshire	West Midlands	70.8%	5.2%
New Anglia	East of England	70.5%	13.0%
Sheffield City Region	Yorkshire and The Humber (part East Midlands)	70.1%	5.7%
Solent	South East	69.0%	15.2%
Cheshire and Warrington	North West	68.7%	7.4%
Leicester and Leicestershire	East Midlands	68.1%	8.0%
York, North Yorkshire and East Riding	Yorkshire and The Humber	67.4%	8.8%
Coast to Capital	South East (part London)	66.9%	35.1%
Coventry and Warwickshire	West Midlands	66.6%	9.7%
Worcestershire	West Midlands	66.4%	8.0%
Thames Valley Berkshire	South East	66.0%	20.3%
Derby, Derbyshire, Nottingham and Nottinghamshire	East Midlands	64.9%	7.2%
Oxfordshire	South East	63.4%	17.4%
Greater Cambridge & Greater Peterborough	East of England (part East Midlands)	62.5%	16.7%
Dorset	South West	62.2%	13.9%
South East	South East (part East of England)	61.9%	25.3%
Swindon and Wiltshire	South West	61.3%	14.5%
Gloucestershire	South West	60.7%	13.4%
The Marches	West Midlands	59.4%	9.8%
Greater Lincolnshire	East Midlands (part Yorkshire and The Humber)	59.3%	8.9%
South East Midlands	East Midlands (part South East and East of England)	58.6%	15.5%
Northamptonshire	East Midlands	58.5%	11.5%
Enterprise M3	South East	58.4%	26.4%
Buckinghamshire Thames Valley	South East	53.1%	27.0%
Hertfordshire	East of England	50.2%	31.6%

Source: Higher Education Statistics Agency through Department for Business, Innovation and Skills[389]

387 Six months after graduation **388** Where LEP covers more than one region, retention rates have been calculated for the relevant home region for each part of each LEP. Where data were only available at county level, they were apportioned in accordance with Local Authority shares of the county's 18- to 24-year-old population. **389** Mapping Local Comparative Advantages in Innovation: Framework and indicators, Department for Business, Innovation and Skills, July 2015, p98-99; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440755/bis-15-344-mapping-local-comparative-advantages-in-innovation-framework-and-indicators.pdf

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4.3 Workforce and economy

The engineering sector is huge, contributing some 27.1% to the UK's GDP (Table 4.18) and employing 19.3% of the workforce (Table 2.8).[390] This section examines in more detail the engineering workforce and the contribution the sector makes to the economy while also revealing, for the first time, the proportions of engineers and technicians working within engineering enterprises.

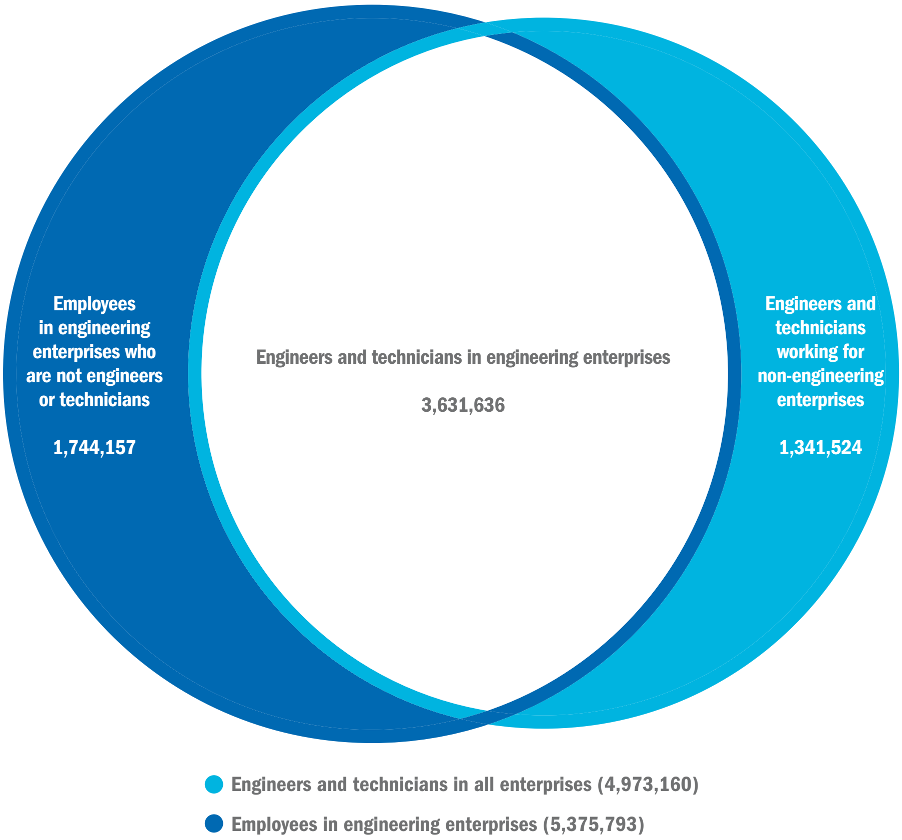
4.3.1 Workforce

Within the engineering community, a question that has repeatedly been asked is to what extent engineers work exclusively within the engineering sector or in the wider economy. Until now, analyses have only been able to provide estimates of the number of employees in engineering occupations and, separately, the number of employees within the engineering sector.

For the first time, EngineeringUK has been able to use the Office for National Statistics' Annual Population Survey (APS)[391 392 393 394] to estimate the number of engineers and technicians working within the engineering sector, the number of engineers and technicians working in other sectors and the number of employees other than engineers and technicians working within the engineering sector.

In 2014, out of a total workforce of 30,232,466,[395] there were 5,375,793 employees in engineering enterprises, two thirds (3,631,636) of whom worked as an engineer or technician.[396] That leaves 1,744,157 other employees in engineering enterprises (such as administrative, business and financial workers). There were 4,973,160 engineers and technicians in the total workforce, a quarter (1,341,524) of whom were working in the wider economy (Figure 4.2).

Figure 4.2: Number of employees in engineering enterprises, engineers and technicians in the total workforce and engineers and technicians in engineering enterprises



Source: Office for National Statistics[397]

390 According to Inter-Departmental Business Register (IDBR) data 391 For information on the Annual Population Survey (APS), see http://www.ons.gov.uk/ons/guide-method/method-quality/quality/quality-information/labour-market/summary-quality-report-for-the-annual-population-survey--aps-.pdf 392 These figures differ from those in section 2.2 as they use APS data rather than IDBR. In chapter 2, IDBR data is used as it allows us to determine turnover as well as number of employees in engineering enterprises and other related figures. However, APS data is used here in order to be able to cross reference the number of engineers and technicians with the number of employees in engineering enterprises. 393 APS sample design provides no guarantee of adequate coverage of any industry, as the survey is not industrially stratified and workers under 16 years of age are not covered. The coverage also omits communal establishments apart from NHS housing and students in halls of residence. Members of the armed forces are only included if they live in private accommodation. 394 The following engineering workforce figures are affected both by the sampling method mentioned in footnote 393 as well as data suppression where samples were too small to provide reliable estimates. Estimates are based on small sample sizes and are therefore subject to a margin of uncertainty. They should therefore be treated with caution. 395 The overall workforce figure is not affected as significantly by sampling and suppression as are individual SIC and SOC code data. This means that it is substantially larger than the total produced by summing all those estimated to be working within a SIC and SOC code, which was 25,667,378 in 2014 396 Defined by EngineeringUK using the Office for National Statistics' system of Standard Industrial Classification (SIC) and Standard Occupational Classification (SOC) codes 397 In-house analysis conducted using EngineeringUK's SIC/SOC engineering footprint of Annual Population Survey: January-December 2014, Office for National Statistics, March 2015, Workbook: Four/Five digit industry (SIC) cross-referenced with four digit occupation (SOC) (Jan-Dec 2014); http://www.ons.gov.uk/ons/about-ons/business-transparency/freedom-of-information/what-can-i-request/published-ad-hoc-data/labour/march-2015/four-five-digit-industry--sic-.xls

Table 4.17: Residents employed in science, research, engineering and technology professions and associated professions by Local Enterprise Partnership (LEP) (July 2013 – June 2014) – England

LEP area	Region	Percentage of all in employment who are in 'science, research, engineering and technology' professions and associated professions
Oxfordshire	South East	12.9%
Thames Valley Berkshire	South East	12.6%
Greater Cambridge and Greater Peterborough	East of England (part East Midlands)	10.9%
West of England	South West	10.2%
Enterprise M3	South East	10.0%
Cheshire and Warrington	North West	9.3%
Swindon and Wiltshire	South West	9.1%
Buckinghamshire Thames Valley	South East	9.0%
Hertfordshire	East of England	8.6%
Solent	South East	8.2%
Coventry and Warwickshire	West Midlands	7.7%
Worcestershire	West Midlands	7.7%
Cumbria	North West	7.6%
Leicester and Leicestershire	East Midlands	7.6%
London	London	7.6%
Gloucestershire	South West	7.5%
South East Midlands	East Midlands (part South East and East of England)	7.3%
Coast to Capital	South East (part London)	7.1%
York, North Yorkshire and East Riding	Yorkshire and The Humber	6.8%
Derby, Derbyshire, Nottingham and Nottinghamshire	East Midlands	6.6%
The Marches	West Midlands	6.6%
Dorset	South West	6.6%
Tees Valley	North East	6.4%
Greater Manchester	North West	6.3%
Greater Birmingham and Solihull	West Midlands	6.3%
Lancashire	North West	6.2%
South East	South East (part East of England)	6.1%
Leeds City Region	Yorkshire and The Humber	6.0%
New Anglia	East of England	5.9%
North Eastern	North East	5.9%
Stoke-on-Trent and Staffordshire	West Midlands	5.9%
Sheffield City Region	Yorkshire and The Humber (part East Midlands)	5.8%
Liverpool City Region	North West	5.8%
Heart of the South West	South West	5.6%
Northamptonshire	East Midlands	5.6%
Humber	Yorkshire and The Humber	5.3%
Cornwall and Isles of Scilly	South West	5.2%
Greater Lincolnshire	East Midlands (part Yorkshire and The Humber)	5.1%
Black Country	West Midlands	4.4%
England		7.2%

Source: Office for National Statistics through Department for Business, Innovation and Skills[398]

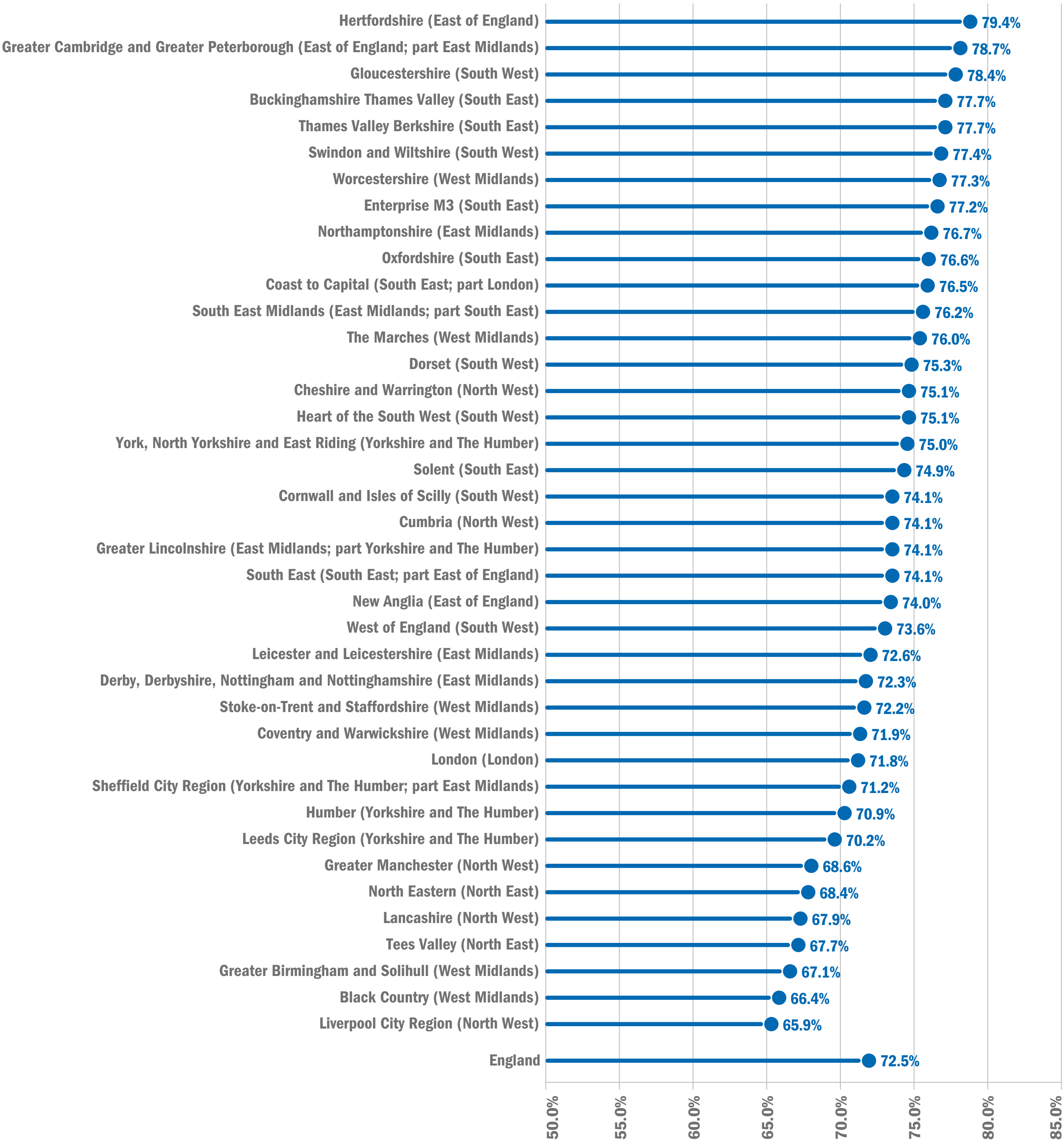
Table 4.17 shows the percentage of residents in each LEP who were employed in science, research, engineering and technology professions and associated professions in the 12 months to June 2014. Oxfordshire (12.9%) had the largest percentage of residents working in these occupations, closely followed by Thames Valley Berkshire (12.6%). In fact, five of the top 10 LEPs are within the South East. The England average was 7.2%, while none of those LEPs in the North East and Yorkshire and The Humber had percentages above this. The Black Country in the West Midlands had the lowest percentage at 4.4%.

398 Mapping Local Comparative Advantages in Innovation: Framework and indicators, Department for Business, Innovation and Skills, July 2015, p80

Figure 4.3 shows employment rates for those aged 16-64 by LEP. The rate for England is 72.5%, with Hertfordshire (in the East of England region) and Greater Cambridge & Greater Peterborough (mainly in the East of England but partly in the East Midlands) leading the way with 79.4% and 78.7% respectively. The South East has the most LEPs in the top 10, with four, while the North East, North West, Yorkshire and The Humber and London have none.

The bottom 10 LEPs by employment rate are located in just four regions, with Yorkshire and The Humber having three, and the North East, North West and West Midlands having two each. Liverpool City Region has the lowest at 65.9%.

Figure 4.3: Employment rates 16-64s by Local Enterprise Partnership (LEP) (October 2013 – September 2014) – England



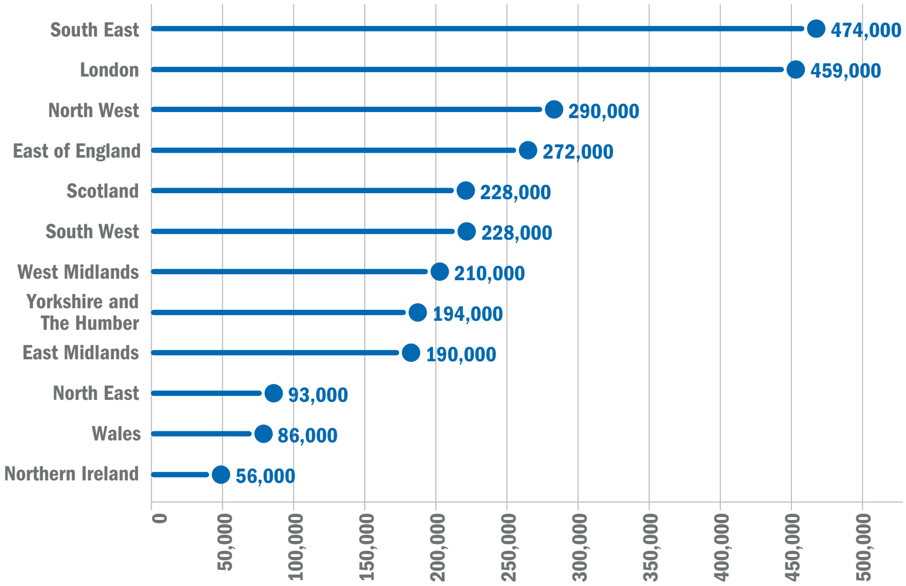
Source: Office for National Statistics through Department for Business, Innovation and Skills[399]

399 Mapping Local Comparative Advantages in Innovation: Framework and indicators, Department for Business, Innovation and Skills, July 2015, p191

As might be expected by the larger populations in the English regions, the South East and London have the largest numbers of residents employed in high level STEM occupations (Figure 4.4). The North East, with the smallest population, is at the bottom of the list. However, this is still above the number in Wales, which has a larger population than the North East.

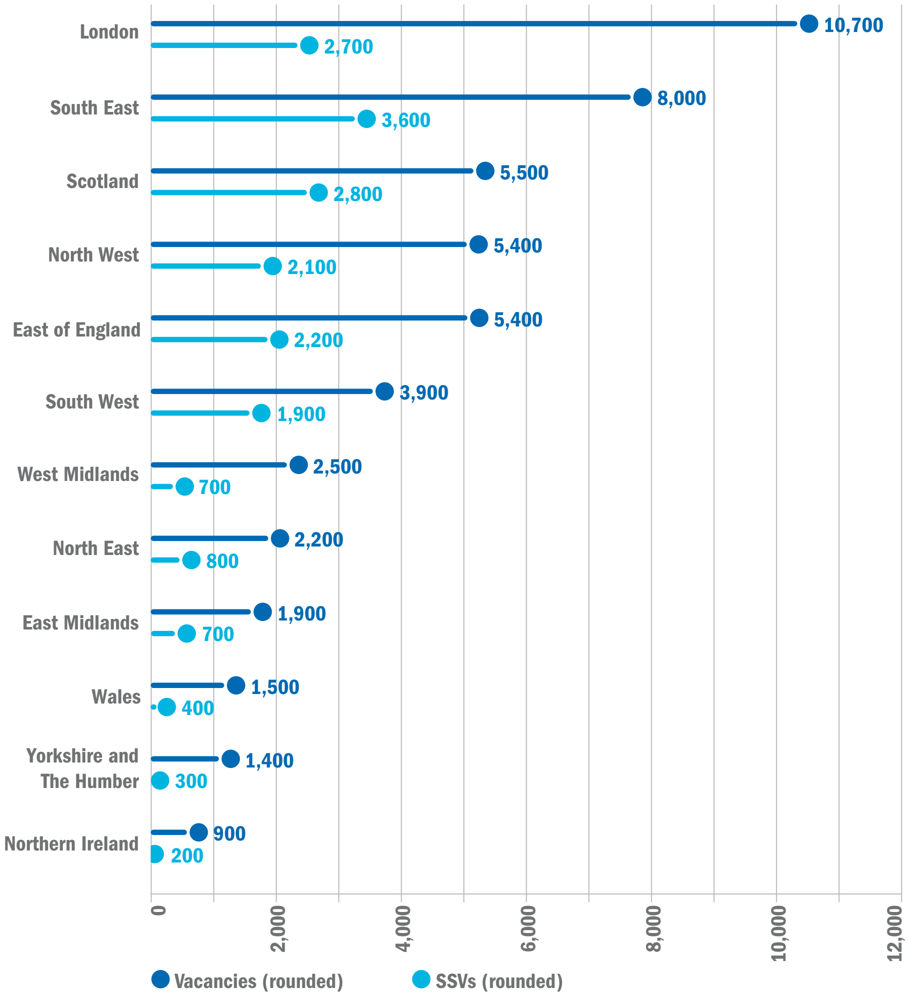
Figure 4.5 shows that London has the largest number of vacancies for high level STEM occupations (10,700). However, it has a lower number of Skills Shortage Vacancies (2,700) than the second-placed South East (3,600) and third-placed Scotland (2,800). This is despite their having a smaller number of vacancies overall (8,000 and 5,500 respectively). This reflects London's position as an attractive destination for skilled professionals.

Figure 4.4: Distribution of employment in high level STEM occupations by nation and English region (2012) – UK



Source: UK Commission for Employment and Skills[400]

Figure 4.5: Distribution of vacancies and Skills Shortage Vacancies for high level STEM occupations by nation and English region (2013) – UK



Source: UK Commission for Employment and Skills[401]

400 Reviewing the requirement for high level STEM skills: Evidence Report 94, UK Commission for Employment and Skills, July 2015, p63; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444052/stem_review_evidence_report_final.pdf. Underlying data provided by UKCES 401 Reviewing the requirement for high level STEM skills: Evidence Report 94, UK Commission for Employment and Skills, July 2015, p64. Underlying data provided by UKCES

4.3.2 Economy

In 2014, engineering sectors contributed some £456 billion to UK GDP – 27.1% of the UK total (Table 4.18). Of the UK nations, Northern Ireland had the smallest engineering sector as a proportion of national GDP, contributing around £8 billion – 22.1% of the national total. The engineering sectors of Wales (£17 billion, 28.4%) and Scotland (£51 billion, 38.7%) both contributed a greater percentage of GDP to their nations' totals than England.

Table 4.19 shows that the UK demand for new engineering roles (both newly created and replacement for those moving on and retiring) will be 2,561,000 by 2022, with a contribution to GDP of £269 billion.

Table 4.18: Contribution of engineering sectors to Gross Domestic Product (GDP)[402] by nation (2014) – UK

	Direct contribution of engineering to GDP	Total GDP (estimated)	Engineering GDP as a percentage of total GDP
England	£380,100,000,000	£1,456,300,000,000	26.1%
Wales	£16,600,000,000	£58,400,000,000	28.4%
Scotland	£50,800,000,000	£131,400,000,000	38.7%
Northern Ireland	£8,100,000,000	£36,900,000,000	22.1%
UK total	£455,600,000,000	£1,683,000,000,000	27.1%

Source: Centre for Economics and Business Research[403 404]

Table 4.19: Total demand for replacement and expansion in engineering roles and their GDP contribution by nation and English region (2012-2022)

Nation	Region[405]	Total demand	2022 GDP forecast
England		2,184,000	£233,959,000,000
	North East	95,000	£8,633,000,000
	North West	274,000	£25,750,000,000
	Yorkshire and The Humber	185,000	£17,160,000,000
	East Midlands	193,000	£17,320,000,000
	West Midlands	211,000	£19,172,000,000
	East of England	247,000	£25,386,000,000
	London	352,000	£52,912,000,000
	South East	402,000	£46,258,000,000
	South West	224,000	£21,367,000,000
Wales		97,000	£8,081,000,000
Scotland		215,000	£21,052,000,000
Northern Ireland		65,000	£5,621,000,000
UK		2,561,000	£268,713,000,000

Source: Centre for Economics and Business Research[406]

402 Figures rounded to the nearest £100,000,000 **403** UK source: The contribution of engineering to the UK economy, Centre for Economics and Business Research, October 2014, p4; http://www.engineeringuk.com/_resources/documents/The%20Contribution%20of%20Engineering%20to%20the%20UK%20Economy%20-%20CEBR%20-%20October%202014.pdf **404** Nations source: Bespoke analysis by Centre for Economics and Business Research for EngineeringUK **405** English regions do not sum to national total due to rounding **406** The contribution of engineering to the UK economy, Centre for Economics and Business Research, October 2014, p11

Part 1 – Engineering in Context
5.0 Understanding and influencing target audiences

Increasing the supply of STEM students and, ultimately, engineers and technicians is dependent above all else on one thing – perception. In 2015, 43% of 11- to 14-year-olds believe that a career in engineering is desirable, while 49% of 15- to 16-year-olds say that they would consider a career in engineering. Just four years ago, in 2012, the corresponding figures were 38% for desirability and 39% for consideration of a career.

Despite these improvements, considerable challenges remain. For example, when asked which one engineering development of the last 50 years has had the greatest impact on them, around two in five (39%) adults could not do so. This is despite the fact that respondents would have been using a computer, smartphone or tablet to complete the survey online.[407] Given that we need to recruit 182,000 workers with engineering skills per year to 2022 just to meet demand, and that we are currently facing a shortfall of 69,000 with engineering skills at level 3+, improving perceptions remains key.

These baseline perceptions, the means of improving them, and the impact that interventions can have, are explored in this section – with a focus on inspiration and aspiration interventions, careers guidance and work experience.

5.1 Baseline perceptions

The Engineers and Engineering Brand Monitor (EEBM)[408] is EngineeringUK's annual survey of engineering and STEM perceptions among nationally-representative samples of the population. Young people, adults and STEM educators are all involved and, in 2015, the questionnaires have been harmonised so that comparisons between these three groups for a number of questions are possible for the first time.

Over the past few years, the EEBM has increasingly been used not only as a benchmark of perceptions for EngineeringUK's engagement activities, but also by the wider engineering and STEM community. This year, several key results have suggested that, while underlying perceptions of engineering are improving, there is still much work to be done.

While 49% of those aged 15-16[409] responded positively to the question "do you think you would ever consider a career in engineering?" in the EEBM – around a quarter (25.6%) more than in 2012 (39%) – the figure has remained consistently lower than for those aged 11-14:[410] 53% in 2015. As has been found in other studies, this suggests that motivation to pursue engineering (and all STEM subjects) wanes significantly as young people progress through secondary school. This may have something to do with them having chosen subjects for GCSE (and equivalent) that will not allow them to pursue engineering. However, this opens up an argument for ensuring that they keep their options open by continuing to study STEM.[411] Indeed, the President of The British Science Association, Dame Athene Donald, has argued that forcing young people to make subject choice decisions at 14 divides the nation "into sheep and goats, science people and arts people," with our culture making it seem as if "scientists are the outsiders".[412]

407 Survey of 2,015 adults aged 18+ commissioned by EngineeringUK and carried out by Populus. **408** To see this year's report, as well as those stretching back to 2009, click on the Engineers and Engineering Brand Monitor 'accordion' at the bottom of http://www.engineeringuk.com/Research **409** Key Stage 4 in England, Wales and Northern Ireland **410** Key Stage 3 in England, Wales and Northern Ireland **411** This strategy is put forward in ASPIRES: Young people's science and career aspirations, age 10 –14, King's College London, November 2013, p4; https://www.kcl.ac.uk/sspp/departments/education/research/aspires/ASPIRES-final-report-December-2013.pdf **412** Lack of science and maths skills 'can hamper adults', BBC News, 4 September 2015; http://www.bbc.co.uk/news/education-34144310

There has been a consistent upward trend in the perceived desirability of engineering among 11- to 14-year-olds surveyed in the EEBM. Since 2012, when 38% felt that a career in engineering was desirable, there has been a steady one to two percentage point increase, resulting in 43% believing it to be desirable in 2015. Meanwhile, perceptions of desirability among educators remained relatively steady from 2012-14, before increasing dramatically in 2015 from 57% to 79%. This means that teachers are now nearly twice as likely as pupils to believe engineering is desirable. The percentage of educators who believe a career in engineering is undesirable has declined in parallel, falling sharply this year to 8% from 17% in 2014. However, 12% of teachers aged 35-44 still said that a career in engineering was undesirable for their pupils.

Despite progress, only 30% of pupils aged 11-14, 34% of 15-16s and 24% of 17-19s say that they know what people who work in engineering do. For all age groups, knowledge of engineering was below that of science and technology. Parents (24%) had even lower levels of knowledge than 11- to 14-year-olds regarding engineering. However, teachers were much more likely to be knowledgeable (44%). With the exception of teachers, all audiences were more likely to know what people working in technology do compared to those working in engineering or science.

More generally, research for The Department for Business, Innovation and Skills (BIS) found that:

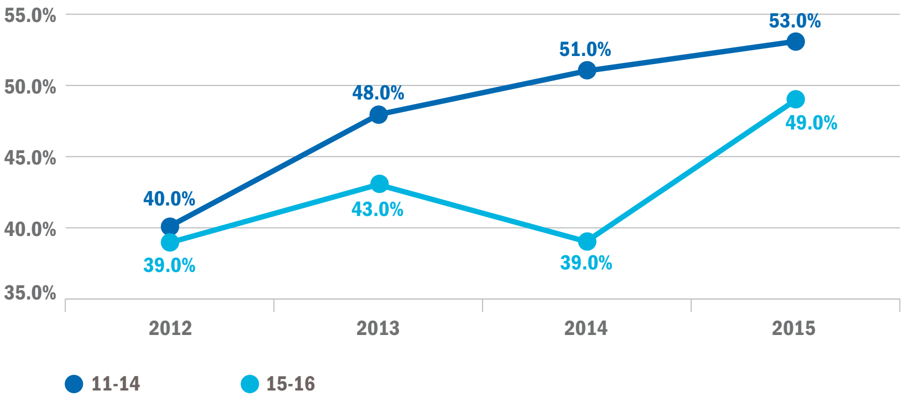
"Young people tend to have an internal sense of potential. They all feel they have 'ideas' and something to offer in life. However, as they progress through their school career, external factors such as their perception of the job market, their exam grades, as well as social and gender expectations means their sense of potential all too often gets dampened and doesn't translate into active ambition for their future."[415]

The research also suggests that young people's "views on careers are often limited to what they know or have experienced and they discuss having impact on those close to hand." It suggests that "focussing on the potential that their actions could have a wider impact on the world can feel daunting and overwhelming."[416] Young people "get frustrated and lose interest fast if they do not understand something and do not see the relevance of the subjects they learn"[417] with 82% agreeing that "I find it easier to learn stuff I think I'll use when I start work."[418]

The study also suggested that only 44% of 13- to 14-year-olds stated that they believe being intelligent earns respect, although this did rise to 55% among 17- to 18-year-olds.[419] Meanwhile, 77% of young people agreed that you need to be really clever to work in STEM.[420] The *ASPIRES* study showed that 80% of young people believe that "scientists are brainy". Unfortunately, the authors conclude, this "influences many young people's views of science careers as 'not for me'"- even if they find science interesting and have good attainment in the subject.[421]

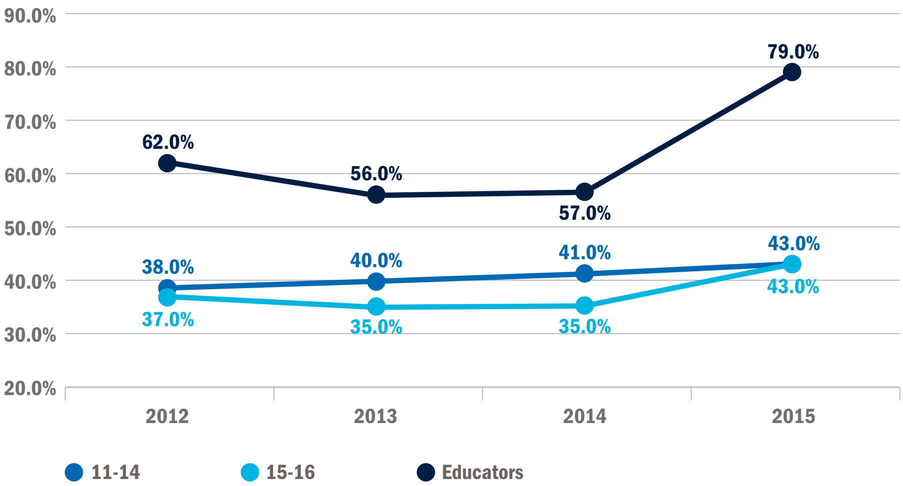
However, through interventions such as The Big Bang Fair and Tomorrow's Engineers, we have shown that these perceptions can be improved. For example, 46% of 11- to 14-year-old girls who attended the Big Bang Fair 2015 knew what people who work in engineering do. This compares with just 16% surveyed by the EEBM 2014.[422] They were also twice as likely to believe that a career in engineering is desirable (52% vs 26%). KS3 students who attended the in-school aspiration programme Tomorrow's Engineers were also much more likely to be knowledgeable about what engineers do than their EEBM counterparts (50% vs 25%). This figure includes a large increase in the likelihood of girls at KS3 knowing (43% vs 16%). For desirability, the figures were 49% for KS3 students attending Tomorrow's Engineers and 41% among their EEBM counterparts, while for KS3 girls they were 37% vs 26%. Also, more than half (51%) of 15- and 16-year-olds said that The Big Bang Fair had

Figure 5.1: Young people aged 11-14[413] and 15-16 who would consider a career in engineering (2011-2015) – UK



Source: Engineers and Engineering Brand Monitor 2015

Figure 5.2: Young people aged 11-14[414] and 15-16 and educators who believe a career in engineering is desirable for them/their pupils (2011-2015) – UK



Source: Engineers and Engineering Brand Monitor 2015

413 2012 EEBM figures refer to responses from 12- to 14-year-olds 414 2012 EEBM figures refer to responses from 12- to 14-year-olds 415 Project STEM Book of Insights 2014, Department for Business, Innovation and Skills, September 2014, p6; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/351433/BIS-14-899-STEM-book-of-insights.pdf 416 Project STEM Book of Insights 2014, Department for Business, Innovation and Skills, September 2014, p7 417 Project STEM Book of Insights 2014, Department for Business, Innovation and Skills, September 2014, p10 418 Project STEM Book of Insights 2014, Department for Business, Innovation and Skills, September 2014, p11 419 Project STEM Book of Insights 2014, Department for Business, Innovation and Skills, September 2014, p16 420 Project STEM Book of Insights 2014, Department for Business, Innovation and Skills, September 2014, p64 421 ASPIRES Young people's science and career aspirations, age 10 –14, King's College London, November 2013, p3 422 The 2014 EEBM is used here for comparison since the 2015 edition was carried out after The Big Bang Fair 2015.

motivated them to choose physics as an option when they have the choice – including 38% of girls. This represents a significant success given that just 2% of 18-year-old girls in England, Wales and Northern Ireland currently enter A level physics exams. In addition, 82% of 11- to 14-year-olds felt that The Fair had showed them that engineering is suitable for both boys and girls. For Tomorrow's Engineers, the figure was even higher, at 83% – including 86% of girls.

5.2 Effective intervention

If we are to challenge young people's baseline perceptions and encourage more of them into STEM, and, indeed, to continue studying STEM subjects, we must make evidence-based interventions.

The evidence base for interventions designed to improve perceptions and knowledge of STEM among young people is diverse and even occasionally contradictory. However, several themes have become apparent that inform the majority of pupil engagement strategies in the STEM community. This has led to a number of programmes based on inspiration and aspiration activities that focus on improving enjoyment of STEM – especially among 11- to 14-year-olds – as well as effective careers guidance linked to the curriculum. EngineeringUK's own engagement programmes, The Big Bang Fair and Tomorrow's Engineers, are predicated on this strategy.

The focus on enjoyment is informed by research that has shown it to be as significant as attainment in a pupil's likelihood to pursue that subject further.[423 424] A recent survey by E.ON of 16- to 18-year-olds found that they were most likely to progress their studies in subjects they enjoy (71%) than those they think will support their future career paths (29%).[425] Research commissioned by BIS showed that "enjoying a subject is key to taking it further". The study also noted that "after GCSEs, they get to drop the ones they didn't enjoy and focus on the ones they prefer," with the initial excitement and enjoyment of new subjects such as science and design and technology waning during GCSEs as difficulty increases.[426]

EngineeringUK's own research has looked at student subject decision making aged 14 and 16, and identified that 89% of those asked said that enjoyment of a subject influenced their decision to select it at GCSE or A level.[427] The *ASPIRES* study has also shown that, while students remain positive about science as a potentially academically-rewarding subject from Year 6 to Year 9 (10- to 14-year-olds), their enjoyment decreases year-on-year. Qualitative data suggest that the significant drop-off in Year 9 is due largely to an increasing focus on exams and written work, at the expense of practical activities – particularly in the run-up to GCSEs.[428]

There is much evidence[429 430 431] to suggest that the 11- to 14-year-old age group is both the most likely point at which young people can lose interest in STEM[432] and at which interventions can have the greatest effect. Indeed, influencing young people before they choose the subjects they will study at GCSE and equivalent is the basis of most STEM intervention programmes, including The Big Bang and Tomorrow's Engineers. The BIS study has highlighted three "key decision points":[433]

- Year 9 when they start making decisions for their GCSEs and have been influenced by two years of secondary school
- Year 11 when the reality that the next step after school is imminent and career / further subject choices have to be made
- Year 12 (or equivalent age at FE college) when higher education or job choices have to be made

Aspiration is likely to be a reliable indicator of a young person's future career, and there is a large body of evidence to show that interest in science is formed by the age of 14. Students who had an expectation of science-related careers at that age were 3.4 times more likely to earn a physical science and engineering degree than students without this expectation.[434]

All of this evidence has led to an underlying strategy of STEM engagement which comprises three things:

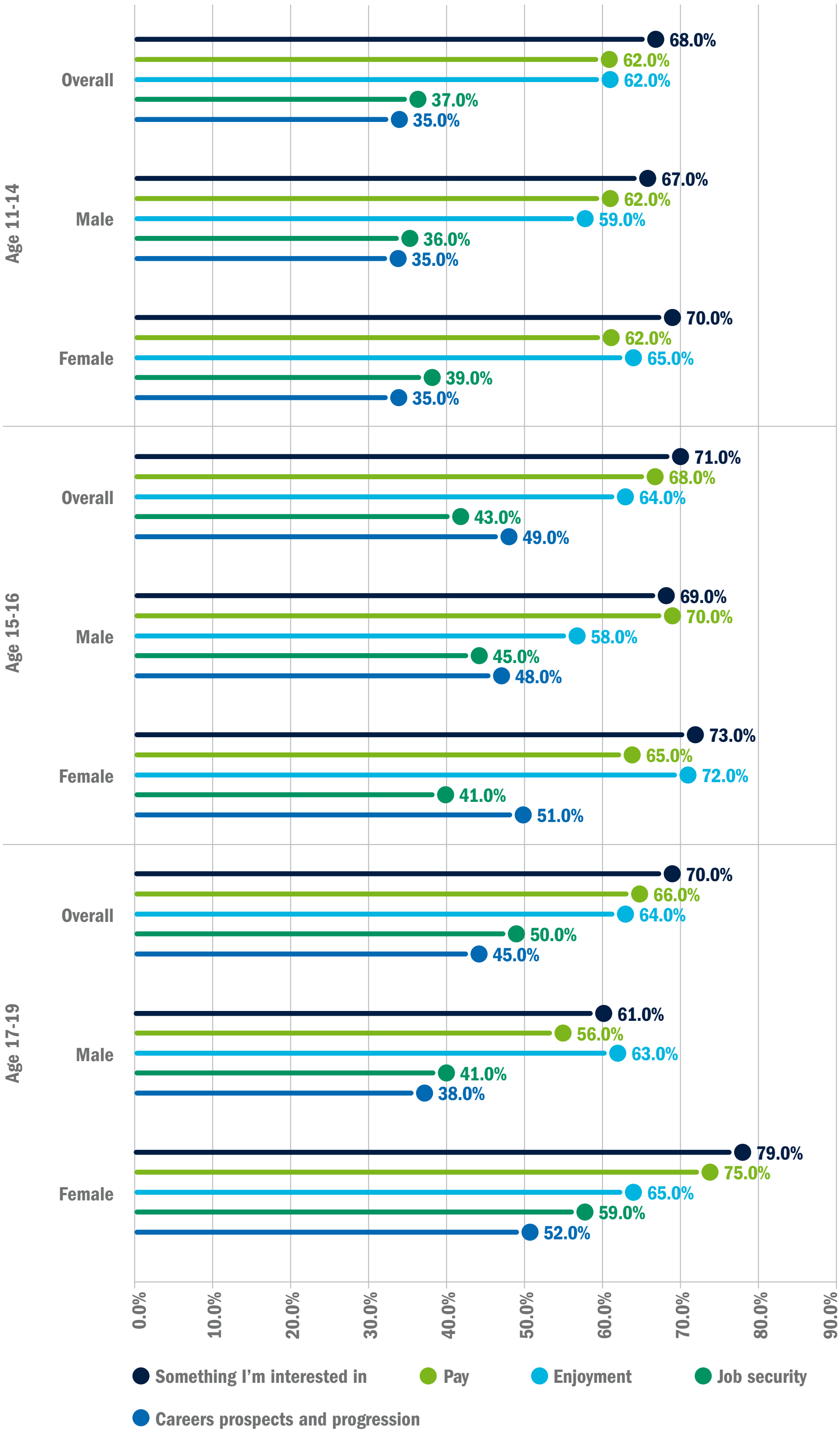
1. Inspiration (from employer role models and educators in STEM)
2. Aspiration (to pursue STEM subjects and careers)
3. Application (to STEM qualifications and careers)

This year, results from the Engineers and Engineering Brand Monitor have suggested a key specific addendum to this strategy: focus on pay.

Figure 5.3 shows the results of a question asking pupils which factors were most important to them when deciding on a career. The top three responses given by all ages were "something I'm interested in", "pay" and "enjoyment". Girls in the 17- to 19-year-old group were most likely to rate pay as an important factor, with three quarters (75%) doing so. This focus on pay among young people was also highlighted in research commissioned by BIS, which states that "money is important to young people when considering their careers, they want to be able to afford what they want in life and become independent."[435]

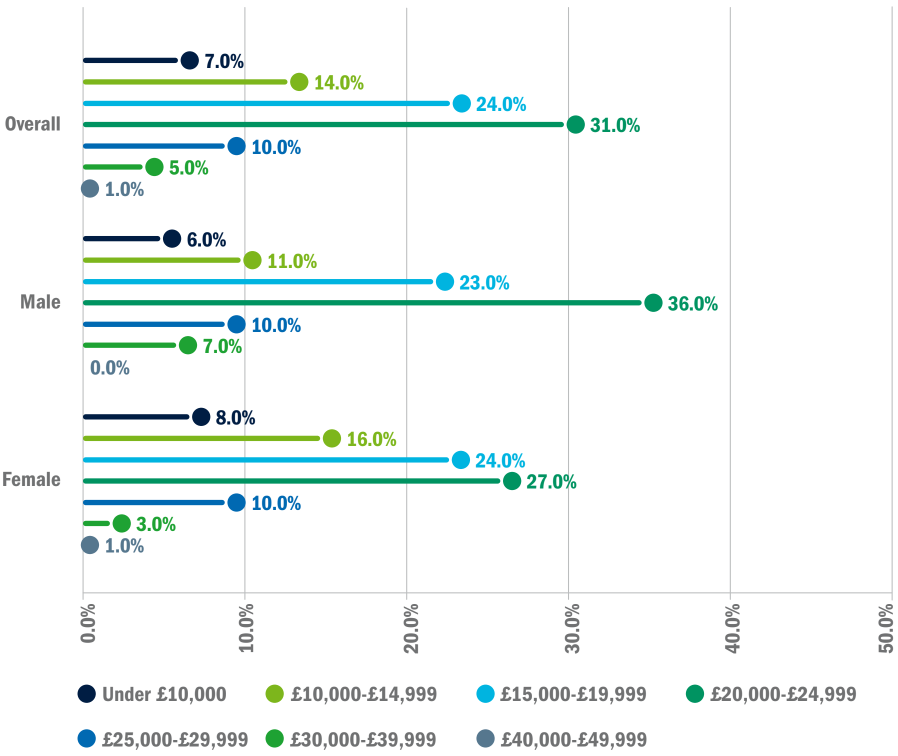
423 An investigation into why the UK has the lowest proportion of female engineers in the EU, EngineeringUK, 2011. Available at http://www.engineeringuk.com/_resources/documents/Apr%202011%20An%20investigation%20into%20why%20the%20UK%20has%20the%20lowest%20proportion%20of%20female%20engineers%20in%20the%20EU.pdf **424** Schools that make a difference to post-compulsory uptake of science: final project report to the Astra Zeneca Science Teaching Trust, University of York, Department of Education, Bennett J, Hampden-Thompson G and Lubben F, 2011; https://www.york.ac.uk/media/educationalstudies/documents/research/AZ%20FINAL%20REPORT%2023%20June%202011.pdf **425** Stepping up to STEM: Inspiring the bright sparks of tomorrow, E.ON, September 2015; http://pressreleases.eon-uk.com/blogs/eonukpressreleases/archive/2015/09/07/2454.aspx **426** Project STEM Book of Insights 2014, Department for Business, Innovation and Skills, September 2014, p42 **427** Student subject decision making aged 14 and 16, EngineeringUK, July 2011, p2; http://www.engineeringuk.com/_resources/documents/Jul%202011%20Student%20subject%20decision%20making%20aged%2014%20and%2016.pdf **428** ASPIRES Young people's science and career aspirations, age 10 –14, King's College London, November 2013, p17 **429** See STEM Careers Awareness Timelines: Attitudes and ambitions towards science, technology, engineering and maths (STEM at Key Stage 3), International Centre for Guidance Studies, 2009; http://www.derby.ac.uk/media/derbyacuk/contentassets/documents/ehs/icegs/STEM-Careers-Awareness-Timelines-final-version.pdf **430** AP8: STEM Careers Awareness Timelines STEM subjects and jobs: A longitudinal perspective of attitudes among Key Stage 3 students, 2008 – 2010, International Centre for Guidance Studies, 2011; https://www.nationalstemcentre.org.uk/res/documents/page/STEM-Attitudes-and-Ambitions-Survey-KS3-Phase2-Report-2011.pdf **431** Good Timing: Implementing STEM careers strategy in secondary schools, Centre for Education and Industry, University of Warwick, the International Centre for Guidance Studies, University of Derby and Isinglass Consultancy Ltd, November 2011; http://www.derby.ac.uk/media/derbyacuk/contentassets/documents/ehs/icegs/icegs_good_timing2011.pdf **432** Student attitudes, engagement and participation in STEM subjects, The University of York, October 2013, p 24; https://royalsociety.org/~/media/education/policy/vision/reports/ev-3-vision-research-reports-20140624.pdf **433** Project STEM Book of Insights 2014, Department for Business, Innovation and Skills, September 2014, p41 **434** What shapes children's science and career aspirations age 10-13?, King's College London, 2013, p3; https://www.kcl.ac.uk/sspp/departments/education/research/aspires/ASPIRES-summary-spring-2013.pdf **435** Project STEM Book of Insights 2014, Department for Business, Innovation and Skills, September 2014, p30

Figure 5.3: Young people aged 11-14, 15-16 and 17-19's top 5 factors in career choices (2015) – UK



Source: Engineers and Engineering Brand Monitor 2015

Figure 5.4: 17- to 19-year-olds' perceived average starting salary of graduate engineers (2015) – UK



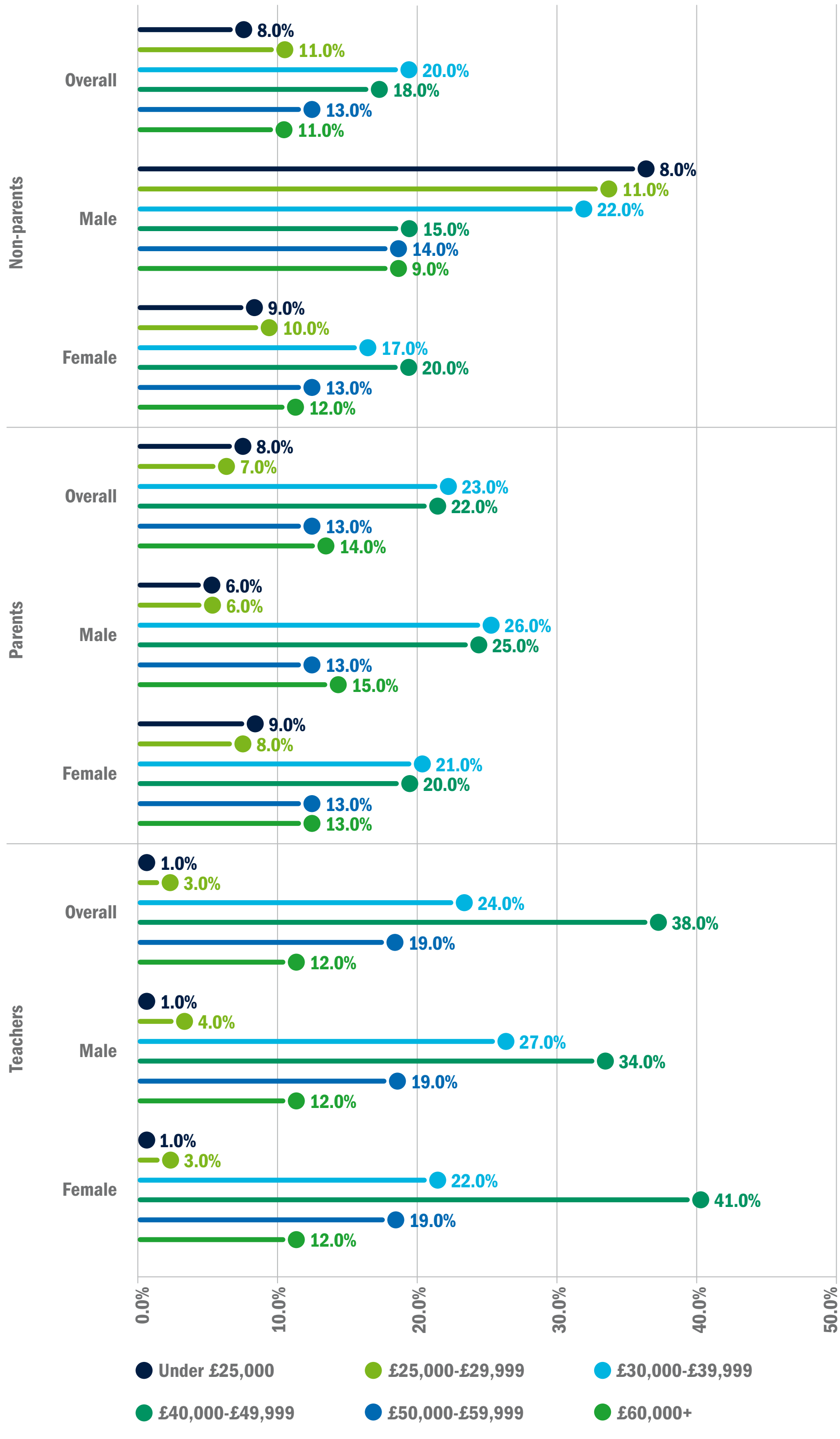
Source: Engineers and Engineering Brand Monitor 2015

Figure 5.4 displays the responses given by 17-19s when asked what they believe to be the average starting salary of a *graduate engineer*. The mean response given was £19,744, with males providing a higher mean figure (a mean of £20,551) than females (a mean of £18,995). The latest (2013/14) average starting salary figures for graduates working in engineering and technology was £27,079.[436] This suggests that 17- to 19-year-olds are underestimating the actual average starting salaries by approximately 27%. In fact, 17- to 19-year-old girls underestimate it by around 30%. Informing girls of the financial benefits of choosing a job in engineering – especially given that the perceived starting salary is an underestimate – may form an important aspect of careers guidance.

Meanwhile, parents, non-parents and teachers were asked the average salary of a *professional engineer* (Figure 5.5). The mean response given by teachers (£46,355.60) was slightly higher than that given by parents (£44,452) or non-parents (£43,204.70). In all cases, the salary perceptions were significantly below the reality. The latest figures relating to the average salary of Chartered Engineers are a mean of £68,539 and a median of £60,000.[437] Although the EEBM question referred to engineers further down their career path, it still suggests that all influencers underestimate the extent of financial rewards resulting from a career in engineering. Given the importance of teachers[438] and parents in advising young people, accurate information should be provided to them.

436 See section 13.1 **437** Engineering Council 2013 Survey of Professionally Registered Engineers and Technicians data: Table 14.8 **438** See section 5.2.2

Figure 5.5: Non-parents, parents and teachers' perceived average salary of professional engineers (2015) – UK



Source: Engineers and Engineering Brand Monitor 2015

All of this suggests that interventions designed to increase the number of young people choosing STEM subjects that facilitate entry into STEM careers should focus on promoting the high wage premiums and salaries in general associated with STEM careers. This is supported by research from the Universities of Birmingham and Bristol, which showed that a one-hour lesson comprising two activities that used data on graduate earnings (with mathematics and engineering being high wage premium subjects) resulted in a 10 percentage point increase in the uptake of mathematics. Conversely, enrolment in art and biology (both low graduate wage premium subjects) fell by about a quarter.[439]

5.2.1 STEM inspiration and engagement activities

Inspiration and aspiration engagement activities remain a core priority for the STEM community. Results from the EEBM suggest that these efforts to get young people involved in STEM are showing dividends. Compared with 2014, there have been increases in 11-14s and 15-16s taking part in science-related activities outside of school: from 63% to 70% for 11-14s and from 48% to 61% for 15-16s.

An Institution of Engineering and Technology (IET) survey showed that the most popular potential way to promote engineering among young people was "school trips to see what Engineers do"(67%), while "visits to school from Engineers" (56%), "Engineering Club at school" (56%) and "more practical activities in school" (54%) were also favoured.[440]

The importance of this type of engagement cannot be overstated. A 2012 YouGov survey for the Education and Employers Taskforce showed that "the 7% of young adults surveyed who recalled four or more [employer engagement] activities while at school were five times less likely to be Not in Employment, Education or Training (NEET) and earned, on average, 16% more than peers who recalled no such activities."[441 442]

The core principles of careers engagement activities are, in general, accepted across the STEM community. However, it has been suggested that the delivery of these activities could be refined. The Institution of Mechanical Engineers has suggested that STEM engagement and education needs to be tailored toward the individual requirements of "Five Tribes"[443] within the potential audience. These range from "STEM Devotees" to "Social Artists", "Enthused Unfocused", "Individualists" and the

439 Labour market knowledge and choice of subject to study: A Pragmatic Cluster Randomized Controlled Trial, Peter Davies, Neil Davies, Tian Qiu, December 2014; https://www.srhe.ac.uk/conference2014/abstracts/0049.pdf **440** Inspiring the next generation of engineers: research report, Institution of Engineering and Technology, March 2015, p93; http://www.engineer-a-better-world.org/media/1011/ssd905-inspiring-the-next-generation-research-report-v2.pdf **441** It's who you meet: why employer contacts at school make a difference to the employment prospects of young adults, Education and Employers Taskforce, 2012, p1; www.educationandemployers.org/media/15052/its_who_you_meet_final_report.pdf **442** see Section 16.4.1 for a detailed case study on employer engagement **443** Five Tribes: Personalising Engineering Education, Institution of Mechanical Engineers, December 2014; http://www.imeche.org/docs/default-source/knowledge/five-tribes-ersonalising-engineering-education.pdf?sfvrsn=0

"Less Engaged". The IMechE recommends giving more encouragement to those who are enthusiastic but currently lacking in confidence, showing a wide range of technologies in engagement activities to appeal to a broader range of young people, and highlighting links between capabilities, interest and values and career opportunities.[444]

Research by the Education and Employers Taskforce reinforces the importance of employer engagement with pupils, particularly for those students expected to be low- and mid-achieving. In relation to Key Stage 4 pupils, teachers felt that:

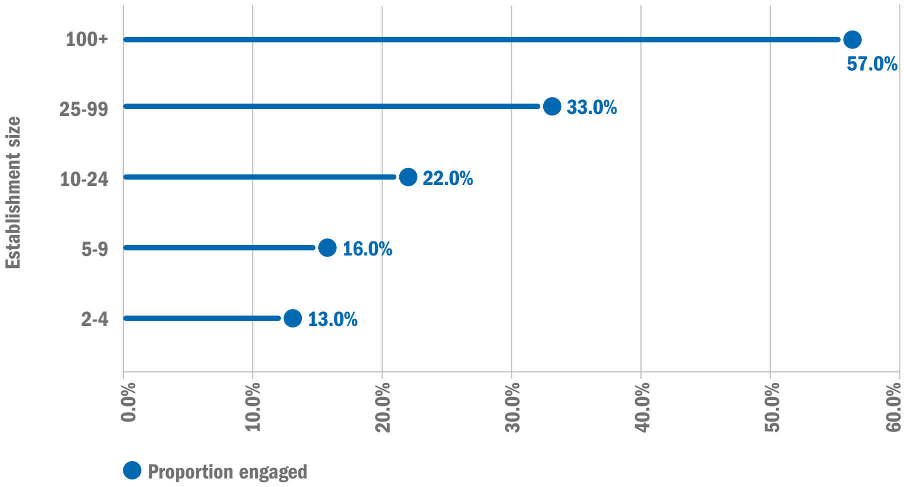
- pupils often gained something new and distinct from their engagements with employers
- they were highly attentive to the views expressed by employers on the value of education and qualifications
- employer engagement impacts on achievement primarily through increasing pupil motivation
- the greatest impact can be expected among middle and lower level achievers – as high achievers are commonly highly motivated already[445]

In relation to Key Stage 5 students, teachers reported that:

- employer engagement formed an essential element in ensuring lower achievers at Key Stage 4 avoid being NEET at post-16
- young people interact with employers in very different ways to school staff
- young people gain both in terms of enhanced motivation to achieve but also through improved contextualisation of learning[446]

There is evidence of a large base of support from employers in delivering schools' engagement. The UK Commission for Employment and Skills (UKCES) has suggested that "18% of employers have been involved with their local schools, colleges and universities to offer the kind of 'inspirational' activities that engage young people with the world of work: things like mentoring, careers talks and mock interviews."[447] This does, however, vary significantly depending on the size of the employer, with just 13% of those with 2-4 employees engaging, compared with 57% of those with 100+ (Figure 5.6). While the Tomorrow's Engineers programme has found that engineering employers of all sizes are willing to engage, those with more than 100 employees make up just 0.9% of all engineering employers compared with 63% of all employers (Figure 2.3).

Figure 5.6: Proportion of employers that had engaged with educational institutions for 'work inspiration' type activities (2014) – UK



Source: UK Commission for Employment and Skills[448]

Table 5.1 shows the most commonly-stated problem encountered by employers when engaging with schools was that schools were simply not interested. Difficulties communicating with the institutions during initial contact (15%) and subsequently (13%) were third and fourth on the list. This suggests that ensuring that schools see the benefits of engagement and improving the brokering of relationships remain high on the list of priorities for STEM engagement.

Table 5.1: Problems encountered by employers when engaging with educational institutions for the purposes of providing work experience/inspiration (2014) – UK

	Schools	FE colleges	Universities
These institutions are not interested in engaging with our organisation / industry	36%	22%	36%
Poor quality candidates / tuition	21%	23%	8%
Difficulties communicating with these institutions – initial contact	15%	15%	28%
Difficulties communicating with these institutions – after initial contact	13%	18%	19%
Too much bureaucracy / red tape	13%	7%	16%
Hard to fit work experience around academic calendar / timetable	5%	5%	5%
Internal issues within the institutions (internal politics, lack of organisation)	3%	7%	4%
Not been approached by these institutions	2%	1%	0%
Very few institutions in the local area	2%	0%	1%
Other	9%	22%	14%

Source: UK Commission for Employment and Skills[449]

444 Five Tribes: Personalising Engineering Education, Institution of Mechanical Engineers, December 2014, p3 445 Teacher and pupil voices on employer engagement: Insights from three focus groups and semi-structured interviews with five English secondary schools (2011-12), Education and Employers Taskforce, January 2014, p4; www.educationandemployers.org/media/19527/teacher_and_pupil_voices_on_employer_engagement.pdf 446 Teacher and pupil voices on employer engagement: Insights from three focus groups and semi-structured interviews with five English secondary schools (2011-12), Education and Employers Taskforce, January 2014, p7 447 Catch 16-24, UK Commission for Employment and Skills, February 2015, p11; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/404997/15.02.18._Youth_report_V17.pdf 448 Catch 16-24, UK Commission for Employment and Skills, February 2015, p13 449 Catch 16-24, UK Commission for Employment and Skills, February 2015, p11

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Unfortunately, the UKCES research also found that nothing could convince 34% of those who do not currently engage with educational institutions to do so, while 15% would like a financial incentive – despite the negligible costs of many inspiration activities (Table 5.2). However, a substantial proportion (12%) said that pro-active approaches from schools, colleges and universities could potentially encourage them to offer work inspiration. Again, the need for effective brokering services is clear from these results.

Table 5.2: Things that could be done to encourage employers who had not engaged with educational institutions for work placements or work inspiration in the last 12 months to do so (2014) – UK

Financial incentives to compensate for the resource used	15%
Pro-active approaches from schools / colleges / universities	12%
Less bureaucracy	6%
Better quality of placement candidates	5%
Business growth / more staff / more work / increased profits	5%
Help or advice on finding candidates	5%
Practical assistance managing the placements	4%
More information on placements	3%
Company / head office decision	3%
More advertising / raise awareness	2%
Other	4%
Nothing	**34%**
Don't know	17%

Source: UK Commission for Employment and Skills[450]

Results from the Confederation of British Industry and Pearson *Education and Skills Survey 2015* looked more closely at STEM engagement and found that most employers chose “more STEM apprenticeships” (54%)[451] and “businesses engaging with schools to enthuse pupils about STEM study” (54%) as “priority actions to promote STEM study”. They also suggested “businesses providing more high-quality work placements” (36%), “encouraging employees to become STEM ambassadors” (33%) and “streamlining of government and stakeholder initiatives (27%)” (Table 16.8).[452] The survey also found that priority areas for action in 11- to 14-year-old education included “more engagement with business to give awareness about work” (39%) and “improving quality of careers advice” (26%).[453]

Clearly, employers are not, in general, reluctant to engage.

Employers surveyed in the CBI/Pearson survey felt that the biggest barrier to engagement was a lack of guidance and support on how to make work experience worthwhile (28%). A lack of interest among educational institutions (25%), educational institutions interested but unsure how employers can help (22%), not enough employee interest in working with educational institutions (16%), and not being sure how to make contact with educational institutions (11%) were also mentioned.[454]

The Institute for Public Policy Research (IPPR) has argued strongly for the involvement of employers in careers education, citing evidence across Europe that shows how workplace-based vocational education with high employer involvement is key in ensuring a smooth transition between education and work, and a lower rate of youth unemployment.[455]

The Scottish government has endorsed this focus on employer engagement and work-based learning, following the findings of the Commission for Developing Scotland’s Young Workforce. Similarly, the Welsh government’s Jobs Growth Wales programme aims to provide job-seekers under 25 with paid six-month placements.[456] Meanwhile, the UK government, supported by UKCES, has invested £130 million (with £220 million employer investment) in eight industrial partnerships, enabling employers and trade unions to come together to take responsibility for future skills needs.[457]

The importance of career inspiration has been recognised in the latest statutory guidance (March 2015) for careers advice, which states that:

“sustained and varied contacts with employer networks, FE colleges, higher education institutions, mentors, coaches, alumni or other high achieving individuals can motivate pupils to think beyond their immediate experiences, encouraging them to consider a broader and more ambitious range of future education and career options.”[458]

It also claims that access to inspirational role models can “instil resilience, goal setting, hard work and social confidence in pupils, encouraging them to overcome barriers to success,” with a particular benefit for those from disadvantaged backgrounds who may have “less support from family and social networks.”[459] In particular, the guidance advises that contact with such workers and their workplaces helps to build a broad knowledge and understanding of careers, helping to “broaden horizons [and] challenging stereotypical thinking about the kind of careers to which individuals might aspire.”[460]

The guidance also highlights the importance of providing young people with an insight into the realities of the workplace and job market. It argues that “there is currently a mismatch between the careers that young people want to pursue and the opportunities available. Choices made at school should be based on a clear view of the current labour market and how opportunities may change in the future,” and that interaction with employers can help to remedy this.[461]

5.2.2 Careers guidance

The recent history of careers guidance provision has been a tumultuous one. In 2011, funding for the national careers guidance body, Connexions, was cut by the coalition. Responsibility for careers guidance was transferred to schools, but without increased funding and with little support beyond weak statutory guidance. As The Sutton Trust comments, “this has resulted in a decline in the quality and quantity of the career guidance available to young people in England and the emergence of a ‘postcode lottery’ where some young people have access to much better career guidance than others.”[462] The focus since then has been on establishing stronger guidelines for schools, national brokering services (such as the National Careers Service, and a number of non-governmental organisations), and increased employer involvement in all types of careers education.

The importance of careers advice in averting the growing skills shortage is highlighted by the CBI and Pearson, who state that “effective careers guidance that involves employers and inspires young people is an essential part of the solution.”[463] However, the Chief Inspector of Education, Children’s Services and Skills, Sir

450 Catch 16-24, UK Commission for Employment and Skills, February 2015, p14 **451** The importance of apprenticeships in closing the skills gap and the means of achieving a successful apprenticeship system is discussed in detail in The Commission on Apprenticeships, Demos, March 2015, p73; http://www.demos.co.uk/files/476_1504_CoA_WEB_2_.pdf?1425489134 **452** Inspiring Growth: CBI/Pearson Education and Skills Survey 2015, Confederation of British Industry/Pearson, May 2015, p24; http://news.cbi.org.uk/business-issues/education-and-skills/gateway-to-growth-cbi-pearson-education-and-skills-survey-2015 **453** Inspiring Growth: CBI/Pearson Education and Skills Survey 2015, Confederation of British Industry/Pearson, May 2015, p40 **454** Inspiring Growth: CBI/Pearson Education and Skills Survey 2015, Confederation of British Industry/Pearson, May 2015, p49 **455** Remember the young ones: Improving career opportunities for Britain’s young people, Institute for Public Policy Research, August 2014, p1; http://www.ippr.org/files/publications/pdf/remember-young-ones_Aug2014.pdf?noredirect=1 **456** Catch 16-24, UK Commission for Employment and Skills, February 2015, p23 **457** *ibid*, p23 **458** Careers guidance and inspiration in schools: Statutory guidance for governing bodies, school leaders and school staff, Department for Education, March 2015, p7; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440795/Careers_Guidance_Schools_Guidance.pdf **459** *ibid*, pp7-8 **460** *ibid*, p8 **461** *ibid*, p8 **462** Advancing ambitions: The role of career guidance in supporting social mobility, University of Derby/Sutton Trust, October 2014, p4; www.suttontrust.com/researcharchive/advancing-ambitions **463** Inspiring Growth: CBI/Pearson Education and Skills Survey 2015, Confederation of British Industry/Pearson, May 2015, p12

Michael Wilshaw, stated in his 2013/14 Annual Report that careers guidance was insufficient "to help [young people] make informed choices about their next steps,"[464] with apprenticeships still not given the same status as academic routes. He also recommended that employers are given more incentive to be involved in the design and delivery of vocational education.[465]

Unfortunately, the CBI/Pearson provides further evidence of the problems in careers guidance: only 7% of employers believe that careers advice for young people is good enough, 77% believe it is not good enough and 16% are unsure.[466] However, on a positive note, the survey also showed that 60% of employers are willing to play a greater role in delivering careers advice.[467] The picture is broadly similar across the devolved nations.[468]

The EEBM has revealed that in the last year, three in five (58%) STEM teachers of 14- to 19-year-olds have been asked for careers advice about a job in engineering. Unfortunately, just two out of five STEM teachers (37%) felt confident giving advice on engineering careers, while 34% said that they were not confident. Also, teachers (50%) were more likely to believe that their pupils know what to do next to pursue a career in engineering than pupils themselves (11-14: 26%; 15-16: 33%; 17-19: 37%).

The EEBM also found that across all ages, pupils would be most likely to *consider going to* parents/guardians, careers advisers and teachers for careers advice, but they would be most likely to *act upon* advice from a careers adviser. Teachers, however, were most likely to believe that their pupils would *act upon* careers advice from their parents/guardians, followed by careers advisers. According to a Wellcome Trust survey, young people view the most useful sources of careers information as being family, followed by careers advisers and teachers.[469]

The role of parents, therefore, should not be underestimated. Research by the Wellcome Trust and Platypus Research[470] highlighted the association between positive parental attitudes towards science, with discussion of experiences at school and engagement in enrichment activities particularly noted. Research by the Institute of Education[471] found that home support is a greater influence on achievement in physics than prior attainment and the *ASPIRES* study has reinforced the importance not just of family support but, specifically, "science capital" on student aspirations to pursue a science-related career by the age of 14. Science capital encompasses "science-related qualifications, understanding, knowledge (about science and 'how it works'), interest and social contacts (eg knowing someone who works in a science-related job)." Those from families with higher science capital are more likely to aspire to – and plan to participate in – STEM study and careers. While those who have lower science capital backgrounds and did not express STEM aspirations at age 10 are unlikely to develop them by the age of 14.[472]

It is therefore concerning that only 15% of parents felt confident giving careers advice about engineering, including 23% of men and just 8% of women. A worrying 66% of parents said that they were not confident, including 53% of men and 78% of women. Research commissioned by BIS suggests that "parents often have limited knowledge of the opportunities available to their children, and although they almost universally only want what's best for their children – they can have 'out of touch' gender stereotype views which hold them back."[473]

Nevertheless, the *QEPrize Create the Future Report* on international perceptions of engineering has shown that 30% of respondents chose being an engineer as one of the three most prestigious careers (ranked fourth below "medical doctor", "scientist" and "lawyer"), 62% felt that it was one of the three careers most vital for economic growth (joint top with "business leader" and above "scientist") and 28% felt it was one of the three most accessible careers (ranked fourth). Internationally, at least, the general public seems to understand how crucial careers in engineering are, although they seem to believe that they are the preserve of the few, not the many.

Career information is a crucial part of The Big Bang Fair. While only 23% of girls aged 11-14 and 25% of those aged 15-16 surveyed in the EEBM knew what to do next in order to become an engineer, the likelihood of Big Bang Fair attendees knowing was more than double that, at 49% and 51%. There was also a positive impact on influencers, with attending teachers (82%) 44% more likely than their counterparts surveyed in the EEBM 2014 (57%) to believe that a career in engineering is desirable. Attending mothers (90%) were 32% more likely than their EEBM 2014 counterparts (68%) to believe that a career in engineering is desirable. Teachers who attended The Big Bang Fair 2015 were much more likely to be confident in giving advice about science, engineering and technology careers than those surveyed in the EEBM 2014, with attending female teachers (48%) more than three times as likely than their EEBM counterparts (15%) to be confident giving advice about careers in technology. Overall, attendee teachers (52%) were 44% more likely to be confident in giving advice about engineering than those in the EEBM (36%).

Meanwhile, a survey by the IET showed that, after being shown careers information focusing on the diversity of options available in engineering, 70% of parents agreed with the statement that "I had no idea how many different types of Engineering jobs there are." Also, 60% said that they "didn't realise there were so many opportunities for girls and women in Engineering".[474] Indeed, showing the same information to young people resulted in 84%

464 The Annual Report of Her Majesty's Chief Inspector of Education, Children's Services and Skills 2013/14, Ofsted, December 2014, p23; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384699/Ofsted_Annual_Report_201314_HMCI_commentary.pdf **465** *ibid*, p24 **466** Inspiring Growth: CBI/Pearson Education and Skills Survey 2015, Confederation of British Industry/Pearson, May 2015, p51 **467** *ibid*, p52 **468** Inspiring Growth: CBI/Pearson Education and Skills Survey 2015, Confederation of British Industry/Pearson, May 2015, p52 **469** Wellcome Trust Monitor Report – Wave 2: Tracking public views on science, Wellcome Trust, May 2013, p127; http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_grants/documents/web_document/wtp053113.pdf **470** Experiments in Engagement: Review of literature around engagement with young people from disadvantaged backgrounds, Wellcome Trust/Platypus Research, April 2014, p12-13; www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtp056382.pdf **471** Understanding Participation in Mathematics and Physics (UPMAP), Institute of Education, 2012, p10; http://www.ioe.ac.uk/UPMAP_AERA2012.pdf **472** ASPIRES Young people's science and career aspirations, age 10 –14, King's College London, November 2013, p3 **473** Project STEM Book of Insights: 2014, Department for Business, Innovation and Skills, September 2014, p17 **474** Inspiring the next generation of engineers: research report, Institution of Engineering and Technology, March 2015, p81 agreeing that "I had no idea how many different types of Engineering jobs there are" and 73% agreeing that they "didn't realise there were so many opportunities for girls and women in Engineering."[475] Showing careers information also significantly increased the percentage of parents who would encourage their child to go into engineering (72% vs 56%) and the percentage of young people who would consider a job in engineering (71% vs 49%).[476]

In relation to career guidance itself, it's vitally important to make the links between education and work clear.[477] Research for BIS suggests that young people "were more inspired by subjects where they could see the end goal of their learning, that is where the theory very quickly turned into practice."[478] The University of Warwick[479] has shown that students don't make these links between the curriculum and future careers[480] and that students don't know that triple science is either desirable or essential for some STEM careers. Meanwhile, the Education and Employers Taskforce and UK Commission for Employment and Skills has demonstrated that young people's career aspirations, "can be said to have nothing in common with the projected demand for labour in the UK between 2010 and 2020."[481]

The National Foundation for Educational Research looked at features of the activities and interventions in schools that were most successful at improving young people's engagement in STEM. It found that the most beneficial activities were based on:[482]

- engaging pupils at an early age and at key transition points
- focusing teaching on practical activities, set in real-life contexts and offering good quality enrichment and enhancement activities
- linking teaching to careers in STEM
- making clear links across and between the STEM subjects
- supporting teachers

In its report *Good Career Guidance*, Gatsby summarised the requisite aspects of effective career guidance, based on the evidence. It came up with eight benchmarks:

1. A stable careers programme
2. Learning from career and labour market information
3. Addressing the needs of each pupil
4. Linking curriculum learning to careers
5. Encounters with employers and employees
6. Experiences of workplaces
7. Encounters with further and higher education
8. Personal guidance[483]

The government's latest statutory guidance (March 2015) includes, in one way or another, a number of Gatsby's benchmarks, with a particular emphasis on employer engagement. There continues to be a duty to secure independent careers guidance for all Year 8-13 pupils, with the necessity of exposing young people to a range of careers first hand and through "real-life contacts." Advisers should use a range of activities, to ensure every pupil develops high aspirations and considers a "broad and ambitious range of careers."[484]

As part of developing their careers guidance strategy, schools are advised to "build strong links with employers," offer individual and curriculum-relevant work experience, and to provide access to advice on non-academic options.[485] The importance of destinations data is also highlighted, especially as a method of evaluating the success of careers and inspiration activities for young people from disadvantaged backgrounds.[486] The quality of careers guidance provision and destinations data will also be taken into account by Ofsted inspectors.[487]

Promisingly, the importance of STEM to all careers is emphasised within the statutory guidance:

"Schools should also ensure that, as early as possible, pupils understand that a wide range of career choices require good knowledge of maths and the sciences. Schools should ensure that pupils are exposed to a diverse selection of professionals from varying occupations which require STEM subjects, and emphasise in particular the opportunities created for girls and boys who choose science subjects at school and college. Schools should be aware of the need to do this for girls, in particular, who are statistically much more likely than boys to risk limiting their careers by dropping STEM subjects at an early age."[488]

A key aspect of the government's new approach to careers guidance is the foundation of the Careers & Enterprise Company,[489] which was announced by Education Secretary Nicky Morgan in December 2014. This initiative has been welcomed by the Confederation of British Industry.[490] The statutory guidance states that the main purpose of the company will be to act as an "umbrella body," brokering relationships between employers and schools and colleges with the aim of ensuring high quality, work-related inspiration and guidance for more young people aged 12-18.[491]

The National Careers Service, which offers information and professional advice to adults and young people aged 13 and over, will continue its work, particularly in offering support through contractors that schools can commission, while also offering to broker relationships between schools, colleges, local communities and employers, along with Local Enterprise Partnerships (LEPs).[492]

The promotion of STEM subjects and skills to young people and the availability of STEM careers guidance has been similarly highlighted by the National Assembly for Wales' Enterprise and Business Committee. It recommended in September 2014 that the Welsh government, among other things, "prioritise its investment in early interventions that can enthuse children in STEM and inspire them throughout their entire education" and "ensure that the revised Welsh Baccalaureate leads to the development of higher-level STEM work experiences similar to the approach taken to providing higher and lower-level apprenticeships."[493] Many of the themes covered by the Enterprise and Business Committee have been addressed by the Welsh government in its explanation of the remit for Careers Choices Dewis Gyrfa (CCDG).[494]

This approach was also recommended by the Commission for Developing Scotland's Young Workforce in June 2014. Among its recommendations were that beginning "well before the start of the senior phase" (ages 16-18), young people should be exposed to a wide range of careers by "schools and employers systematically working together in meaningful partnership to expose young people to the opportunities available across the modern economy," with the opportunity to pursue vocational pathways alongside academic studies emphasised. The aim set out by the commission is to have all secondary schools in a long-term partnership with employers within three years.[495 496]

475 *ibid*, p83 **476** *ibid*, p86 **477** See also Teachers and Careers: The role of school teachers in delivering career and employability learning, International Centre for Guidance Studies, March 2015, p23 for a discussion of how this can apply to subjects such as physics **478** Project STEM Book of Insights 2014, Department for Business, Innovation and Skills, September 2014, p27 **479** Good Timing: Implementing STEM careers strategy in secondary schools, Centre for Education and Industry, University of Warwick, the International Centre for Guidance Studies, University of Derby and Isinglass Consultancy Ltd, November 2011, p11 **480** The issue of making clear the relevance of learning and the purpose of holding (English and Maths) qualifications in relation to real-life situations is also raised by Engaging Learners in GCSE Maths and English, National Institute of Adult Continuing Education, February 2015, p7; http://www.niace.org.uk/sites/default/files/resources/Engaging%20learners%20in%20GCSE%20maths%20and%20English.pdf **481** Nothing in Common: Career Aspirations of Young Britons Mapped Against projected Labour Demand (2010-2020), Education and Employers Taskforce and UK Commission for Employment and Skills, March 2013, p8; http://www.educationandemployers.org/wp-content/uploads/2014/06/nothing_in_common_final.pdf **482** Improving young people's engagement with science, technology, engineering and mathematics (STEM), National Foundation for Educational Research, 2013, p2; https://www.nfer.ac.uk/publications/99927/99927.pdf **483** Good Career Guidance, Gatsby, April 2014, p7; http://www.gatsby.org.uk/uploads/education/reports/pdf/gatsby-sir-john-holman-good-career-guidance-2014.pdf **484** Careers guidance and inspiration in schools: Statutory guidance for governing bodies, school leaders and school staff, Department for Education, March 2015, p4 **485** *ibid*, p5 **486** *ibid*, p5 **487** *ibid*, p17 **488** *ibid*, p7 **489** Catch 16-24, UK Commission for Employment and Skills, February 2015, p22 **490** Inspiring Growth: CBI/Pearson Education and Skills Survey 2015, Confederation of British Industry/Pearson, May 2015, p51 **491** Careers guidance and inspiration in schools: Statutory guidance for governing bodies, school leaders and school staff, Department for Education, March 2015, p9 **492** *ibid*, p10 **493** Science, Technology, Engineering and Mathematics Skills, National Assembly for Wales – Enterprise and Business Committee, pp5-6; http://www.senedd.assembly.wales/documents/s31151/Report%20-%20September%202014.pdf **494** 2015 – 2016 Career Choices Dewis Gyrfa (Careers Wales) Annual Remit Letter, Welsh Government, December 2014; http://gov.wales/docs/dcells/publications/150512-ccdg-remit-en.pdf **495** Education Working For All!, Commission for Developing Scotland's Young Workforce, June 2014, pp8-10; http://www.gov.scot/resource/0045/00451746.pdf **496** The Scottish Government's response is contained within Developing the Young Workforce: Scotland's Youth Employment Strategy, Scottish Government, December 2014; http://www.educationscotland.gov.uk/Images/DYWResponseYouthEmpl%20Strategy_tcm4-853595.pdf

In Northern Ireland, The Department of Education and the Department for Employment's *Joint Careers Strategy Action Plan 2015/16* sets out a similar plan for Careers Education, Information, Advice and Guidance (CEIAG) as the rest of the United Kingdom. For example, the action plan states that "this project will improve work experiences for young people, schools and employers, improve the administrative process of organising work experience opportunities and provide equality of opportunity for young people." This will be achieved by the development of "a central work experience website to provide guidance and information to pupils, schools, employers and parents on the benefits, selection and organisation of work experience."[497] For careers guidance, the plan states that a project "will ensure access to impartial advice including offering face to face impartial advice to all Year 12, with additional support to those at risk of becoming disengaged and support for those with barriers; and providing more advice to parents."[498] The plan has an even greater emphasis than those in other parts of the UK on improving information among influencers, with a specific strategy of delivering "a region-wide series of information sessions to parents focusing on priority sectors, STEM, gender issues and support available to those with additional needs."[499]

Finally, an improvement of careers education provision could also have an enormous impact on the economy. The Royal Society has highlighted the potential economic cost of poor careers advice, citing a National Careers Council projection of £28 billion lost in tax and output in England due to youth unemployment, and £200 million per year due to incorrect post-compulsory education choices.[500]

5.2.3 Work experience

Research by the Education and Employers Taskforce for the Edge Foundation[501] highlighted the importance of work experience by showing that students aged 16 to 17 who have part-time work are more likely to be in work at the age of 18 to 19, and are also less likely to be NEET five years later.[502] Research has also shown that graduates with work experience "get better degrees, higher wages and are less likely to be unemployed."[503]

These findings, however, are undermined by the Wellcome Trust's survey of 460 young people aged 14 to 18, which revealed that only 61% had any work experience – of whom, only 28% had work experience with a STEM employer.[504]

As participation in higher education has increased, fewer young people are taking up part time work during their studies.[505] Consequently, work experience has become one of the most important factors in determining employability. UKCES investigated the provision of work experience among the UK's employers, their perception of work experience in hiring, and the extent to which young people had engaged in work experience. They describe young people as "caught in a Catch-22 situation… finding it difficult to get work without experience and difficult to obtain experience without work." This has resulted in a situation in which youth unemployment remains high at 16.9%,[506] compared to 6% overall. Young people comprise just 13% of the population,[507] and yet "40% of all unemployed people in the UK are under the age of 25."[508]

This is particularly concern as a result of the "increasingly 'hour glass' effect[509] in the economy with growth in high skilled jobs at the top of the labour market, contraction in the middle and growth in service jobs at the bottom is making it more difficult to progress in work. The evidence shows that young people are most likely to be recruited into these low wage, low skilled jobs where the pathways for getting on are unclear."[510]

UKCES reports that "66% of employers say work experience is a critical or significant factor in their recruitment,"[511] – more than the candidate's particular level of academic attainment (49%) and relevant vocational qualifications (50%).[512] However, "the proportion of employers offering work experience placements to people in education is just 30%," with "significant regional variations in employer-education engagement".[513 514]

The report also states that "employers rate the young people they recruit highly" and believe that even 16-year-old school leavers are prepared for work. However, 25% of employers state that these school leavers lack experience, declining to 20% for 17- to 18-year-old school leavers, 14% for 17- to 18-year-old college leavers and 10% for university leavers. In contrast, only 4% of employers believe that 16-year-old school leavers lack literacy and numeracy skills, declining with leaving age.[515]

The CBI/Pearson *Education and Skills Survey* also found that 46% of employers viewed a "lack of general workplace experience" as a barrier to recruiting STEM-skilled staff, while 44% cited a "lack of appropriate attitude and aptitudes for working life." Also, 40% cited a "shortage of STEM graduates" or that the "content of qualification(s) [is] not relevant to business needs," 34% felt that the quality of STEM graduates" was a problem, 30% blamed a lack of applications, and 26% blamed a lack of practical experience/lab skills.[516]

UKCES claims that "'earning and learning' should be the norm with things like high quality apprenticeships becoming an everyday career pathway for many more young people and a natural way for businesses to recruit and develop talent."[517] The EEBM 2015 has shown that pupils and teachers were more likely to consider or recommend an academic route into engineering than a vocational one. Only around two in five pupils (37% of 11- to 14-year-olds, 36% of 15- to 16-year-olds and 39% of 17- to 19-year olds) and 43% of teachers viewed being an apprentice as desirable. However, parents were more supportive of vocational routes than teachers or the young people themselves: 51% of parents believed that being an apprentice is a desirable outcome for their children.

UKCES summarises with a call for action:

"With 1 in 5 vacancies in the UK difficult to fill because of a lack of the right skills in the labour market, the importance of developing the skilled and experienced workforce of tomorrow cannot be overstated. Employers should be empowered to lead this agenda and open up their workplaces to more young people."[518]

This has been taken to heart in a report backed by the London Enterprise Panel, London Councils and the Mayor of London. The report called for "at least 100 hours experience of the world of work" for every young Londoner, which "may include career insights from industry experts, work tasters, coaching, mentoring, enterprise activities, part-time work, participation in Skills London and The Big Bang Event, work shadowing, work experience/supported work experience and other relevant activities." This experience should be captured in "a personalised digital portfolio."[519]

497 Careers Strategy Joint Action Plan 2015-2016, Department of Education and Department for Employment, p2; http://www.deni.gov.uk/joint_careers_strategy_action_plan_2015.16.pdf **498** *ibid*, p2 **499** *ibid*, p2 **500** Vision for science and mathematics education, Royal Society, 2014, p57 **501** Drawing on analysis commissioned by the DfE in young people's education and labour market choices aged 16/17 to 18/19, Centre for Analysis of Youth Transitions, 2011, p48; www.gov.uk/government/uploads/system/uploads/attachment_data/file/183355/DFE-RR182.pdf **502** Profound employer engagement in education: What it is and options for scaling it up, Education and Employers Taskforce, October 2013, p6; www.edge.co.uk/media/121971/profound_employer_engagement_published_version.pdf **503** Climbing the ladder: skills for sustainable recovery, UK Commission for Employment and Skills, July 2014, p9; www.gov.uk/government/uploads/system/uploads/attachment_data/file/328282/Summer_What_0v4.pdf **504** Wellcome Trust Monitor Wave 2: Tracking public views on science, biomedical research and science education, May 2013, p129; www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_grants/documents/web_document/wtp053113.pdf **505** Catch 16-24, UK Commission for Employment and Skills, February 2015, p15 **506** November 2014 **507** Catch 16-24, UK Commission for Employment and Skills, February 2015, p6 **508** *ibid*, p4 **509** See section 1.1.3.1 **510** Catch 16-24, UK Commission for Employment and Skills, February 2015, p4 **511** *ibid*, p4 **512** *ibid*, p8 **513** *ibid*, p4 **514** For more on this work experience and inspiration 'postcode lottery' see Geographical variation in access to work placements and work inspiration: data from the Employer Perspectives Survey 2014, UK Commission for Employment and Skills, February 2015; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/404998/15.02.18._Commentary_V10.pdf **515** Catch 16-24, UK Commission for Employment and Skills, February 2015, p10 **516** Inspiring Growth: CBI/Pearson Education and Skills Survey 2015, Confederation of British Industry/Pearson, May 2015, p23 **517** Catch 16-24, UK Commission for Employment and Skills, February 2015, p5 **518** *ibid*, p5 **519** London Ambitions: Shaping a successful careers offer for all young Londoners, London Enterprise Panel, London Councils and Mayor of London, June 2015, p9; https://lep.london/sites/default/files/documents/publication/London%20Ambitions%20Careers%20Offer.pdf

5.3 Influencing women's perceptions of STEM

Despite extensive campaigns and interventions, a clear gender gap remains between men and women's perceptions of, and participation in, STEM. A recent survey by Network Rail of 12- to 17-year-old girls found that three of the top five jobs that they perceived to be 'jobs for boys' were in engineering.[520] When asked which careers they believed could offer them opportunities in the future, only one engineering sector career was included in their top five: computing electronics and technology ranked third, at 17.6%. Engineering itself ranked eighth.[521]

Research has shown that men are more likely than women to find engineering interesting.[522] This is concerning. The number of 18-year-olds overall is due to drop by 8.7% between 2012 and 2022, while the number of engineering workers required in that period is set to increase. So encouraging women into the STEM sector is vital if we are to fulfil business recruitment needs – a requirement recognised by the House of Commons Science and Technology Committee.[523] Indeed, if women were to participate more fully in STEM employment, it could contribute an additional £2 billion to the economy.[524]

This disparity is especially prevalent in vocational routes. Just 2,730 women studied engineering-related apprenticeships in England in 2013/14 – 6.6% of the total – compared with 38,360 men (Table 10.10).

The Engineers and Engineering Brand Monitor has consistently, over an extended period, highlighted the gender bias in perceptions of STEM, and engineering in particular. In the EEBM 2015, compared with females:

- Male pupils, parents and non-parents were more likely to consider an engineering career
- Male pupils were more likely to believe that engineering careers are desirable relative to other careers
- Male parents and pupils aged 7-16 were more likely to have a positive perception of STEM
- Among 11-14s, 15-16s, parents, non-parents and teachers, males were more like to know what people working in engineering do
- Among 7-11s, boys were more likely to pick positive words/phrases to describe engineering

- Male teachers were more likely to have been asked for careers advice about engineering in the past year
- Male teachers and parents were more likely to be confident giving careers advice on engineering
- Male pupils were more likely to believe that they know how to become an engineer

This gender bias, among both young people and their influencers, is confirmed by results of a survey of 9- to 12-year-olds and their parents commissioned by the Institution of Engineering and Technology (IET). The survey found that the top four subjects for boys were STEM-based (ICT/computing, science, design and technology, and maths), while for girls the top three were art, English, and music, with PE/ sports, design and technology, and ICT/ computing joint-fourth.[525] Meanwhile, a survey of girls aged 11-18 commissioned by Accenture found that 60% of 12-year-old girls believed that maths and science are too difficult to learn, while 47% of 11- to 18-year-olds felt that STEM subjects are a better match for boys.[526]

In the IET study parents were heavily influenced by the gender of their child when considering the appeal of careers to young people in general and to their own children. Most chose stereotypically gendered careers.[527] Engineering was regarded as the career their child would be most interested in by 28% of parents of boys, but
only 6% of parents of girls.[528] [529] These gender stereotypes were also apparent among the children themselves, with boys much more likely to be interested in STEM careers.[530] The gender split was also seen in results from a survey of 2,000 young people aged 8-15 carried out by EON, which found that maths was the boys' favourite subject and English was preferred by girls.[531]

Once again, we have found that ages 11 to 14 are key in determining whether girls lose interest in engineering or not. Research commissioned by Network Rail suggests that girls are attracted to engineering when they are 11 years old but have "switched off" by the time they are 14, believing it to be "unglamorous and anti-social".[532]

The gender gap is particular concerning as the *UK Household Longitudinal Survey* has shown that girls aged 10-15 are more likely than boys to aspire to go to university (83% of girls to 69% of boys).[533] This means that the STEM community could be failing to capitalise on girls' enthusiasm to continue studying. Indeed, the figures bear this out: research by the IET[534] suggests that women make up just 6% of engineers and 3% of engineering technicians. Women make up around one sixth of the engineering workforce, giving the UK by far the

520 These included building and construction (57%), engineering (40%) and computing electronics and technology (22%) **521** Underlying data supplied by Network Rail for School girls think engineering is a job for the boys, finds Network Rail Survey, Network Rail, April 2015; http://www.networkrailmediacentre.co.uk/news/school-girls-think-engineering-is-a-job-for-the-boys-finds-network-rail-survey **522** Public Attitudes to Science 2014, Department for Business, Innovation and Skills, March 2014, p112 **523** Women in scientific careers Sixth Report of Session 2013–14, House of Commons Science and Technology Committee, 15 January 2014, p7; www.publications.parliament.uk/pa/cm201314/cmselect/cmsctech/701/701.pdf **524** Building on progress: boosting diversity in our workplaces, Confederation of British Industry, 2014, p3; http://www.cbi.org.uk/media/2789364/building-on_progress.pdf **525** Inspiring the next generation of engineers: research report, Institution of Engineering and Technology, March 2015, p13 **526** Accenture Finds More Than Half of 12-Year-Old Girls in the UK and Ireland Believe STEM Subjects are Too Difficult to Learn, Accenture, September 2015; https://newsroom.accenture.com/news/accenture-finds-more-than-half-of-12-year-old-girls-in-the-uk-and-ireland-believe-stem-subjects-are-too-difficult-to-learn.htm?c=glb_accglbtwt_10001556&n=smc_0215 **527** Inspiring the next generation of engineers: research report, Institution of Engineering and Technology, March 2015, p30 **528** *ibid*, p32 **529** This is supported by research commissioned by British Gas: Two thirds of young people worry about career prospects after exams, British Gas, August 2015; http://www.britishgas.co.uk/media/releases/ReleaseDetailPage.aspx?releaseId=1366 **530** Inspiring the next generation of engineers: research report, Institution of Engineering and Technology, March 2015, p37 **531** Stepping up to STEM: Inspiring the bright sparks of tomorrow, E.ON, September 2015; http://pressreleases.eon-uk.com/blogs/eonukpressreleases/archive/2015/09/07/2454.aspx **532** Girls become 'switched off' from idea of an engineering career at the age of 14, Mirror, 27 August 2015; http://www.mirror.co.uk/news/uk-news/girls-become-switched-off-idea-6328113 **533** Measuring National Well-being – Exploring the Well-being of Children in the UK, 2014, Office for National Statistics, October 2014, p22; http://www.ons.gov.uk/ons/dcp171776_379712.pdf **534** Engineering and Technology: Skills and Demand in Industry 2014, Institution of Engineering and Technology, July 2014, p6; http://www.theiet.org/factfiles/education/skills2014-page.cfm?type=pdf lowest proportion of female engineering professionals in Europe.[535 536]

This is especially significant within a wider international context, with the *QEPrize Create the Future Report* survey finding that in emerging economies, such as India, Turkey, China and Brazil, the gap in interest in engineering between men and women is much smaller than in developed countries including the UK, the US, Germany, the Republic of Korea and Japan.

The Institute for Public Policy Research (IPPR) suggests that there are four key barriers to attracting more women into engineering:

1. Too few girls acquire the prerequisites, particularly physics, at A-level.
2. There is an unhelpful perception of STEM and engineering careers among both girls and their families, as 'masculine' or 'brainy'.
3. Poor understanding of engineering careers and the engineering pathway persists.
4. The STEM ecosystem is fragmented, which can lead to an ineffective use of resources.[537]

The 2014 Girlguiding Girls' Attitudes Survey suggested that careers advice is gender biased to the extent that "one in three of those aged 11 to 21 says that girls are not encouraged to think about apprenticeships (35%), and that girls and boys tend to get different careers advice, even when their interests and abilities are similar (32%)."[538] The survey also found that girls aged 11-21 believed that negative perception is the reason that they are more likely than boys to drop STEM subjects as they move through education. More than half (56%) believed it is because STEM has the "image of being more for boys". A third (33%) thought that "girls who are interested in STEM are teased" and one in five (22%) thought that "teachers or careers advisers often encourage girls and boys who may have similar interests to choose different subjects".[539]

ScienceGrrl, meanwhile, has made 11 recommendations[540] aimed at making STEM equally attractive to both girls and boys, without relying on gender stereotypes. These fall under the following headings:

1. Leadership on gender equality
2. Rebranding STEM
3. Role models
4. STEM mentoring and sponsorship
5. Bringing the gender lens to teaching
6. Primary school science
7. Bringing the gender lens into the curriculum
8. Support project based, creative and real world learning
9. STEM resources: technical routes
10. Unifying the STEM ecosystem
11. Leadership on careers advice

EngineeringUK's engagement programmes – The Big Bang and Tomorrow's Engineers – were among those mentioned in relation to the recommendation of supporting project based, creative and real world learning, with a suggestion that local employers be encouraged to support such schemes. Tomorrow's Engineers is tailored toward this aim, with a growing team working locally with employers of all sizes to improve the quality, diversity, reach and impact of their schools' outreach activity.

This approach, emphasising the diversity of STEM careers, has been endorsed by the Department for Education in its latest statutory guidance, which relates to careers guidance and inspiration in schools. It specifically suggests that:

"Schools should also ensure that, as early as possible, pupils understand that a wide range of career choices require good knowledge of maths and the sciences. Schools should ensure that pupils are exposed to a diverse selection of professionals from varying occupations which require STEM subjects, and emphasise in particular the opportunities created for girls and boys who choose science subjects at school and college. Schools should be aware of the need to do this for girls, in particular, who are statistically much more likely than boys to risk limiting their careers by dropping STEM subjects at an early age."[541]

5.4 The relationship between gender, attainment and confidence, and the influence of teacher encouragement

Authored by Dr Tamjid Mujtaba, Research Officer, and Professor Michael J. Reiss, Professor of Science Education, UCL Institute of Education, University College London, England

5.4.1 Key findings

A survey of the views of 12- to 13-year old and 14- to 15-year-old students shows that, although girls had a better conceptual understanding of physics than boys, they were statistically significantly less likely to be confident in their answers. We sub-divided girls and boys into further groups: high aspiring boys, high aspiring girls, low aspiring boys and low aspiring boys. Year 8 and 10 girls with high aspirations to continue with physics after the age of 16 had statistically significantly lower conceptual confidence than both boys with high aspirations and boys with low aspirations to continue with physics after the age of 16. Students who were from professional backgrounds were more likely to have higher conceptual confidence than students whose parents were from non-professional backgrounds.

Girls reported less encouragement than boys in response to the statement: *My teacher thinks that I should continue with physics beyond my GCSEs*. Year 8 and 10 girls with high aspirations to continue with physics after the age of 16 had lower physics self-concepts than boys with high aspirations to continue with physics after the age of 16. However, the difference became larger once we controlled for teacher encouragement, suggesting both that teacher encouragement is associated with a higher self-concept and that high aspiring girls are less likely to receive this than high aspiring boys. Once we controlled for teacher encouragement, the difference between low aspiring boys and high aspiring girls disappeared (such girls initially had a higher self-concept). This, again, suggests that teacher encouragement received by low aspiring boys is related to a higher self-concept.

5.4.2 The nature of the research

There is a long established concern about both the shortage of people working in science and mathematics industries and the fact that females are less likely to enter such professions. Linked to this are problems with young people actually taking up these subjects after the age of 16. This work is based on data from around 10,000 students in the UPMAP (Understanding Participation rates in post-16 Mathematics and Physics) Project. We collected longitudinal survey data from around 23,000 students. The survey was designed to explore intrinsic and extrinsic factors that were associated with students' choices in mathematics and physics.[542 543]

5.4.3 Research design and findings

The survey was designed to capture data on a range of mathematics- and physics-related issues. Here, we consider the physics ones: intentions to continue to study physics post-16, physics self-concept, attitudes to lessons, attitudes to teachers, support for learning, conceptual tasks and confidence, alongside a range of other measures which are not

535 European Engineering Report, Verein Deutscher Ingenieure [VDI] (Association of German Engineers), April 2010. http://www.vdi.de/uploads/ media/2010-04_IW_European_Engineering_Report_02.pdf **536** Women in Engineering: Fixing the Talent Pipeline, Institute for Public Policy Research, September 2014, p3; http://www.ippr.org/files/publications/pdf/women-in-engineering_Sept2014.pdf?noredirect=1 **537** *ibid*, p14 **538** Girls' Attitudes Survey 2014, Girlguiding, September 2014; http://new.girlguiding.org.uk/girls-attitudes-survey-2014 **539** *ibid* **540** Through Both Eyes: the case for a Gender lens in STEM, ScienceGrrl, 2014, p6; http://sciencegrrl.co.uk/assets/SCIENCE-GRRL-Stem-Report_FINAL_WEBLINKS-1.pdf **541** Careers guidance and inspiration in schools: Statutory guidance for governing bodies, school leaders and school staff, Department for Education, March 2015, p7 **542** A full list of our publications is available at our project website www.ioe.ac.uk/UPMAP, from where you can also download the survey instruments we used **543** We are grateful to the Economic and Social Research Council for funding the study and to all the participating students, teachers and schools for participating in it. Other team members: Celia Hoyles, Bijan Riazi-Farzad, Melissa Rodd, Richard Sheldrake, Shirley Simon, Fani Stylianidou discussed in detail here. Our physics survey included around 200 questions, a large proportion of which were physics-specific. The analysis is based on the Year 8 and Year 10 survey responses of students as learners of physics from 141 English schools. The same students participated in a similar survey two years later, when they were in Years 10 and 12 respectively. Here we explore what role gender plays in students' conceptual attainment, their confidence in their conceptual ability, their self-concept and how teacher engagement relates to the physics self-concept.

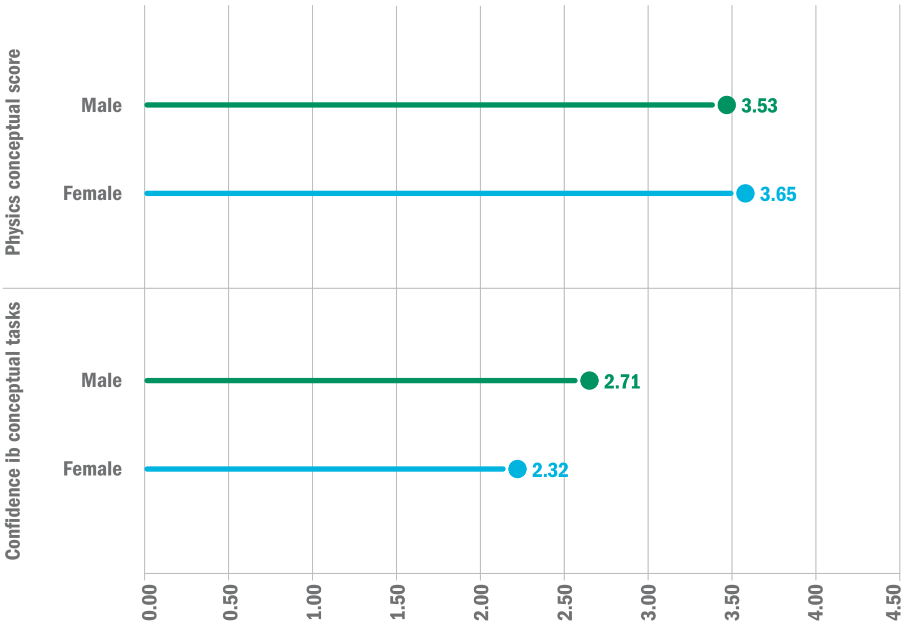
Year 8 and 10 student scores in conceptual understanding and confidence in their responses

The UPMAP surveys included some questions on conceptual tasks; students were asked within the physics survey to answer questions on electricity and forces. So, for example, students were shown diagrams of electric currents in a circuit and were asked "Which of the following best describes the electric current in this circuit?" In the forces tasks a similar format was taken; an example of one question is, "Which of the following best describes the forces acting on the ball when it is at point A on the way up?" We scored each student's answer as correct or incorrect. After each set of conceptual tasks students were asked "How confident are you that your answers to this question are correct?" The confidence questions were on a scale from 1 to 4 (with 4 being very confident and 1 being not at all confident).

In total there were just over 3,900 Year 8 and Year 10 girls for whom we had valid conceptual data and responses to how confident they were to the answers. For boys, we had just over 4,800 valid responses. In our analysis here we simply explore the mean differences in scores and responses between boys and girls, without accounting for any other background characteristics. The findings in Figure 5.7 show that although girls had a better conceptual understanding of physics (and this was statistically significant at 0.01), they were statistically significantly less likely to be confident in their answers (and this was statistically significant at 0.001).

In some of our published, work we have sub-divided girls and boys into further groups: high aspiring boys, high aspiring girls, low aspiring boys and low aspiring girls.[544] We have found that girls with high aspirations to continue with physics post-16 (and those that actually choose to do physics post-16) have more positive perceptions of their physics education than boys with low aspirations. However, we also found that girls with high aspirations were no more confident in their physics than boys with low

Figure 5.7: Conceptual attainment and confidence in conceptual attainment of Year 8 and 10 girls and boys



Source: University College London, Institute of Education

aspirations. In order to build on the findings, in Figure 5.7 we explored high and low aspiring girls' and boys' confidence in their conceptual tasks using multi-level modelling approaches. These analyses were also controlled for students' background characteristics: ethnicity, parents' social class/occupational status. Our analysis shows that Year 8 and 10 girls with high aspirations to continue with physics after the age of 16 have statistically significantly lower conceptual confidence than both boys with high aspirations and boys with low aspirations to continue. Girls with high aspirations had higher conceptual confidence than girls with low aspirations to continue with physics after the age of 16. There was a statistically significant influence of parental occupation/social class; students who were from professional backgrounds were more likely to have higher conceptual confidence than students whose parents were from non-professional backgrounds, eg store workers.

Year 8 and 10 students' self-concept and perceptions of teacher support

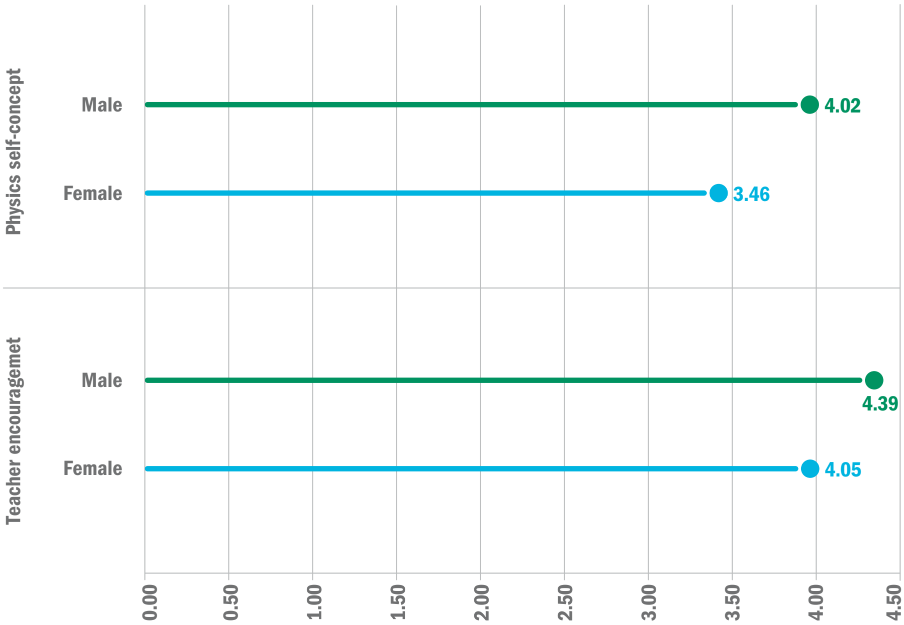
We collected data on students' physics self-concept which consisted of five items which asked students to respond to statements on a Likert scale e.g. "I am good at physics". The self-concept statements were scored so that a high score represents strong agreement/high self-concept (1=strongly disagree; 2=disagree; 3=slightly disagree; 4=slightly agree; 5=agree; 6=strongly agree). In total, we had a valid self-concept construct for just over 5,400 Year 8 and Year 10 girls and just over 4,500 boys. Figure 5.8 shows that girls had a lower self-concept than boys (an average of 3.46 versus 4.02). These findings were statistically significant at 0.001.

One of our survey items also measured students' perceptions of teacher support: "My teacher thinks that I should continue with physics beyond my GCSE". This was measured on the same Likert scale as self-concept. Graph 2 shows that girls reported less encouragement than boys (an average of 4.05 versus 4.39). These findings were statistically significant at 0.001. In our analysis found in other publications we have found that lack of encouragement is statistically significantly related to lower aspirations and participation in physics post-16.[545 546]

We expanded the analysis in Figure 5.8 and explored high- and low-aspiring girls' and boys' self-concept and how that relates to teacher encouragement, whilst also controlling for students' background characteristics: ethnicity, parents' social class/occupational status. In our first model, we only controlled for the influence of students' background characteristics and not teacher encouragement. Once we also controlled for teacher encouragement, the nature of the findings changed. Initially, before controlling for teacher encouragement, we found that Year 8 and 10 girls with high aspirations to continue with physics after the age of 16 had statistically significant lower physics self-concept than boys with high aspirations.

544 "What sort of girl wants to study physics after the age of 16? Findings from a large-scale UK survey", Mujtaba, T., & Reiss, M. J., in International Journal of Science Education, 35, 2013, pp2979-2998.
545 "Inequality in experiences of physics education: Secondary school girls' and boys' perceptions of their physics education and intentions to continue with physics after the age of sixteen", Mujtaba, T., & Reiss, M. J., in International Journal of Science Education, 35, 2013, pp1824-1845. 546 "A survey of psychological, motivational, family and perceptions of physics education factors that explain 15 year-old students' aspirations to study post-compulsory physics in English schools", Mujtaba, T., & Reiss, M. J., in International Journal of Science and Mathematics Education, 12, 2013, pp371-393.

Figure 5.8: The physics self-concept and teacher encouragement of Year 8 and 10 girls and boys



Source: University College London, Institute of Education

However, the difference became larger once we controlled for teacher encouragement. This suggests that teacher encouragement is associated with a higher self-concept, and that high-aspiring girls are less likely to receive this than high-aspiring boys.

Before we controlled for teacher encouragement, girls with high aspirations to continue with physics after the age of 16 had a higher self-concept than girls with low aspirations. Boys with low aspirations to continue with physics after the age of 16 had a lower physics self-concept than girls with high aspirations to continue with physics after the age of 16. However, once we controlled for teacher encouragement, the difference between low-aspiring boys and high-aspiring girls disappeared, again suggesting that teacher encouragement received by low-aspiring boys is related to a higher self-concept. We found that there was a statistically significant influence of parental occupation/social class; students who were from professional backgrounds were more likely to have higher physics self-concepts than students whose parents were from non-professional backgrounds.

The physics self-concept of students two years later and the role of earlier teacher encouragement

The UPMAP project followed the original Year 8 and 10 students into Years 10 and 12 respectively, and we asked similar survey questions. We did not receive survey data for all the original students, although we did have responses on the self-concept of 3,364 boys and 4,298 girls. A basic test of means replicated the findings in Figure 5.8: that girls (mean of 3.29) had a statistically significant lower self-concept than boys (mean 3.39). It also showed that, on average, the self-concept of boys and girls has declined by a statistically significant factor over the two years.

At Year 12, students who were classified as 'high aspiring' had chosen physics at A-level or an equivalent qualification, whilst those with low aspirations had not chosen physics at A-level. We wanted to explore whether the influence of choice at the age of 16 had an influence on the relationship between teacher encouragement, age and gender. In the following analysis we differentiated between the younger cohort (Year 10 students who had still not chosen subjects) and the older Year 12 cohort, who had at this stage chosen whether or not to continue with physics at A-level (or equivalent). Girls with high aspirations at Year 12 reported lower self-concepts than high aspiring boys, but their self-concepts were higher than both low-aspiring boys and girls (who had not chosen physics). At Year 10, the findings continued to resemble those of two years earlier, in that there was no difference between high-aspiring girls and low-aspiring boys (although high-aspiring girls had a lower self-concept than low-aspiring boys).

Part 1 - Engineering in Context
6.0 Mining the talent pool - capacity and equity

There is a sound moral argument for giving every child an equal chance to succeed, but this is about more than individual attainment. The potential impact on our economy as a whole makes the need to address this inequality irrefutable. Studies suggest that if the UK had, in recent decades, taken action to close the achievement gap at 11, so that the poorest pupils achieved the same levels as others by the end of primary school, GDP would be around £30 billion higher in 2020 and around £60 billion higher in 2030.[547]

The number of teenagers classified as Not in Education, Employment or Training (NEET) has long been a concern. This now appears to be resolved, thanks to legislation that raised the school leaving age to 18. However, this section clearly shows that there remain widespread – and unresolved – inequalities for disadvantaged young people in GCSE attainment, level 3 attainment, progression to higher education and earnings.

These inequalities directly affect the wellbeing and economic future of every single disadvantaged teenager. They cannot be overlooked by government, schools, colleges or employers.

Raising the school leaving age to 18 in 2015[548] reduced the 16- to 17-year-old NEET figure to just 53,000 (see Table 6.1). Policy makers are now shifting their focus to 18- to 24-year-olds, as highlighted by IPPR in its report, *No More Neets, A Plan For All Young People To Be Learning Or Earning*.[549]

This fall in numbers of teenage NEETS is not a UK phenomenon: it is mirrored across the globe. Figure 6.1 from the Organisation for Economic Co-operation and Development (OECD) report, *NEET Youth in the Aftermath of the Crisis: Challenges and Policies*, shows that the share of teenagers among NEETs is small and falling.[550]

OECD's breakdown of the NEET population by age shows that the majority are in their 20s (left panel of Figure 6.1). The 25- to 29-year-olds are the most important group, accounting for 45% of the NEET population across OECD countries. Youths aged 16-19 years make up only 16% of all NEETs.

547 Too young to fail – Giving all children a fair start in life, Save the Children, 2013, p9 **548** http://www.education.gov.uk/childrenandyoungpeople/youngpeople/participation/rpa **549** No More Neets, A Plan For All Young People To Be Learning Or Earning, Graeme Cooke, IPPR, November 2013 **550** Carcillo, S. et al. (2015), "NEET Youth in the Aftermath of the Crisis: Challenges and Policies", OECD Social, Employment and Migration Working Papers, No. 164, OECD Publishing, p22 http://dx.doi.org/10.1787/5js6363503f6-en

Figure 6.1: Percentage point change in the share of 15- to 19-year-olds and 25- to 29-year-olds among NEETs (2007-2012)

Left panel: breakdown of NEETs by age group in %, 2012. Right panel: percentage-point change in the share of 15-19 and 25-29 year-olds among NEETs, 2007-12
Source: OECD calculations based on EU-LFS, SEW (Australia), LFS (Canada), CASEN (Chile), ENOE (Mexico), HLFS (New Zealand), CPS (United States) and OECD Education Database (Israel, Korea, Turkey).

6.1 Our untapped potential

As previously mentioned, studies suggest that raising the educational outcomes for poorer children would increase GDP by £30 billion a year by 2020 and by £60 billion a year by 2030.[551] Our extension analysis to Working Futures 2012-2022 shows that the UK needs to recruit 1.82 million workers with engineering skills over the period 2012-2022 (182,000 per year) (Section 15.5.1), with current supply levels leaving a shortfall of 69,000 people per year.

Table 6.1 shows that in Q2 2015, there were still 871,000 18- to 24-year-old NEETs. This is a clearly visible, yet untapped pool that government, business and industry, professional engineering institutions and third sector organisations need to be conscious of and predisposed to act upon.

The number of NEETs in England continues to fall and is now at its lowest level for a decade. Government figures reveal a 0.3 percentage point year-on-year fall in the number of NEET 16- to 24-year-olds for the April-June 2015 period to 922,000. This is a decrease of 21,000 from January to March 2015 and down 44,000 from a year earlier.[552]

Table 6.1: People aged from 16 to 24 Not in Education, Employment or Training

	Young people who were NEET				
Levels	**Total**	**Unemployed**	**Economically inactive**	**Total people in relevant population group**	**People who were NEET as a percentage of people in relevant population group**
16-24					
Apr-Jun 2013	1,093,000	593,000	500,000	7,346,000	14.9%
Apr-Jun 2014	966,000	463,000	503,000	7,315,000	13.2%
Apr-Jun 2015	**922,000**	**431,000**	**490,000**	**7,258,000**	**12.7%**
Change on year	-44,000	-31,000	-13,000	-57,000	-0.5%
Change %	-4.6%	-6.8%	-2.6%	-0.8%	
16-17					
Apr-Jun 2013	72,000	35,000	37,000	1,515,000	4.8%
Apr-Jun 2014	60,000	25,000	35,000	1,501,000	4.0%
Apr-Jun 2015	**51,000**	**27,000**	**24,000**	**1,475,000**	**3.4%**
Change on year	-9,000	2,000	-11,000	-27,000	-0.5%
Change %	-15.2%	6.3%	-30.8%	-1.8%	
18-24					
Apr-Jun 2013	1,021,000	558,000	463,000	5,832,000	17.5%
Apr-Jun 2014	906,000	437,000	469,000	5,814,000	15.6%
Apr-Jun 2015	**871,000**	**405,000**	**466,000**	**5,784,000**	**15.1%**
Change on year	-35,000	-33,000	-2,000	-30,000	-0.5%
Change %	-3.9%	-7.5%	-0.5%	-0.5%	

Source: Labour Force Survey

6.2 New insights and data

The most relevant findings that have emerged since the last report are described in the following sub-sections.[553]

6.2.1 Attainment and HE progression by Free School Meal

The Social Mobility and Child Poverty Commission was established in 2012 to monitor and report on what is happening to child poverty and social mobility in our country. As a result, its annual State of the Nation report contains some very noteworthy findings.

The report looked at the measure of attainment and the gaps in attainment by social background of children attending schools in England at the end of Key Stage 4 (usually when aged 16). Specifically, it examined achievement in the core subjects of maths and English, which are taken by almost all pupils.

The commission found a trend of rising attainment for both children eligible free school meals (FSM) and other pupils. There were major improvements from 2005 to 2013: almost twice as many children eligible for FSM achieved good GCSEs in English and maths in 2013 compared with 2005 (Table 6.2). However, there was arguably limited progress in closing the attainment gap between FSM pupils and all other pupils (relative chance): a 1.4 percentage point reduction from 2008 to 2013 and a 1.9 percentage point decrease from 2005.[554]

Table 6.2: Attainment at 16 – proportion of children achieving A*–C in English and Maths, by Free School Meal eligibility

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
All other pupils	47.5%	49.5%	50.5%	52.4%	54.8%	59.3%	62.5%	63.0%	65.3%
FSM	19.0%	21.5%	22.3%	24.4%	27.1%	31.7%	35.1%	36.8%	38.7%
Attainment gap	28.5%	28.0%	28.2%	28.0%	27.7%	27.6%	27.4%	26.2%	26.6%
Relative chance	2.5	2.3	2.3	2.1	2.0	1.9	1.8	1.7	1.7

Source: DfE, GCSE and equivalent attainment by pupil characteristics in England, 2012/13: FR 5/20141

The report moves on to analysing the attainment and social gaps in attainment at 19 of children attending schools in England who were at maintained schools at the age of 15. It uses two A levels/International Baccalaureate as the benchmark. The resultant trend is of limited change (Table 6.3). The proportion of young people eligible for free school meals achieving two A levels by the age of 19 has been broadly static over time, with fewer than one in five FSM children achieving at this level in 2013.[555] Other pupils remain more than twice as likely to get two or more A levels/International Baccalaureates as FSM students.

551 Too young to fail – Giving all children a fair start in life, Save the Children, 2013, p9 **552** http://www.ons.gov.uk/ons/rel/lms/young-people-not-in-education--employment-or-training--neets-/august-2015/index.html **553** Plus some key data from the 2015 report which warranted reproducing in edited form. **554** State of the Nation 2014: Social Mobility and Child Poverty in Great Britain, October 2014, p274 **555** *ibid*, p275

Table 6.3: Attainment at 19 by free school meals at 15 – proportion of children in maintained schools at age 15 who achieve level 3 qualifications (at least two A levels or equivalent) by age 19, by Free School Meal eligibility at age 15 (2005-2013)

Age 19 in	2005	2006	2007	2008	2009	2010	2011	2012	2013
FSM	14.3%	14.4%	14.0%	13.7%	14.4%	14.7%	15.2%	15.6%	15.9%
Non-FSM	37.0%	36.3%	35.8%	34.9%	35.3%	35.0%	36.9%	37.5%	37.9%
Gap	22.7%	21.9%	21.8%	21.3%	20.9%	20.8%	21.7%	21.9%	21.9%

Source: DfE, Statistical first release SFR 0/201401234567

This trend continues into higher education but, at this level, shows some sign of progress (Table 6. 4). The proportion of pupils aged 15 going to higher education by the age of 19 increased between 2005/06 to 2012/13, with pupils eligible for FSM has improved by 10 percentage points compared to pupils not eligible for FSM who improved by 7 percentage points.[556]

However, there has been no major narrowing of the absolute gap, as the proportion of non-FSM pupils aged 15 who have entered higher education by age 19 has also continued to rise. Young people eligible for free school meals are still only half as likely to progress to university as others.

Table 6.4: Estimated percentage of 15-year-old pupils from state-funded schools by free school meal status who entered HE by age 19 in UK higher education institutions and English further education colleges (2005/06-2012/13)

	Estimated % who entered HE			
Entered HE by age 19 in academic year	**FSM[1]**	**Non-FSM[1]**	**Gap (PP)[2]**	**All**
2005/06	13%	33%	19	30%
2006/07[3]	14%	33%	19	30%
2007/08	15%	33%	18	31%
2008/09[3]	17%	35%	18	32%
2009/10	18%	36%	18	34%
2010/11	20%	38%	18	35%
2011/12	21%	39%	18	36%
2012/13	23%	40%	17	37%

Source: BIS

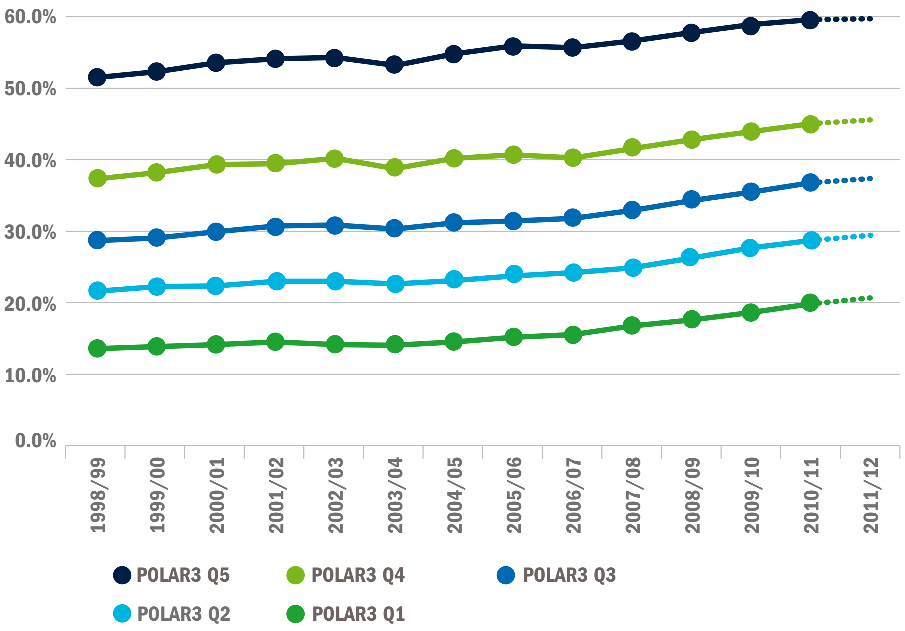
Notes: [1] FSM and Non-FSM refer to whether pupils were receiving Free School Meals at age 15 or not. [2] Gap is the difference between FSM and non-FSM expressed in percentage points. Percentage figures are rounded; gap figures are calculated from un-rounded data and therefore may not correspond to the gap between rounded percentages. [3] An improvement has been made to the calculation of these figures to remove a small number counted in both HE and FE institutions.

Additionally, Figure 6.2 shows that across the period 1998/99–2011/12, participation in HE among the most advantaged group increased by nine percentage points compared with only seven percentage points for the most disadvantaged group (although, since the mid-2000s, the percentage point increases for both these groups have been the same). So, while the proportional gap between the most advantaged and the most disadvantaged has reduced, participation rates for quintile 5 (areas with higher participation rates) are now three times higher than quintile 1 (the lowest participation neighbourhoods). This compares with around four times higher at the start of the period.[557]

On entering university, unfortunately, the disparities continue. For example, Figure 6.3 shows clearly that those from the lowest participation neighbourhoods (POLAR3 quintile 1) are significantly more likely to no longer be in HE after one year than those from areas with higher participation rates (POLAR3 quintile 5): around 9%, compared with around 5%.[558]

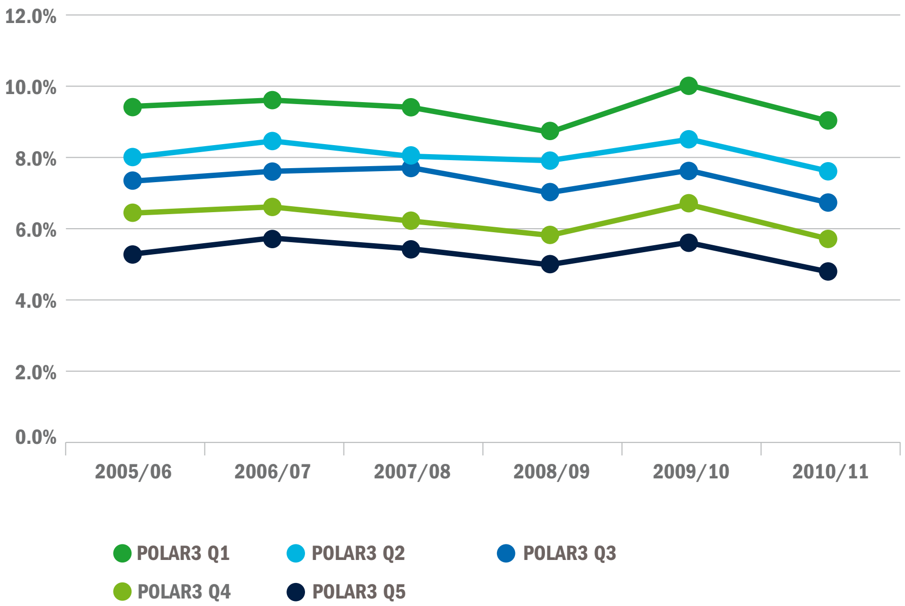
556 Widening Participation In Higher Education, Department of business, innovation and skills, Widening participation in higher education, July 2015, p4 **557** http://www.hefce.ac.uk/whatwedo/wp/ourresearch/polar/polar3/ **558** National strategy for access and student success in Higher Education, Department for Business, Innovation and Skills, April 2014, p52

Figure 6.2: Young participation rate for all POLAR3 quintiles (1998/99-2011/12)



Source: HEFCE 2013/28

Figure 6.3: Percentage of young entrants who are no longer in HE after one year, by POLAR3 classification (2005/06-2010/11)



Source: HEFCE 2013/28

Finally, in its research brief *Missing Talent*,[559] The Sutton Trust looked at the issue from a different perspective and made some interesting findings. In the chapter headed *Mining the Talent Pool*, the trust looked at the 7,000 pupils every year who scored in the top 10% nationally at the end of primary school but who receive a set of GCSE results that place them well outside the top 25%.

They found that of all the able young people studied, being from a poor home more than doubles your chances of missing out on top GCSE grades. This means that bright disadvantaged pupils will, on average, score 4As and 4Bs, while their equally able classmates from better off backgrounds get eight straight As. But the problem is much more pronounced for some students. One in ten of the poor but clever pupils barely achieve C grades (or do much worse), lagging behind their more-advantaged peers by almost a whole GCSE grade per subject.

Furthermore, they found that the bright but disadvantaged group is also less likely to take subjects that will stand them in good stead for university choices. Almost a quarter will not be taking a language at GCSE and just 53% will take triple sciences – separate papers in physics, chemistry and biology – compared with 69% of their more advantaged peers.

They found that over a third (36%) of bright but disadvantaged boys seriously underachieve at age 16.[560] Clever but poor girls are slightly less likely to underperform, with just under a quarter (24%) getting disappointing GCSE results. These figures compare with 16% of boys and 9% of girls from better off homes who similarly fall behind by age 16.

559 http://www.suttontrust.com/wp-content/uploads/2015/06/Missing-Talent-final-june.pdf **560** The Sutton Trust – Over a third of clever but poor boys significantly underachieve at GCSE http://www.suttontrust.com/researcharchive/missing-talent/

6.2.2 Attainment by type of school

In addition to inequality associated to social background and home location, there is also inequality in access to the most selective HE institutions by the type of school one attends.

In comparing 'middle' (state schools) against 'top' (independent schools), Table 6.5 shows inequality in access to the most selective HE institutions by school type.[561]

In 2011/12, less than a quarter (23.0 per cent) of A level students from state schools went on to the most selective universities, compared with three-fifths (61.9%) of A level students who attended independent schools. This is a gap of 38.9 percentage points.

The inequalities apparently continue even beyond HE.

A report[562] from the Social Mobility and Child Poverty Commission examined who was in charge of our country. It did so on the basis of new research which analysed the background of 4,000 leaders in politics, business, the media and other aspects of public life in the UK. The hope was that the findings would prompt a re-think in the institutions that have such a critical role to play in making Britain a country where success relies on aptitude and ability more than background or birth.

The analysis showed that independent-school-educated people accounted for:

- 71% of senior judges
- 62% of senior armed forces officers
- 55% of Permanent Secretaries
- 53% of senior diplomats
- 50% of members of the House of Lords
- 45% of public body chairs
- 44% of the Sunday Times Rich List
- 43% of newspaper columnists
- 36% of the Cabinet
- 35% of the national rugby team
- 33% of MPs
- 33% of the England cricket team
- 26% of BBC executives
- 22% of the Shadow Cabinet

This compares with 7% of the public as a whole.[563]

6.2.3 Access to triple science and languages

Analysis in subject take-up has been carried out by the Open Public Services Network which shows that access to subjects such as triple science and language GCSEs vary enormously, with young people in poor neighbourhoods either denied access or strongly encouraged not to take up certain subjects.[564]

The data reveals that:[565]

- In North East Lincolnshire, 50% of the 10 schools in the LEA did not offer triple science GCSE. More than a third of schools do not enter any pupils for triple science in Knowsley (43%), Slough (36%), Kingston upon Hull (38%) and Newcastle (36%).
- In contrast, in Sussex and Cumbria – local authorities with over 30 schools – every school offers GCSE in three sciences.
- Children in Knowsley are half as likely to be enrolled for a science GCSE as children in Buckinghamshire.
- Children in Kensington are four times more likely to be enrolled for a language GCSE than children in Middlesbrough where, on average, only one child in every four takes a language GCSE.
- You are most likely to be entered for an art GCSE in the Isles of Scilly and least likely in Kingston upon Hull, where it is five times less likely.

Furthermore, the report found that in six areas, more than a third of schools did not have pupils taking three science GCSEs. These six are Medway, Slough, Newcastle upon Tyne, City of Kingston Upon Hull, Knowsley and North East Lincolnshire.[566]

Worryingly for the STEM community, they highlight concerns that the accountability regime – in which schools are rated on the number of points they achieve in exams – can incentivise schools to offer more limited opportunities to children, in an effort to maximise the school's rating at the expense of the child's future. Children from more deprived areas tend to get poorer grades than children from more affluent areas (see 6.2.1). Schools in these areas can improve their chances of better grades by only offering less demanding courses. Evidence that this may be occurring can be seen, for example, in the much lower rates of enrolment for triple science GCSEs in more deprived areas.[567]

6.2.4 The London effect

Research by the Centre for Market and Public Organisation, University of Bristol, found that the high success rate enjoyed by GCSE students in London (highlighted in last year's report and dubbed 'the London effect'), can be explained by the higher proportion of ethnic minority pupils in the capital.[568] Whilst the capital's diversity plays a key role in pupils' high levels of success, London also has a low rate among the lowest performing group: white British.

These results show that pupils in London's state-funded schools scored around eight GCSE grade points higher than those in the rest of the country. This is the difference between gaining eight A grades compared with eight Bs, or eight Cs compared with eight Ds.[569]

However, once children's ethnic background was factored in, the London effect in pupil progress was found to disappear. The report concluded that:

- White British pupils tend to achieve the lowest GCSE scores against their attainment at the end of primary school, compared with those from ethnic minority backgrounds.
- This group also makes up just over a third (36%) of Year 11 (15- and 16-year-olds) in London, while they make up around 84% of this school year group in the rest of England.
- "London simply has a lot higher fraction of high-performing groups and a lot lower fraction of low-performing groups, principally White British pupils."
- "Being a recent immigrant or being of non-White British ethnicity has a very substantial positive effect on progress through school," as the children of immigrants typically have "high aspirations and ambitions, and place greater hopes in the education system than the locals do."

Table 6.5: Higher education participation in the most selective institutions by school type – proportion of A level students going to most selective universities by type of school

Percentage progressed to HE by age 19 from:	2007/08	2008/09	2009/10	2010/11	2011/12
State school	24.8	25.6	25.9	23.8	23.0
Independent school	63.2	62.4	65.0	63.7	61.9
Gap (pp)	38.5	36.8	39.1	39.9	38.9

Source: Department of business, innovation and skills, Widening participation in higher education

561 State of the Nation 2014: Social Mobility and Child Poverty in Great Britain, October 2014, p298 **562** Elitist Britain? Social Mobility and Child Poverty Commission, August 2014 **563** *ibid*, p10 **564** Lack of options: how a pupil's academic choices are affected by where they live, OSPN report, February 2015 https://www.thersa.org/discover/publications-and-articles/reports/lack-of-options-how-a-pupils-academic-choices-are-affected-by-where-they-live/ **565** *Ibid*, p8 **566** *Ibid*, p12 **567** *Ibid*, p4 **568** Understanding the success of London's schools, Simon Burgess, Working Paper No. 14/333, October 2014, p3 http://www.bristol.ac.uk/media-library/sites/cmpo/migrated/documents/wp333.pdf **569** *Ibid*, p4

6.2.5 The importance of Key Stage 4 attainment

Some very interesting research undertaken by The Centre for the Analysis of Youth Transitions (CAYT) that looked at the extent that schools have an effect on their pupils' HE decisions has thrown up a noteworthy finding.[570] The research suggests that the focus of 'widening participation' efforts on the basis of secondary school characteristics should be to ensure that pupils from all schools make the right choices over the subjects and qualifications they take at Key Stage 4, and that they maximise their chances of getting good grades at this level.

Having compared pupils with the same background characteristics, Key Stage 2 scores and Key Stage 4 attainment, they found that the differences in HE participation fall to less than 4 percentage points in terms of participation overall, and to less than 1 percentage point in terms of participation at a high-status institution. They also found that the addition of a rich set of controls for attainment at Key Stage 5 added very little to this picture. This suggests that:[571]

- To the extent that schools have an effect on their pupils' HE decisions, it is likely to come primarily via their effect on Key Stage 4 attainment. That is not to say that the change in the magnitude of the differences in HE participation before and after controlling for Key Stage 4 attainment represents the causal effect of a particular school characteristic on Key Stage 4 attainment, because there could be other unobserved differences between schools (or pupils within those schools) that are driving these results; for example, pupils from certain types of schools may have tried harder on the tests. Nonetheless, it suggests that any causal effects of school characteristics on HE participation are most likely to come via this route.
- Any effect that secondary schools may have in terms of encouraging their pupils to stay in education beyond compulsory school-leaving age (or to do well once they are there) is likely to come via increasing attainment at Key Stage 4.
- Any direct effect (ie any effect over and above that arising from increasing pupils' attainment) that secondary schools may have on their pupils' choices over whether and where to go to university is likely to be very small. This suggests that doing things such as encouraging pupils to apply to university, or helping them with their application, does not appear to play a large role in explaining why pupils from some schools are more likely to go to university than others; the key way in which schools seem to influence their pupils' HE participation decisions appears to come via prior attainment, especially at Key Stage 4.

Taken together, these results suggest that the focus of 'widening participation' efforts on the basis of secondary school characteristics should be to ensure that pupils from all schools make the right choices over the subjects and qualifications they take at Key Stage 4, and that they maximise their chances of getting good grades at this level. This is because good grades in highly-regarded subjects and qualifications at Key Stage 4 are not only associated with a higher probability of staying in education beyond the age of 16 and doing well at Key Stage 5, but that they also continue to be significantly associated with HE participation decisions and university outcomes, even after accounting for subsequent measures of attainment.

6.2.6 Earnings

The Institute for Fiscal Studies (IFS) has looked at the outcomes of graduates who sat their A levels at a state school, against those who went to a fee-paying school.[572] The researchers gathered data from a cohort of more than 200,000 graduates who completed their undergraduate degree at a UK university in 2007, and compared the wages six months and three-and-a-half years after graduation.

The institute found that, of those who were in work three-and-a half years after graduation, those who had been to a private school were earning, on average, £28,592: £4,548 more than the average salary for state school graduates, which stood at £24,044 (Table 6.6).

The IFS added that this wage gap was partly because independent school pupils tend to go to more prestigious universities and are more likely to study subjects linked to higher earnings.

Table 6.6: Gross annual earnings at 6 months and 3.5 years, by school type

		Salary at 6 months		Salary at 3.5 years	
		Private school	**State school**	**Private school**	**State school**
Overall	Mean	£21,643	£18,919	£28,592	£24,044
	Median	£20,000	£18,000	£26,665	£23,295
	Number	6,800	53,299	2,254	17,467
Females	Mean	£20,436	£18,259	£26,316	£22,861
	Median	£20,000	£18,000	£25,000	£22,350
	Number	3,592	31,889	1,177	10,329
Males	Mean	£22,996	£19,903	£31,078	£25,755
	Median	£22,000	£19,000	£29,000	£25,000
	Number	3,208	21,410	1,077	7,138

Source: Longitudinal DLHE 2006-07

570 The link between secondary school characteristics and university participation and outcomes, CAYT Research Report, Department for Education, June 2014 **571** *ibid*, p9 **572** Heterogeneity in graduate earnings by socio-economic background, IFS Working Paper W14/30, 12 December 2014, p16

6.3 Gender

"People and their talents are two of the core drivers of sustainable, long-term economic growth. If half of these talents are underdeveloped or underutilized, the economy will never grow as it could."[573]

We have previously highlighted government intent in addressing this issue. For example, the Women's Business Council (WBC)[574] was established in 2012, to advise government on how women's contribution to growth can be optimised. We can now add the establishment of The Women and Equalities Select Committee[575] in Parliament for the first time. The new Select Committee will examine the expenditure, administration and policy of the Government Equalities Office (GEO).

Shortly after its launch, the Committee Chair, Maria Miller said:

"The committee has a very broad remit, covering age; disability; gender reassignment; marriage and civil partnership; pregnancy and maternity; race; religion or belief; sex; and sexual orientation. We are keen to hear views on specific issues which the committee should consider in its future work, and we welcome ideas from everyone."

Time will tell how successful these interventions are. In the meantime, the reality is that there is a significant employment gap between men and women across Europe. This means that European economies are failing to utilise the full potential of their societies. Research by IPPR[576] has found that, despite decades of increased participation and attainment in education among women, as well as improved legislative guarantees of maternity and parental leave, there remains significant room for improvement. The research found that, across the 28 EU member states:[577]

- the gap between male and female employment rates stood at 11.7 percentage points in 2013[578]
- the female employment rate remained steady at around 62.5% between 2008 and 2013

The report goes on to describe the emergence over the past decade of a set of dynamics that has led to three undesirable labour market outcomes that affect women, across seven European countries (Germany, Spain, France, the Netherlands, Sweden, the UK and Poland). These were:[579]

- low rates of female employment
- underemployment of women in terms of hours
- the prevalence of women working below their 'skill grade'

There is good news when it comes to representation of women on UK boards. The latest annual report from Lord Davies of Abersoch shows that, four years on from his original report commissioned by Business Secretary Vince Cable, female representation has almost doubled to 23.5%.[580]

The report indicates that the UK only needs 17 more women appointed to these boards to meet the 25% target that was originally set.

As of March 2015, published statistics show that:

- FTSE 100: women's representation on boards has increased to 23.5% – up from 20.7% in March 2014, and 12.5% in 2011
- FTSE 250: women's representation on boards has increased to 18% – up from 15.6% in March 2014, and 7.8% in 2011
- FTSE 100: now has 263 women board members
- FTSE 100: 28.5% of Non-Executive Directors are women
- FTSE 100: 8.6% of Executive Directors are women
- FTSE 250: now has 365 women board members
- FTSE 250: 23% of Non-Executive Directors are women
- FTSE 250: 4.6% of Executive Directors are women
- **There are no all-male boards in the FTSE 100**
- **However,** there remain 23 all-male boards in the FTSE 250

At the time of printing Lord Davies's final report has gone further by recommending a voluntary target of 33% women on FTSE 350 Boards by 2020 with a particular focus on increasing the executive layer.

Finally, in fairness to the government, in addition to establishing the select committee, it has also launched some tangible support to help increase female participation in the workforce. Two new employer-led pilot projects which will open up new routes into engineering for women and increase their potential to advance in engineering careers.[581]

The two projects will be run by British-based global engineering consultancies WS Atkins and Hyder Consulting. The £208,000 of joint government and employer funding will create skills programmes for new and former women engineers and improve the representation of women in the UK workforce.

The two companies were chosen from a competitive tender under the government's Employer Ownership of Skills Fund,[582] which provides a fast and simple grant offer for businesses. The projects receiving funding are:

- WS Atkins to support the training of 100 women to level 3 qualifications to aid their return to engineering after a break in their careers
- Hyder Consulting to support the training of 80 female engineers up to level 4 (degree equivalent) standards to help them advance their careers

6.4 Cost to the economy[583]

The Sutton Trust has estimated the economic benefits of creating a more socially mobile, highly skilled workforce at up to £140 billion a year by 2050.[584]

Over their working life and compared to peers who have never been NEET, a person who has been NEET will lose up to £50,000 in earnings compared with a non-graduate peer, and up to £225,000 compared with a graduate peer.[585] Furthermore, the cost to the state of Britain's NEET problem is around £22 billion in additional public spending, and in excess of £77 billion a year when including lost income.[586]

Save the Children[587] has looked at this issue from a different angle. The charity determined that if the UK had, in recent decades, taken action to **close the achievement gap** at 11, so that the poorest pupils achieved the same levels as others by the end of primary school:

- GDP in 2013 would have been around £20 billion or 1% higher
- GDP in 2020 would be around £30 billion or 1.8% higher
- GDP in 2030 would be around £60 billion or 3.1% higher

573 Klaus Schwab, Founder and Executive Chairman, World Economic Forum, Insight Report, The Global Gender Gap Report 2014, World Economic Forum, October 2014, p v **574** http://womensbusinesscouncil.dcms.gov.uk/ **575** http://www.parliament.uk/business/committees/committees-a-z/commons-select/women-and-equalities-committee/role/ **576** Women and Flexible Working, Improving Female Employment Outcomes in Europe, Institute for Public Policy Research, December 2014 **577** Women and Flexible Working, Improving Female Employment Outcomes in Europe, Institute for Public Policy Research, December 2014, p1 **578** Eurostat (2014) Eurostat Labour market database, Luxembourg. http://epp.eurostat.ec.europa.eu/portal/page/portal/labour_market/introduction **579** Women and Flexible Working, Improving Female Employment Outcomes in Europe, Institute for Public Policy Research, December 2014, p3 **580** https://www.gov.uk/government/publications/women-on-boards-2015-fourth-annual-review **581** https://www.gov.uk/government/news/government-joins-forces-with-industry-to-get-more-women-into-engineering **582** https://www.gov.uk/government/publications/employer-ownership-of-skills-pilot **583** Due to no new significant data, this section is a reproduction of section 6.4 from the 2015 report. **584** Higher Education as a tool of social mobility: Reforming the delivery of HE and measuring professional graduate output success, Centre Forum, May 2014, page 8 **585** Make NEETs History in 2014, Impetus Private Equity Foundation, January 2014, p11 **586** Coles, B; Godfrey, C; Keung, A et al (2010) Estimating the life-time cost of NEET: 16-18 year olds not in education employment or training. University of York, York. **587** Too young to fail – Giving all children a fair start in life, Save the Children, 2013, p9

It also determined that if the UK had, in recent decades, taken action to **close the international achievement gap so that it performed as well as Finland, Canada and South Korea:**

- UK GDP in 2013 would have been around £40 billion or 2.6% higher
- UK GDP by 2020 would be around £80 billion or 4.4% higher
- UK GDP by 2030 would be around £160 billion or 8.0% higher

It's not only the UK who benefits. The cost to the European Union of youth not finding work is enormous: one estimate puts the annual cost of the NEET population—in terms of both direct costs and lost output– at €153 billion in 2011.[588]

6.5 Improving social mobility

Highlighting the inequities is only half the battle. The other is actually doing something about it.

A report[589] by the Social Mobility and Child Poverty Commission, *Cracking the code: how schools can improve social mobility*, shows that schools can actually do something about improving social mobility, particularly in terms of educational disadvantage.

The report finds a wide variation in results between schools with similar intakes, showing that there is a lot of scope to raise performance. Its analysis showed that there is growing evidence that similar schools (in terms of how disadvantaged the children who attend them are) perform very differently. They found that:[590]

- The best performers are helping three times as many disadvantaged children to achieve five good GCSEs, including English and maths, as schools with similar levels of disadvantage. In the best performing schools,[591] 60% of disadvantaged children achieve five good GCSEs, including English and maths, compared with only 25% in the lowest performing.[592]
- If schools closed half the gap in performance to the top 20% of schools with similar concentrations of disadvantage, over 14,000 more disadvantaged students would get five good GCSEs each year. To put that in perspective, in 2012/13, around 61,000 disadvantaged children got five good GCSEs. So this would mean that almost 25% more disadvantaged children would be achieving at this level if the gap was closed.

As part of the analysis, a new survey of more than a thousand teachers was undertaken. This found that some teachers' expectations of students from disadvantaged backgrounds are too low, and that getting the best teachers to teach in the worst schools requires stronger incentives, including higher pay.[593] The survey found that:

- While it is clear that most teachers did not think social background had any influence on expectations at their school, over one in five (21%) overall – and one in four (25%) in secondary schools – agreed that some of their colleagues had lower expectations of students from disadvantaged backgrounds relative to those of other students.
- There was limited appetite among teachers to seek out roles in the most challenging schools. As has been previously argued, one of the key steps in unlocking social mobility is ensuring that good teachers are deployed in weaker schools and disadvantaged areas. But just 15% of teachers agreed that they would actively seek out a future role at a school that was more challenging than the one they already taught at, either because it had poorer results or a more diverse or disadvantaged intake.
- More than half (53%) of respondents agreed that the pressure of working in a weaker school would be a significant deterrent, unless there were mitigating factors like salary, position and travelling time. When asked to pick from a list of factors that might make them more interested in securing a role in a weaker school, a majority of respondents (63%) identified a salary increase. This compared with 39% of teachers who focussed on specific development or training and 38% who opted for clear opportunities for career progression.

Finally, whilst on the theme of teachers, it is very interesting to note the significant finding of the research undertaken by academics at the London School of Economics and Stanford University for the Sutton Trust. This showed[594] that:

The effect of good teaching is especially significant for pupils from disadvantaged backgrounds: over a school year, these pupils gain 1.5 years' worth of learning with very effective teachers, compared with 0.5 years with poorly performing teachers. In other words, for poor pupils, the difference between a good teacher and a bad teacher is a whole year's learning.

The final word on helping to improve social mobility in the UK goes to the Institute for Public Policy Research,[595] who highlight the vital importance that careers education and guidance can actually make to young people:

"In those European countries that have low rates of youth unemployment, careers education and guidance play a crucial role in ensuring a smooth transition from education to work, but it has been badly neglected in England."

588 Education to Employment: Getting Europe's Youth into Work, McKinsey Centre for Government, page 5 589 Cracking the code: how schools can improve social mobility, Social Mobility and Child Poverty Commission, October 2014 590 *ibid*, p iii 591 The top 20 per cent of performers compared to schools with a similar level of disadvantage 592 The bottom 20 per cent of performers compared to schools with a similar level of disadvantage 593 Cracking the code: how schools can improve social mobility, Social Mobility and Child Poverty Commission, October 2014,p iv 594 Improving social mobility through education, Mobility Manifesto, The Sutton Trust, September 2014, p6 595 Dolphin, T. Remember the young ones: Improving career opportunities for Britain's young people, London: Institute for Public Policy Research, 2014, p.3. http://www.ippr.org/assets/media/publications/pdf/rememberyoung-ones_Aug2014.pdf

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Part 2 - Engineering in Education and Training
7.0 GCSEs and equivalent qualifications

Following exacting reforms – designed to increase the rigour and simplicity of level 2 qualifications – entries to the traditional, and challenging, science subjects have fallen. Entries to GCSE chemistry and biology in England, Wales and Northern Ireland have fallen by 3.3% and 1.9% respectively. Significantly, physics entries have fallen by 2.6%, from 137,227 to 133,610 – and, when Scotland is included in the figures (GCSE and equivalent qualifications), that drop increases to 8% or 175,503 entries. In contrast, GCSE mathematics entries increased by 3.4% in England, Wales and Northern Ireland, from 736,403 to 761,230. Furthermore, whilst the numbers are still relatively small, more pupils than ever are studying newer STEM subjects at GCSE, such as computing, engineering and further additional science.

7.1 Education in England

Of all social factors, educational attainment has the largest influence in determining an individual's chances of being in poverty as an adult. Research conducted by the Office for National Statistics (ONS) reports that, when all other factors are equal, individuals with low educational attainment are almost five times as likely to be in poverty and eleven times as likely to be severely materially-deprived than those who are well educated.[596]

The impact of education on future life chances is significant even at a young age. Research conducted on behalf of the Department for Education (DoE) by London Economics found that, even after accounting for A level attainment, high performance on maths tests at the age of 10 was associated with a 12.5% earnings premium for males and a 23.9% earnings premium for females later in life.[597]

However, despite the importance of high educational attainment at age 10, the educational performance of pupils at level 2 (GCSEs) is a crucial stage that can determine their later life chances. For example, the Sutton Trust reported that 15% of highly able pupils who score in the top 10% nationally at age 11 fail to achieve in the top 25% of pupils at GCSE. In addition, highly able pupil-premium pupils[598] are less likely to be taking GCSEs in key facilitating subjects such as history, geography, triple sciences or languages that are important for future educational and professional progression.[599]

In 2013/14, the Department for Education estimated that nearly a quarter of children (1.6 million) were not attending a school rated as 'good' or 'outstanding' by Ofsted.[600]

The Department for Education spent £40 billion educating almost 7 million children between the ages of 4 and 16 in 2014. The school sector comprises 21,500 state-funded schools, of which 17,300 are maintained schools accountable to local authorities, and 4,200 are academies that are directly accountable to the Secretary of State.[601]

In an attempt to address the issues of sub-standard education, the department has overseen substantial reform to both the landscape of schools and qualifications. For example, In 2013/14, the DoE spent an estimated £382 million on oversight and intervention in the school sector, which included the establishment of 1,036 sponsored academies from previously underperforming maintained schools.[602]

Between 2011 and 2014, the department has increased the criteria which led to schools being judged as either 'good' or 'outstanding', and Ofsted has reclassified its 'satisfactory' judgement to become 'requires improvement'.[603]

Recent data from Ofsted shows that turning underperforming schools into sponsor-led academies results in an improvement in standards. For example, the DoE reported that sponsored academies that have operated for three years showed a 12% improvement in GCSE attainment since opening, compared with a 5% increase in maintained schools over the same period.[604] However, a House of Commons Education Committee report noted that such data mainly pertains to pre-coalition established academies, and that further research was required to ascertain the impact of post-2010 academy policy.[605]

With the aim of increasing the rigour of level 2 qualifications, the government announced that new GCSEs in English language, English literature and maths will be taught in schools in England from September 2015, with students getting their results in August 2017.

Subsequently, new GCSEs in the sciences, history and geography, in addition to languages, are scheduled to be taught from September 2016.

Except in specific circumstances, the reformed GCSEs will not contain different tiers, but be subject to a new 1-9 grading scale, where 9 represents the highest grade. Furthermore, exams will take place only in the summer, with the exception of English, English language and mathematics students, who will be permitted to retake in November.[606]

In an effort to consolidate level 2 qualifications, the government has reaffirmed its decision not to include IGCSE results in performance tables where a newly reformed GCSE covers the same subject.[607]

In June 2015, the education secretary Nicky Morgan announced that results from the English Baccalaureate were to be given greater prominence in school performance tables, in an effort to increase the numbers of pupils taking them.[608] The English Baccalaureate (EBacc) was introduced in 2009/10 and recognises achievement across:[609 610]

- English
- Maths
- Two sciences
- A language
- History or geography

From September 2015, schools where 100% of pupils don't study EBacc subjects will not be able to obtain Ofsted's top rating of 'outstanding'.[611]

In light of such announcements, it will be interesting to see whether the number of students undertaking the EBacc next year changes substantially.

596 ONS: Intergenerational transmission of disadvantage in the UK & EU, 23rd September 2014, p1. **597** London Economics: The earnings and employment returns to A levels – A report to the Department for Education, February 2-15, piii **598** The pupil premium is additional funding for publicly funded schools in England to help raise the attainment of pupils from disadvantaged backgrounds. **599** The Sutton Trust: Research Brief – Missing Talent, 5th June 2015, p1. **600** Department for Education: Academies and maintained schools – Oversight and intervention, 2014, p7 **601** *Ibid*, p5 **602** *Ibid*, p4 **603** *Ibid*, p7 **604** House of Commons Education Committee: Academies and free schools Fourth Report of Session 2014–15,27 January 2015, p12 **605** *Ibid*, p13 **606** Ofqual: GCSE changes: a summary, 11 September 2015. **607** Department for Education: Qualifications included in performance tables, 16th of January 2016 **608** The Guardian: Schools face pressure under plans to target academic GCSEs – 14 June 2015 **609** GCSE and Equivalent Attainment by Pupil Characteristics in England 2012/13, Department for Education, 23 January 2014, p4 **610** For a list of EBacc eligible subjects please see https://www.gov.uk/government/publications/english-baccalaureate-eligible-qualifications **611** BBC news: Schools 'will reject requirement to teach EBacc to all', 18 June 2015

Academy

Academies are independent, state-funded schools that receive their funding directly from central government rather than through a local authority.

They have more freedom than other state schools over their finances, curriculum, length of terms and school days and do not need to follow national pay and conditions for teachers.

Free school

Free schools are set up by groups of parents, teachers, charities, businesses, universities, trusts, religious or voluntary groups, but are funded directly by central government.

They can be run by an 'education provider' – an organisation or company brought in by the group setting up the school – but these firms are not allowed to make a profit.

The schools are established as academies, independent of local authorities and with increased control over their curriculum, teachers' pay and conditions, and the length of school terms and days.

Grammar school

Grammar schools are state schools that select their pupils on the basis of academic ability. Pupils in their final year of primary school sit an exam known as the 11-plus which determines whether or not they get a place. There is no central 11-plus exam, with papers being set on a local basis.

They are funded in much the same way as other maintained schools. Central government allocates funds, largely on a per pupil basis, to local authorities. A local funding formula then determines how much each school receives.

Maintained school

Maintained schools are funded by central government via the local authority, and do not charge fees to students. The categories of maintained school are community, community special, foundation (including trust), foundation special (including trust), voluntary aided and voluntary controlled. There are also maintained nursery schools and pupil referral units.

Maintained faith school

A maintained faith school is a foundation or voluntary school with a religious character. It has a foundation which holds land on trust for the school – and which may have provided some or all of the land in the first place – and which appoints governors to the school. In many cases, the land is held on trust for the specific purposes of providing education in accordance with the tenets of a particular faith.

Decisions on the establishment of maintained faith schools are taken under local decision-making arrangements – either by the local authority or the schools adjudicator, following a statutory process. If proposals are approved to establish a maintained faith school, a further application will be needed to the Secretary of State to designate the school with a religious character.

Maintained faith schools are like all other maintained schools in a number of ways. They must:

- follow the National Curriculum
- participate in National Curriculum tests and assessments
- be inspected by Ofsted regularly
- follow the School Admissions Code

Trust school

Trust schools are state-funded foundation schools that receive extra support (usually non-monetary) from a charitable trust made up of partners working together for the benefit of the school. Achieving trust status is one way in which maintained schools can formalise their relationship with their partners. Trust status can help schools ensure that their partners are committed to the success of the school for the long term, helping to shape its strategic vision and ethos.

Any maintained school – primary, secondary or special schools (but not maintained nursery schools) can become a trust school. Trust schools remain local authority-maintained.

Trust status will help schools to:

- raise standards through strengthening new and existing long-term partnerships between schools and external partners
- broaden opportunities and increase aspirations for pupils, support children's all-round development, and tackle issues of deprivation and social exclusion
- strengthen overall leadership and governance
- give business foundations and other organisations the opportunity to be more involved in their local community
- engage with parents – schools will need to consult parents before entering a trust
- bring a renewed energy and enthusiasm to the way they work by learning from other schools and external partners
- create a distinctive, individual or shared ethos

University technical colleges (UTC)

The best-known model of technical academies, they specialise in subjects that need modern, technical, industry-standard equipment – such as engineering and construction – and teach these disciplines alongside business skills and the use of ICT. Each UTC is sponsored by a university and industry partner and responds to local skills needs. They provide young people with the knowledge and skills they need to progress at 19 into higher or further education, an apprenticeship or employment.

Studio school

These are innovative schools for 14- to 19-year-olds, delivering project-based, practical learning alongside mainstream academic study. Students will work with local employers and a personal coach, and follow a curriculum designed to give them the skills and qualifications they need in work or to continue in education.

Technical academy

While there is no single definition or model for a technical academy, it is likely to be a new institution with no pre-existing school for secondary age pupils and to offer a curriculum combining academic with technical and/or vocational learning.

7.2 Education in Scotland

Compulsory education in Scotland ranges from age 5 to 16 and is broken down by primary school years P1-7 and secondary school years S1-S4. GCSE-equivalent qualifications are currently under reform, with the previous Intermediate 2 qualifications gradually being phased out by new National 5 exams, which set to completely replace the former in 2015/16.[612]

The learning objectives for state schools are orchestrated by the Scottish Curriculum for Excellence (CfE). The Scottish government notes that improving science, technology, engineering and mathematics (STEM) education is a key priority for CfE.[613] Furthermore, CfE highlights Scotland's "long tradition of scientific discovery, of innovation in the application of scientific discovery, and of the application of science in the protection and enhancement of the natural and built environment".[614]

Education Scotland's Sciences 3-18 Curriculum Impact Report highlighted much strength in science provision, although it did identify a need to build confidence amongst teaching staff.[615]

In its 2012 report, the Science and Engineering Education Advisory Group (SEEAG) outlined a number of recommendations for improving STEM education in Scotland.[616] As a result of the SEEAG report, an independent advisory group, STEMEC, was commissioned to improve STEM education and learning in Scotland's schools. Key areas identified by the group include initial teacher education, the development of professional learning communities, primary science, strengthening CPD, and a more interdisciplinary approach to STEM education.[617]

7.3 Education in Northern Ireland

Students sitting GCSEs in Northern Ireland attain the highest A*-C achievement rates of any UK home nation or region, with 78.7% of students attaining these grades in 2015. However, despite this high achievement, the Northern Ireland government has recognised that it faces the same challenge as other regions and countries: declining interest in, and uptake of, STEM subjects.[618] In response, the government has developed a STEM strategy, which identifies key priorities for action, including co-ordinating business links between schools, local companies, SMEs and micro businesses; increasing sensitivity to local demand; improving the attractiveness of the STEM sector; and providing better careers advice and guidance.[619]

7.4 Education in Wales

Engineering is the only STEM subject that is not routinely taught as part of the school curriculum in Wales. However, the Welsh government has implemented a learning pathways strategy, which enables pupils to pursue subjects that are not directly available in schools through local network partnerships with work-based providers, further education institutions and employers working in collaboration with schools.[620] Furthermore, in 2012, a National Science Academy was established to fund and promote STEM subjects from early years education through to secondary school and higher education. Since 2012, £2.2 million has been invested by the academy in a number of schemes to promote STEM subjects among young people.

7.5 GCSE entrant numbers

Table 7.1 shows the 10-year trend for the number of entries to different STEM subjects. The numbers of students entered onto the separate science subjects of chemistry, biology, and physics have declined, with 3,617 (2.6%) fewer pupils sitting a physics exam in 2015 than in 2014. However, it is worth noting that entries onto further additional science grew by 2,770 (10.7%), in addition to a surge in those sitting examinations in computing (up by 18,641 – 111.1%) and engineering (up by 1,882 – 37.4%).

Table 7.1: GCSE full STEM courses entries (2005-2014) – all UK candidates

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change over 1 year	Change over 10 years
Science double award – halved to illustrate	479,789	478,028	8,433	-	-	-	-	-	-	-		
Science double award	959,578	956,056	16,866	-	-	-	-	-	-	-		
Science	-	57,316	537,606	493,505	453,757	405,977	552,504	451,433	374,961	395,484	5.5%	
Additional science	-	-	433,468	396,946	352,469	306,312	289,950	283,391	323,944	302,825	-6.5%	
Additional science (further)	-	-	-	-	-	-	-	-	21,119	23,389	10.7%	
Mathematics	750,570	760,299	738,451	754,738	762,792	772,944	675,789	760,170	736,403	761,230	3.4%	1.4%
Design and technology	371,672	354,959	332,787	305,809	287,701	253,624	240,704	219,931	213,629	204,788	-4.1%	-44.9%
Biology	60,082	63,208	85,521	100,905	129,464	147,904	166,168	174,428	141,900	139,199	-1.9%	131.7%
Chemistry	56,764	59,219	76,656	92,246	121,988	141,724	159,126	166,091	138,238	133,618	-3.3%	135.4%
Computing	-	-	-	-	-	-	-	4,253	16,773	35,414	111.1%	
ICT	109,601	99,656	85,599	73,519	61,022	47,128	53,197	69,234	96,811	111,934	15.6%	2.1%
Physics	56,035	58,391	75,383	91,179	120,455	140,183	157,377	160,735	137,227	133,610	-2.6%	138.4%
Science single award	96,374	98,485	-	-	-	-	-	-	-	-		
Statistics	68,331	82,682	86,224	77,744	69,456	53,400	50,620	43,870	61,642	56,355	-8.6%	-17.5%
Mathematics (additional)	3,282	9,793	16,973	18,765	17,183	13,282	3,436	3,478	3,495	3,518	0.7%	7.2%
Engineering	-	-	-	-	-	1,850	2,128	2,897	5,027	6,909	37.4%	
All subjects	5,752,152	5,827,319	5,669,077	5,469,260	5,374,490	5,151,970	5,225,288	5,445,324	5,217,573	5,277,604	1.2%	-8.2%

Source: Joint Council for Qualifications

612 School Education, Audit Scotland for the Accounts Commission, June 2014, p4; www.audit-scotland.gov.uk/docs/local/2014/nr_140619_school_education.pdf 613 Scottish government; http://www.gov.scot/Topics/Education/Schools/curriculum/STEM (Accessed 11/09/2015). 614 Education Scotland: CfE Briefing 15: Sciences for all, October 2013. 615 Education Scotland: The Sciences 3-18, September 2013. 616 Science and Engineering Education Advisory Group (SEEAG): Supporting Scotland's STEM education and culture, January 2012. 617 Scottish Government: http://www.gov.scot/Topics/Education/Schools/curriculum/STEM/STEMEC (Accessed 11/09/2015. 618 The Department for Employment and Learning: Success through STEM – one year on, 2012 619 *Ibid*, p4 620 Welsh government: STEM: Guidance for schools and colleges, September 2012, p13.

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Table 7.2 presents entries onto GCSEs by age group from 2014 to 2015. The data reveals a continuation of the decline in the number of 15-year-olds or younger sitting GCSE examinations, with the notable exception of computing, statistics and additional mathematics, all of which saw growth among this cohort.

The decline in 15-year-old and younger pupil entries is driven by GCSEs beginning in 2012 shifting from a modular to a linear format, whereby pupils sit one final exam at the end of study. An additional aspect of these reforms was that only pupils' first attempt is counted in performance tables.[621] As a result, schools are more inclined to enter pupils into an examination as late as possible.

Considering the decline in GCSE entries by home nation, Table 7.3 reveals that the popularity of subjects is generally equivalent across all UK countries. However, it is worth noting that physics accounts for a larger proportion of all subject entries in England (2.6%) than in Wales (2.1%) or Northern Ireland (1.8%). Similarly, further additional science is also more popular in England than either Wales or, in particular, Northern Ireland, where no pupils were entered for the subject.

Table 7.3: GCSE full STEM courses entries by home nation (2015) – all UK candidates

	England		Wales		Northern Ireland	
	Entrants	Percentage of all subjects	Entrants	Percentage of all subjects	Entrants	Percentage of all subjects
Science	368,106	7.6%	19,530	7.2%	7,848	4.6%
Additional science	318,443	6.6%	12,875	4.8%	1,642	1.0%
Additional science (further)	22,925	0.5%	464	0.2%	0	0.0%
Mathematics	691,851	14.3%	42,571	15.7%	26,808	15.6%
Design and technology	192,183	4.0%	8,014	3.0%	4,591	2.7%
Biology	129,240	2.7%	5,847	2.2%	4,112	2.4%
Chemistry	124,817	2.6%	5,640	2.1%	3,161	1.8%
Computing	34,019	0.7%	1,143	0.4%	252	0.1%
ICT	98,908	2.0%	4,787	1.8%	8,239	4.8%
Physics	124,986	2.6%	5,572	2.1%	3,052	1.8%
Statistics	54,976	1.1%	1,042	0.4%	337	0.2%
Mathematics (additional)	691,851	14.3%	0	0.0%	3,518	2.1%
Engineering	6,355	0.1%	210	0.1%	344	0.2%
All subjects	4,835,712	-	270,567	-	171,325	-

Source: Joint Council for Qualifications

Table 7.2: Entry for GCSE full STEM courses by age group (2014-2015) – all UK candidates

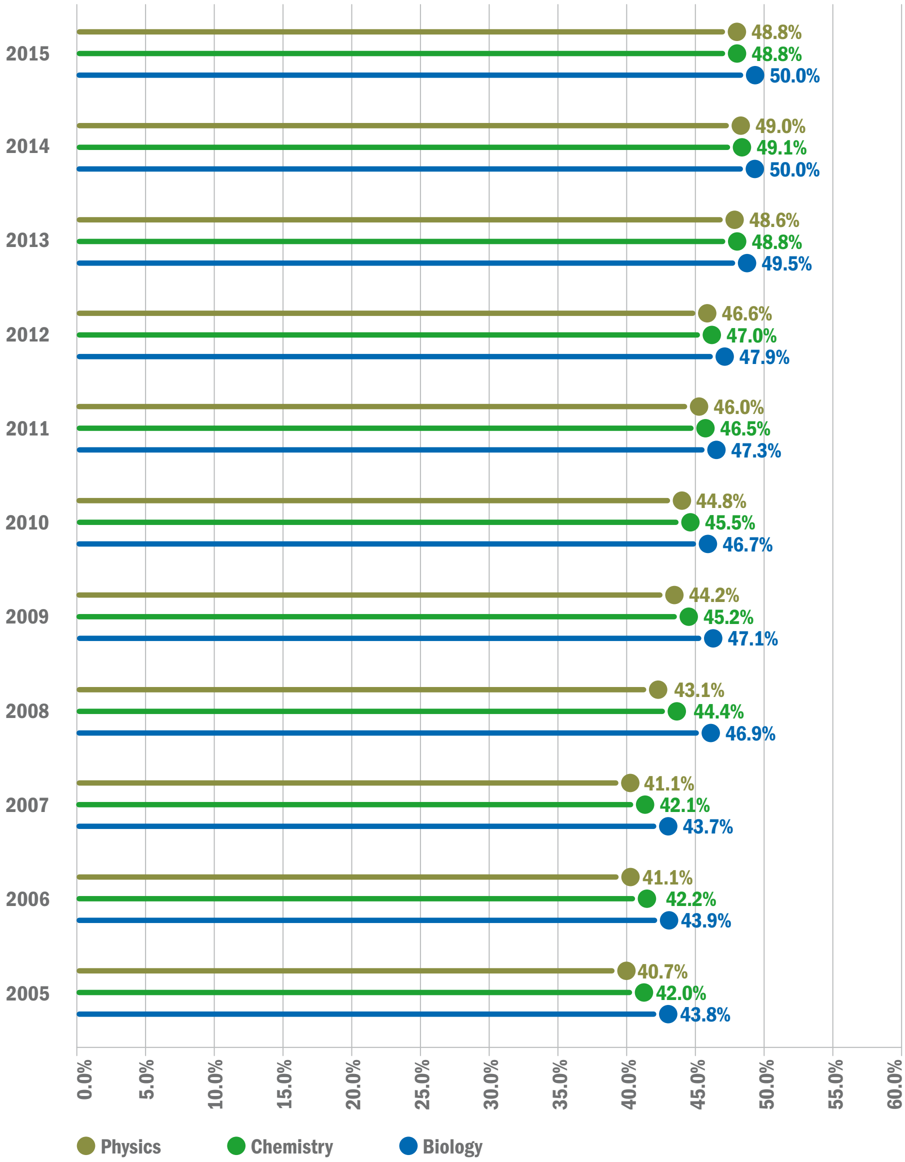
	2014				2015				Change over 1 year			
	Aged 15 and under	Aged 16	Aged 17+	All candidates	Aged 15 and under	Aged 16	Aged 17+	All candidates	Aged 15 and under	Aged 16	Aged 17+	All candidates
Science	207,394	156,391	11,176	374,961	175,517	208,192	11,775	395,484	-15.4%	33.1%	5.4%	5.5%
Additional science	9,698	309,722	4,524	323,944	9,595	322,353	4,697	336,645	-1.1%	4.1%	3.8%	3.9%
Additional science further	103	20,897	119	21,119	91	23,135	163	23,389	-11.7%	10.7%	37.0%	10.7%
Mathematics	39,292	596,524	100,587	736,403	33,484	596,767	130,979	761,230	-14.8%	0.0%	30.2%	3.4%
Design and technology	9,901	200,962	2,766	213,629	7,263	194,749	2,776	204,788	-26.6%	-3.1%	0.4%	-4.1%
Biology	7,962	128,879	5,059	141,900	7,427	126,760	5,012	139,199	-6.7%	-1.6%	-0.9%	-1.9%
Chemistry	5,522	129,982	2,734	138,238	3,871	127,084	2,663	133,618	-29.9%	-2.2%	-2.6%	-3.3%
Computing	724	15,842	207	16,773	1,389	33,607	418	35,414	91.9%	112.1%	101.9%	111.1%
ICT	6,749	87,512	2,550	96,811	5,941	103,342	2,651	111,934	-12.0%	18.1%	4.0%	15.6%
Physics	2,840	131,842	2,545	137,227	2,420	128,700	2,490	133,610	-14.8%	-2.4%	-2.2%	-2.6%
Statistics	26,445	34,730	467	61,642	29,212	26,597	546	56,355	10.5%	-23.4%	16.9%	-8.6%
Mathematics (additional)	9	2,760	726	3,495	11	2,728	779	3,518	22.2%	-1.2%	7.3%	0.7%
Engineering	445	4,470	112	5,027	366	6,446	97	6,909	-17.8%	44.2%	-13.4%	37.4%
All subjects	489,190	4,466,309	262,074	5,217,573	423,681	4,544,077	309,846	5,277,604	-13.4%	1.7%	18.2%	1.2%

Source: Joint Council for Qualifications

621 Ofqual: GCSE, A level and AS qualification updates, 9th April 2014

Figure 7.1 shows the proportion of female entrants who took separate science GCSEs over a 10-year period. In contrast to the general trend of increasing gender parity, the percentage of female pupils entered onto physics and chemistry GCSEs declined slightly between 2014 and 2015, from 49.0% to 48.8% for physics and from 49.01% to 48.8% for chemistry. Biology remained unchanged from the previous year, at 50.0% of entrants. Although small, this recent decline raises questions around the effect of recent GCSE reforms on female participation in traditionally male-biased subjects.

Figure 7.1: Proportion of female entrant numbers to separate science GCSEs (2005-2015) – all UK candidates



Source: Joint Council for Qualifications

7.6 A*-C achievement rates[622]

Achievement at GCSE is not only important in enabling pupils to progress to higher learning, it is also crucial in improving the nation's productivity. For example, the Department for Education estimates that the increase in productivity for a pupil who achieves 5-7 GCSEs at grades A*-C (including English and maths), compared with those who only acquire 3-4 good GCSEs, is equivalent to approximately £60,000 per individual over their lifetime.[623]

As Table 7.4 shows, the percentage of students achieving an A*-C in physics in 2015 increased by 0.7% on 2014 rates, to 92.0%: a bigger increase than any other science subject, and more than the all-subject average (0.2%). A*-C achievement rates for statistics and mathematics grew by the largest amounts, increasing by 1.1% and 0.9% respectively from 2014 to 2015. However, both these subjects had lower initial rates than other STEM subjects, with only 63.3% of mathematics and 71.3% of statistics pupils achieving an A*-C grade. The largest change in any direction was for further additional science, which saw its A*-C achievement rate decline by 5.0% in one year.

As previously mentioned, recent GCSE reforms, such as the shift from modular to linear assessment, are likely to have influenced the ability and preparedness of pupils sitting exams. Furthermore, the fact that only first attempts are included in performance tables may have influenced schools' decisions on the difficulty of subjects that they enter their pupils for.

Figure 7.2 shows that, of all STEM subjects, computing has the lowest A*-C achievement rate, at just over 40%. In contrast, mathematics (additional) has the highest proportion of A*-C passes: the number of which rose sharply in 2011 and then steadily increased to a peak of 93.4% in 2015.

Table 7.5 displays the A*-C achievement rate by English region and devolved nation. Within England, London had the highest rate of GCSE A*-C passes at 72.0% in 2015 – an increase of 0.3 percentage points from the previous year. It is worth noting that London had the second highest increase in this rate since 2002. At the time, London's A*-C pass rate was 56.8%, which was lower than the UK average at that time (57.9%). UK-wide, the North East had the largest increase in A*-C achievements, both over a one-year (1.5%) and 10-year period (16.1%).

However, it is still pupils in Northern Ireland who are most likely to be awarded an A*-C grade at GCSE, with almost 8 out of 10 pupils doing so. Yorkshire and The Humber was the worst performing region, with only 65.3% of pupils achieving an A*-C grade in 2015 (although this figure did show a 0.4 percentage point improvement on the previous year – twice the national average rate of improvement).

Although the number of entries and percentage of passes are metrics that warrant due consideration, the actual number of pupils eligible to progress to higher level academic study is arguably the most important figure in ascertaining the future supply of engineers.

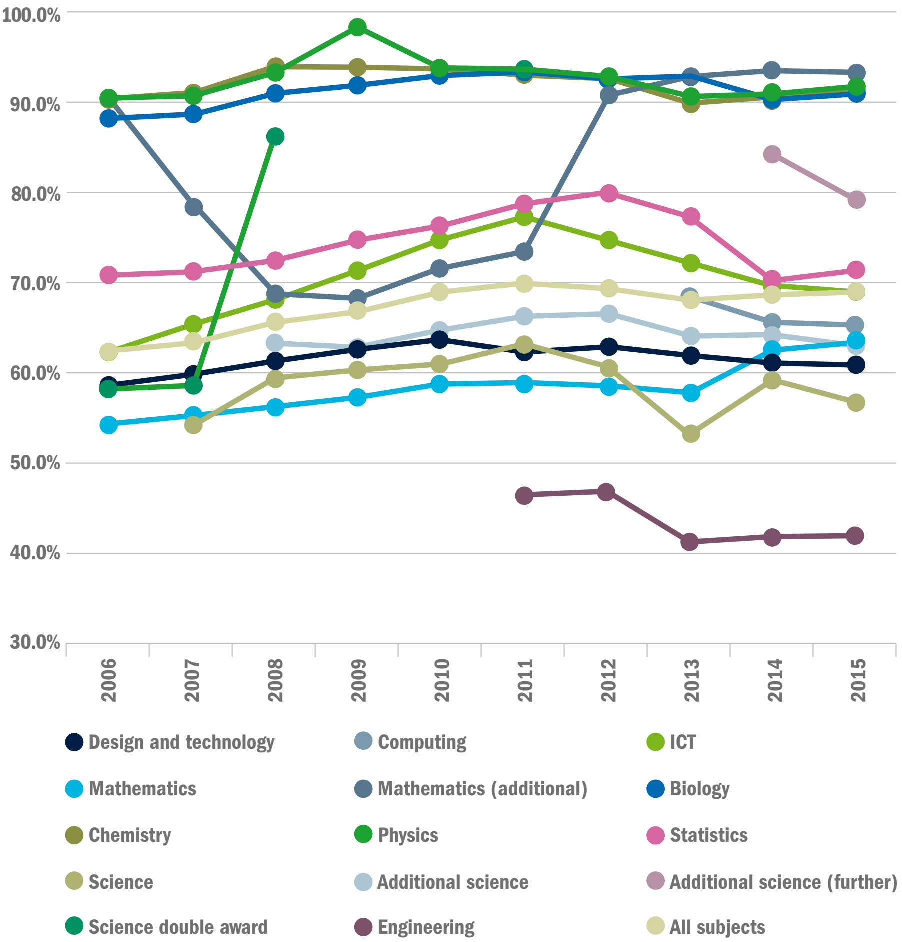
Table 7.4: GCSE A*-C pass rates (2006-2015) – all UK candidates

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Percentage point change over 1 year	Percentage point change over 10 years
Design and technology	58.6%	59.8%	61.2%	62.5%	63.5%	62.4%	62.7%	61.8%	61.0%	60.8%	-0.2%p	2.2%p
Computing	-	-	-	-	-	-	-	68.4%	65.5%	65.1%	-0.4%p	-
ICT	62.2%	65.0%	68.3%	71.4%	74.7%	77.2%	74.7%	72.2%	69.5%	68.8%	-0.7%p	6.6%p
Mathematics	54.3%	55.2%	56.3%	57.2%	58.5%	58.8%	58.4%	57.6%	62.4%	63.3%	0.9%p	9.0%p
Mathematics (additional)	90.5%	78.8%	68.9%	68.0%	71.5%	73.4%	90.5%	92.8%	93.5%	93.4%	-0.1%p	2.9%p
Science double award	58.3%	58.6%	86.3%	-	-	-	-	-	-	-	-	-
Biology	88.4%	88.9%	91.1%	91.9%	92.9%	93.1%	92.6%	89.8%	90.3%	90.9%	0.6%p	2.5%p
Chemistry	90.2%	90.9%	94.0%	93.9%	93.6%	93.1%	93.0%	90.0%	90.7%	91.2%	0.5%p	1.0%p
Physics	90.6%	90.6%	93.5%	98.5%	93.7%	93.7%	93.2%	90.8%	91.3%	92.0%	0.7%p	1.4%p
Statistics	70.7%	71.1%	72.5%	74.7%	76.2%	78.6%	80.0%	77.4%	70.2%	71.3%	1.1%p	0.6%p
Science		54.1%	59.3%	60.2%	60.9%	62.9%	60.7%	53.1%	59.1%	56.7%	-2.4%p	-
Additional science			63.2%	62.8%	64.7%	66.2%	66.4%	64.1%	64.2%	63.2%	-1.0%p	-
Additional science (further)	-	-	-	-	-	-	-		84.2%	79.2%	-5.0%p	-
Engineering	-	-	-	-	-	46.5%	46.8%	41.1%	41.6%	40.3%	0.0%p	-
All subjects	62.4%	63.3%	65.7%	66.9%	69.0%	69.8%	69.4%	68.1%	68.8%	69.0%	0.2%p	6.6%p

Source: Joint Council for Qualifications

622 Grades A*-G are considered passes in GCSEs. However we purposely only analyse A*-C pass rates, as this is the range of grades frequently required for entry onto AS level courses. 623 Department for Education: Valuing educational progress in England: the economic benefits of the progress made in GCSE performance research report, December 2014, p4

Figure 7.2: GCSE A*-C achievement rate (2006-2015) – all UK candidates



Source: Joint Council for Qualifications

Table 7.5: Proportion of entries achieving an A*-C grade by English region and devolved nation (2002-2015) – all UK candidates

	2002	2014	2015	Percentage point change over 1 year	Percentage point change 2002-2015
North East	51.1%	65.7%	67.2%	1.5%p	16.1%p
North West	55.5%	68.3%	68.6%	0.3%p	13.1%p
Yorkshire and The Humber	51.9%	64.9%	65.3%	0.4%p	13.4%p
West Midlands	55.5%	66.7%	66.9%	0.2%p	11.4%p
East Midlands	56.2%	65.7%	65.6%	-0.1%p	9.4%p
Eastern	60.2%	68.8%	69.0%	0.2%p	8.8%p
South West	61.8%	69.0%	69.1%	0.1%p	7.3%p
South East	62.3%	70.9%	70.9%	0.0%p	8.6%p
London	56.8%	71.7%	72.0%	0.3%p	15.2%p
Wales	59.7%	66.6%	66.6%	0.0%p	6.9%p
Northern Ireland	68.4%	78.0%	78.7%	0.7%p	10.3%p
All UK	57.9%	68.8%	69.0%	0.2%p	11.1%p

Source: Joint Council for Qualifications

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Table 7.6 reveals that 122,921 pupils achieved a physics GCSE at grade A*-C in 2015, and thus were eligible to pursue A level study. Of these, 60,134 (48.9%) were females. In fact, females had a higher rate of A*-C achievement than males (92.2% compared with 91.8%). Indeed, female pupils are more likely to achieve an A*-C grade than males in all STEM subjects with the exception of science.

Interestingly, subjects with the largest pro-male bias in pupils entering for exams also show the largest pro-female bias in A*-C achievement rates. For example, the female A*-C achievement rate is 7.3 percentage points higher than males in computing, 18.4 points higher in design and technology and 18.8 percentage points higher in engineering.

Disappointingly, engineering had the lowest proportion (7.4%) and number (511) of female entrants. The fact that so few females pursue engineering at level 2 may reflect a lack of aspiration for, or awareness of, engineering pathways at an age when pupils' aspirations have otherwise largely been decided. For example, a robust body of research has demonstrated that the period between ages 10-14 is a critical time for the development of young people's attitudes to science, and that by age 14, most young people's attitudes to science are fairly fixed.[624]

Table 7.6: Number of GCSE A*-C passes (2015) – all UK candidates

		Entrants	Percentage achieving % A*-C	Calculated number of pupils achieving A*-C
Design and technology	Total	204,788	60.8%	124,511
	Male	123,571	53.5%	66,110
	Female	81,217	71.9%	58,395
	% Female	39.7%		46.9%
Computing	Total	35,414	65.1%	23,055
	Male	29,736	63.9%	19,001
	Female	5,678	71.7%	4,071
	% Female	16.0%		17.7%
ICT	Total	111,934	68.8%	77,011
	Male	64,777	66.4%	43,012
	Female	47,157	72.1%	34,000
	% Female	42.1%		44.2%
Mathematics	Total	761,230	63.3%	481,859
	Male	373,603	63.9%	238,732
	Female	387,627	62.6%	242,655
	% Female	50.9%		50.4%
Mathematics (additional)	Total	3,518	93.4%	3,286
	Male	1,855	92.0%	1,707
	Female	1,663	94.9%	1,578
	% Female	47.3%		48.0%
Biology	Total	139,199	90.9%	126,532
	Male	69,657	90.0%	62,691
	Female	69,542	91.8%	63,840
	% Female	50.0%		50.5%
Chemistry	Total	133,618	91.2%	121,860
	Male	68,391	90.1%	61,620
	Female	65,227	92.4%	60,270
	% Female	48.8%		49.5%
Physics	Total	133,610	92.0%	122,921
	Male	68,389	91.8%	62,781
	Female	65,221	92.2%	60,134
	% Female	48.8%		48.9%
Statistics	Total	56,355	71.3%	40,181
	Male	30,340	68.9%	20,904
	Female	26,015	74.0%	19,251
	% Female	46.2%		47.9%
Science	Total	395,484	56.7%	224,239
	Male	197,125	60.0%	118,275
	Female	198,359	53.4%	105,924
	% Female	50.2%		47.2%
Additional science	Total	332,960	63.2%	210,431
	Male	162,588	60.3%	98,041
	Female	170,372	66.0%	112,446
	% Female	51.2%		53.4%
Additional science (further)	Total	23,389	79.8%	18,664
	Male	11,686	77.7%	9,080
	Female	11,703	81.8%	9,573
	% Female	50.0%		51.3%
Engineering	Total	6,909	40.3%	2,784
	Male	6,398	38.9%	2,489
	Female	511	57.7%	295
	% Female	7.4%		10.6%
All subjects	Total	5,277,604	69.0%	3,641,547
	Male	2,588,865	64.7%	1,674,996
	Female	2,688,739	73.1%	1,965,468
	% Female	50.9%		54.0%

Source: Joint Council for Qualifications

624 Archer et al. ASPIRES Young people's science and career aspirations, age 10 –14 (2013).

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7.7 IGCSE qualifications[625]

In July 2014, the government announced that due to the introduction of newly-reformed GCSEs in maths and English in 2015, IGCSEs in these subjects would no longer be included in the 2017 performance tables.[626] In the context of this announcement, it is interesting to note that there has been a precipitous decline in both the number of entrants, and also the A*-C achievement rate, between 2012/13 and 2013/14.

As Table 7.7 shows, on average, entrants to STEM subjects have halved, with those undertaking an IGCSE in mathematics rapidly declining by 20,000 (76.3%) and physics declining by 52.9%. Furthermore, mathematics experienced the largest drop in A*-C achievement rates, decreasing by 20.5%. This is in stark contrast to the changes between 2011/12 and 2013/14, which saw STEM subject entrants surge by over 80% on average.

Curiously, entrants to all subjects saw an 18.7% increase, and students undertaking an IGCSE in information technology grew by 61.1%. However, despite these increases, the percentage of those achieving A*-C declined for all subjects, both on an individual and collective basis.

It is worth noting that in August 2015, Ofqual announced that entries to IGCSEs in the separate science subjects for 2015 have increased.[627] However, we are unable to comment on this data until it is publicly available.

Table 7.7: IGCSE STEM course entrants (2010/11-2013/14) – England

		2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 3 years
	Entrants	5,408	7,976	14,558	6,920	-52.5%	28%
Biological sciences	A*-C achievement rate	96.0%	94.7%	95.1%	88.5%	-6.6%p	-7%p
	Number achieving A*-C	5,191	7,552	13,851	6,126	-55.8%	18%
	Entrants	5,365	7,579	14,619	7,385	-49.5%	38%
Chemistry	A*-C achievement rate	94.8%	95.2%	92.6%	76.2%	-16.4%p	-19%p
	Number achieving A*-C	5,085	7,213	13,539	5,625	-58.5%	11%
	Entrants	5,979	8,393	15,688	7,385	-52.9%	24%
Physics	A*-C achievement rate	96.3%	95.4%	94.8%	89.2%	-5.6%p	-7%p
	Number achieving A*-C	5,756	8,010	14,872	6,585	-55.7%	14%
	Entrants	18,704	23,187	26,169	6,201	-76.3%	-67%
Mathematics	A*-C achievement rate	97.8%	95.4%	94.3%	73.8%	-20.5%p	-24%p
	Number achieving A*-C	18,298	22,125	24,682	4,577	-81.5%	-75%
	Entrants	473	898	1,897	3,057	61.1%	546%
Information technology	A*-C achievement rate	85.8%	88.5%	79.1%	65.4%	-13.7%p	-20%p
	Number achieving A*-C	406	795	1,501	1,999	33.2%	392%
	Entrants	56,842	109,261	156,717	186,076	18.7%	227%
All subjects	A*-C achievement rate	95.8%	93.9%	83.9%	64.2%	-19.7%p	-32%p
	Number achieving A*-C	54,461	102,621	131,506	119,518	-9.1%	119%

Source: Department for Education

625 Figures for IGCSEs are for the 2013/14 cohort of pupils, which is a year behind GCSE data from 2014/15. This is due to the IGCSE data being released later than standard GCSE results. 626 Department for Education: Letter to awarding organisations from the minister of state for school reform, Nick Gibb, 16th January 2015 627 Ofqual: Summer 2015 GCSE results: a brief explanation, 20 August 2015.

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7.8 Free school meals and social mobility

As Figure 7.3 demonstrates, in 2013/14, only 33.5% of pupils eligible for free school meals (FSM) achieved at least 5 A*-C GCSEs (or equivalent) including English and mathematics. This figure is 27.0 percentage points lower than that for non-FSM pupils, 60.5% of whom achieved grades A*-C at GCSE.

Furthermore, 36.5% of pupils classified as disadvantaged[628] achieved at least five A*-C GCSEs (or equivalent) including English and mathematics, compared with 64.0% of all other pupils: a gap of 27.4 percentage points.

The Sutton Trust has identified that in the top 500 state secondary schools, uptake of FSM pupils is 7.6%: almost half the national average figure of 16.5%.[629]

As we mentioned in Section 7.10.4 of our 2015 report, the quality of a school bears a significant impact on addressing social inequality. Only 25% of FSM pupils in schools rated as inadequate by Ofsted can expect to achieve five GCSEs at grades A*-C, compared with double this amount in a school considered outstanding. Furthermore, an FSM pupil in a school rated as outstanding by Ofsted can expect to have a higher chance of achieving five GCSEs at A*-C grade (50%) than a non-FSM pupil in a school considered inadequate (47%).[630]

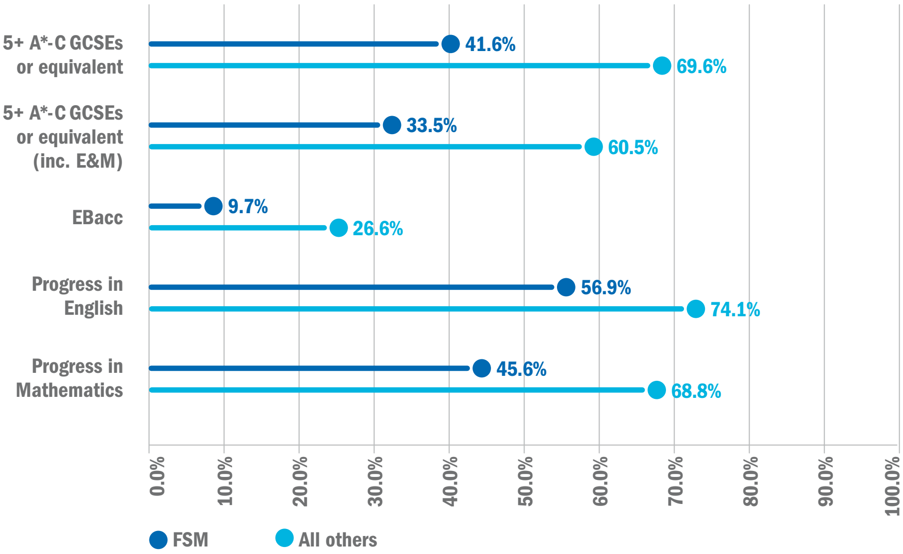
7.9 Ethnicity and achievement

In 2013/14, Chinese pupils were the highest achieving ethnicity at GCSE level in England. Against a 56.6% national achievement average, 74.4% of Chinese pupils achieved five or more A*-C GCSEs including English and mathematics. That's a notable 17.9 percentage points above the national average (Figure 7.4). Furthermore, nearly half (49.5%) achieved the English Baccalaureate: an achievement rate 25.4 percentage points above than the national average of 24.2%.

Pupils from a black background were the lowest achievers of the major ethnic groups, with just over half (53.1%) achieving at least five A*-C GCSEs (or equivalent) grades including English and mathematics. However, 75.5% of black pupils are making the expected progress in English and 68.4% in mathematics. These figures are above the national averages of 71.6% and 65.5% for these subjects respectively.

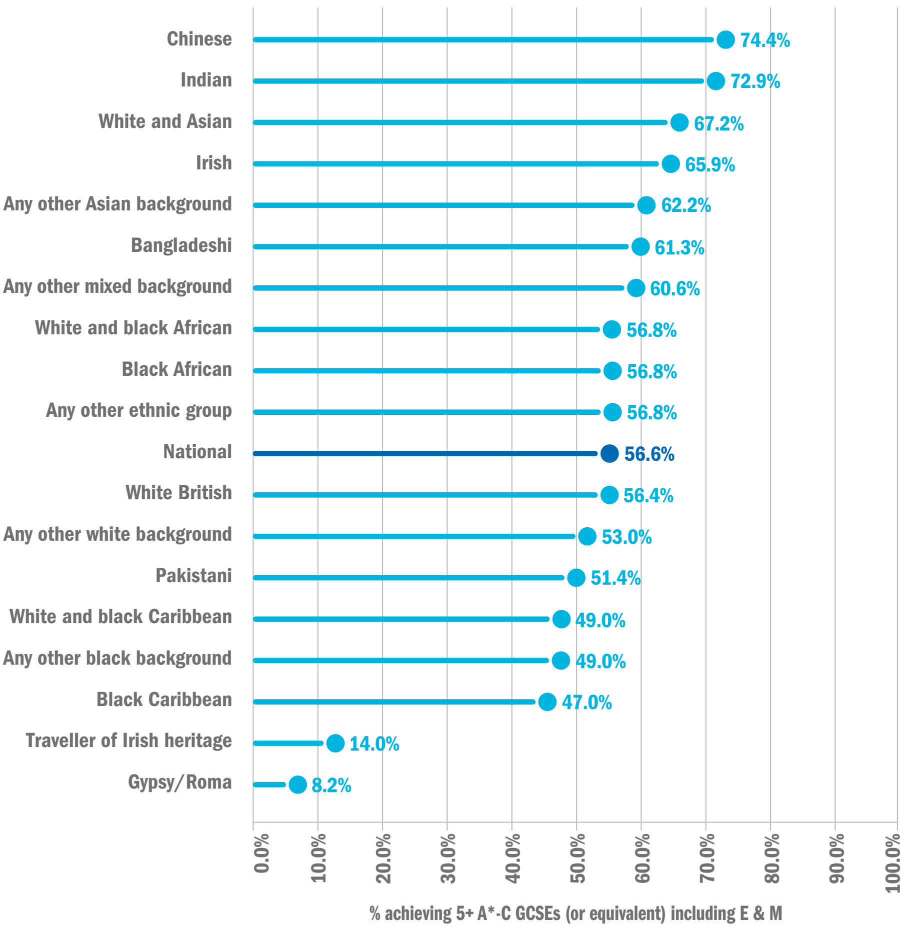
It is also worth noting that achievement of pupils from a white British background was slightly below the national average, with only 56.4% achieving five or more A*-C grade GCSEs including English and Mathematics, compared with 56.6% of all pupils.

Figure 7.3: Attainment at Key Stage 4 by FSM eligibility (2013/14) – England



Source: Department for education

Figure 7.4: Percentage of pupils achieving 5+ A*-C GCSEs (or equivalent) including English and mathematics (2013/14) – England



Source: Department for education

628 Disadvantaged pupils are defined as pupils known to be eligible for free school meals in the previous six years as indicated in any termly or annual school census, pupil referral unit (PRU) or alternative provision (AP) census or are children looked after by the local authority for more than 6 months. Department for Education: GCSE and equivalent attainment by pupil characteristics, 2013 to 2014, (Revised) 29th January 2015, p13. 629 The Sutton Trust: Selective Comprehensives: The social composition of top comprehensive schools, June 2013, p4. 630 Engineering UK: The State of Engineering, 2014, p86

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7.10 Vocational qualifications

For many pupils, vocational qualifications are a viable alternative pathway to higher level study. Although Ofsted has suggested that the number of pupils studying vocational science courses at level 2 will decrease in response to the new combined EBacc measure,[631] new initiatives such as the introduction of Tech Awards are likely to ensure that vocational qualifications form an even more significant part of the 14-16 education landscape.

Tech awards are vocational qualifications related to the world of work that are designed to provide pupils with an initial step on the path to higher-level vocational study, whilst still attaining a firm academic grounding in core subjects at level 2. From September 2015, pupils aged 14 to 16 years old will be eligible to study up to three technical awards alongside five core GCSEs.[632]

Table 7.8 shows the number of students completing BTEC subjects at level 2. It shows that, for all STEM subjects except other sciences, both the total number and the proportion of female completions have declined since 2013/14. For example, total engineering level 2 BTEC completions declined by 12.5%, with the number of females completing down by nearly twice this amount, at 20.7%.

In a similar manner, the number of construction completions fell by a quarter, with over a third fewer females attaining a level 2 BTEC in construction in 2014/5 than in 2013/14.

This decline is concerning, especially as, according to the association of graduate recruiters, construction companies are expected have among the largest increase in vacancies of any sector (22.1%) in the 2014/15 recruitment season.[633] Furthermore, the recent announcement of a relaxation in planning laws, which will effectively give automatic permission for construction companies to build on suitable brownfield sites, is likely to lead to a further demand for qualified construction works in the coming years.[634]

Table 7.8: Number of students completing BTEC selected subjects at level 2, by gender and age (2005/06-2014/15) – all domiciles

		2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change over 1 year	Change over 10 years
Other sciences	UK	1,077	4,038	17,601	34,383	68,314	105,467	125,179	138,106	105,028	133,827	27.4%	12325.9%
	International	0	0	0	132	1	11	21	26	66	67	1.5%	
	Female	569	2,102	9,176	18,003	35,372	53,340	62,409	66,952	50,927	64,545	26.7%	11243.6%
	Aged under 19	903	3,782	17,196	34,081	67,659	104,802	124,458	137,116	104,346	133,153	27.6%	14645.6%
	Aged 19-24	144	214	307	321	440	466	504	657	539	516	-4.3%	258.3%
	Aged 25+	30	42	97	113	214	206	238	350	209	225	7.7%	650.0%
	Total	**1,077**	**4,038**	**17,601**	**34,515**	**68,315**	**105,478**	**125,200**	**138,132**	**105,094**	**133,894**	**27.4%**	**12332.1%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%p	
	Percentage female	52.8%	52.1%	52.1%	52.2%	51.8%	50.6%	49.8%	48.5%	48.5%	48.2%	-0.3%p	-4.6%p
Engineering	UK	3,575	4,802	6,652	8,686	9,987	11,735	15,565	19,775	18,533	16,201	-12.6%	353.2%
	International	713	376	381	181	214	102	299	337	735	665	-9.5%	-6.7%
	Female	117	172	254	401	537	615	790	1,097	966	766	-20.7%	554.7%
	Aged under 19	2,990	4,020	6,019	7,888	9,180	10,948	14,520	18,449	17,777	15,769	-11.3%	427.4%
	Aged 19-24	1,009	1,011	859	830	874	735	1,033	1,325	1,154	787	-31.8%	-22.0%
	Aged 25+	288	143	155	148	147	151	309	336	337	310	-8.0%	7.6%
	Total	**4,288**	**5,178**	**7,033**	**8,867**	**10,201**	**11,837**	**15,864**	**20,112**	**19,268**	**16,866**	**-12.5%**	**293.3%**
	Percentage non-UK	19.9%	7.8%	5.7%	2.1%	2.1%	0.9%	1.9%	1.7%	3.8%	3.9%	0.1%p	-16.0%p
	Percentage female	2.7%	3.3%	3.6%	4.5%	5.3%	5.2%	5.0%	5.5%	5.0%	4.5%	-0.5%p	1.8%p
ICT/ computing	UK	5,717	8,817	18,845	24,482	29,040	32,251	41,330	44,085	38,656	37,297	-3.5%	552.4%
	International	260	164	237	222	121	12	319	126	318	178	-44.0%	-31.5%
	Female	1,143	1,986	6,184	8,310	10,021	11,248	15,360	16,320	13,445	12,765	-5.1%	1016.8%
	Aged under 19	4,936	7,536	17,329	22,716	26,947	30,084	39,390	42,024	37,048	36,011	-2.8%	629.6%
	Aged 19-24	881	1,244	1,515	1,720	1,900	1,950	1,945	1,841	1,679	1,270	-24.4%	44.2%
	Aged 25+	159	200	237	268	313	229	312	345	246	194	-21.1%	22.0%
	Total	**5,977**	**8,981**	**19,082**	**24,704**	**29,161**	**32,263**	**41,649**	**44,211**	**38,974**	**37,475**	**-3.8%**	**527.0%**
	Percentage non-UK	4.5%	1.9%	1.3%	0.9%	0.4%	0.0%	0.8%	0.3%	0.8%	0.5%	-0.3%p	-4.1%p
	Percentage female	19.1%	22.1%	32.4%	33.6%	34.4%	34.9%	36.9%	36.9%	34.5%	34.1%	-0.4%p	14.9%p

631 Ofsted: Maintaining curiosity: A survey into science education in schools, November 2013, p25. 632 Department for Education: Press release – Tech Awards to boost vocational education for 14- to 16-year-olds, June 2014. 633 Association of graduate recruiters: Graduate Recruitment Survey 2015 Winter Review, 2015 634 HM treasury: Fixing the foundations: Creating a more prosperous nation, July 2015, p45

Table 7.8: Number of students completing BTEC selected subjects at level 2, by gender and age (2005/06-2014/15) – all domiciles – continued

		2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change over 1 year	Change over 10 years
Construction	UK	940	1,997	4,089	6,859	9,248	9,955	13,149	13,973	12,003	8,976	-25.2%	854.9%
	International	58	62	92	13	35	25	30	35	11	8	-27.3%	-86.2%
	Female	32	59	152	254	319	358	409	465	509	322	-36.7%	906.3%
	Aged under 19	880	1,908	4,037	6,707	9,067	9,694	12,513	13,545	11,453	8,854	-22.7%	906.1%
	Aged 19-24	91	134	122	141	170	209	391	234	233	51	-78.1%	-44.0%
	Aged 25+	13	17	21	23	43	76	275	226	327	78	-76.1%	500.0%
	Total	**998**	**2,059**	**4,181**	**6,872**	**9,283**	**9,980**	**13,179**	**14,008**	**12,014**	**8,984**	**-25.2%**	**800.2%**
	Percentage non-UK	6.2%	3.1%	2.2%	0.2%	0.4%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%p	-1.3%p
	Percentage female	3.2%	2.9%	3.6%	3.7%	3.4%	3.6%	3.1%	3.3%	4.2%	3.6%	-1.4%p	5.3%p
All subjects (including STEM and non-STEM)	UK	63,342	107,047	186,881	264,045	374,263	489,165	581,126	599,394	461,301	427,759	-7.3%	575.3%
	International	1,167	830	1,060	848	826	534	1,571	1,120	2,530	2,383	-5.8%	104.2%
	Female	26,765	47,903	87,420	124,038	178,582	235,134	278,387	281,990	210,485	201,270	-4.4%	652.0%
	Aged under 19	54,525	96,005	175,192	250,215	358,296	473,031	564,206	580,956	446,784	418,094	-6.4%	666.8%
	Aged 19-24	7,385	8,909	9,966	11,575	13,144	13,194	13,986	14,434	12,452	9,057	-27.3%	22.6%
	Aged 25+	2,551	2,933	2,768	3,089	3,632	3,448	4,460	5,097	4,578	2,989	-34.7%	17.2%
	Total	**64,509**	**107,877**	**187,941**	**264,893**	**375,089**	**489,699**	**582,697**	**600,514**	**463,831**	**430,142**	**-7.3%**	**566.8%**
	Percentage non-UK	1.8%	0.8%	0.6%	0.3%	0.2%	0.1%	0.3%	0.2%	0.5%	0.6%	0.0%p	-1.3%p
	Percentage female	41.5%	44.4%	46.5%	46.8%	47.6%	48.0%	47.8%	47.0%	45.4%	46.8%	1.4%p	5.3%p

Source: Pearson

Table 7.9 provides further data on selected vocational attainment at level 2 provided by OCR. As was the case for BTEC level 2 completions, the numbers of pupils completing other vocational subjects has declined dramatically, with completions in other sciences falling by 61.2% from 18,522 to 7,184 between 2012/13 and 2013/14. ICT/Computing completions fell by over a third (34.9%), which was in line with an all-subject average decline of 37.3%. This recent crash is in stark contrast to the 10-year historical trend, which saw all subject completions soar from 477 in 2004/5 to a peak of 321,925 in 2011/12.

Table 7.9: Number of students completing other selected vocational subjects at level 2, by gender and age (2004/05-2013/14) – all domiciles

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 9 years
Other sciences	UK	0	0	202	5,066	8,560	15,767	20,670	21,095	18,522	7,184	-61.2%	
	International	0	0	0	0	0	0	0	0	0	0		
	Female	0	0	108	2,720	4,408	8,097	10,962	10,908	9,051	3,523	-61.1%	
	Aged under 19	0	0	190	5,057	8,525	15,742	20,639	21,078	18,509	7,181	-61.2%	
	Aged 19-24	0	0	12	8	21	17	9	3	7	2	-71.4%	
	Aged 25+	0	0	0	1	14	8	22	14	6	1	-83.3%	
	Total	**0**	**0**	**202**	**5,066**	**8,560**	**15,767**	**20,670**	**21,095**	**18,522**	**7,184**	**-61.2%**	
	Percentage non-UK			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		
	Percentage female			53.5%	53.7%	51.5%	51.4%	53.0%	51.7%	48.9%	49.0%	0.2%p	
ICT/ computing	UK	0	0	6,177	67,318	138,392	220,761	263,894	279,102	217,939	141,961	-34.9%	
	International	0	0	0	0	9	123	208	164	135	41	-69.6%	
	Female	0	0	2,866	30,817	65,781	106,750	128,151	135,160	105,709	68,556	-35.1%	
	Aged under 19	0	0	6,136	67,144	138,069	220,378	263,740	278,850	217,931	141,755	-35.0%	
	Aged 19-24	0	0	35	129	179	270	154	112	68	21	-69.1%	
	Aged 25+	0	0	6	45	153	236	208	304	75	226	201.3%	
	Total	**0**	**0**	**6,177**	**67,318**	**138,401**	**220,884**	**264,102**	**279,266**	**218,074**	**142,002**	**-34.9%**	
	Percentage non-UK			0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	-0.0%p	
	Percentage female			46.4%	45.8%	47.5%	48.3%	48.5%	48.4%	48.5%	48.3%	-0.2%p	
All subjects (STEM and non-STEM)	UK	477	1,887	10,549	81,154	159,355	253,762	304,757	321,761	255,524	160,305	-37.3%	33506.9%
	International	0	0	0	0	9	123	208	164	135	41	-69.6%	
	Female	330	1,159	5,490	38,744	77,171	124,514	149,987	157,656	125,078	78,100	-37.6%	23566.7%
	Aged under 19	422	1,739	10,261	80,638	158,451	252,374	304,276	321,376	255,392	159,912	-37.4%	37793.8%
	Aged 19-24	44	112	232	346	449	662	347	205	145	148	2.1%	236.4%
	Aged 25+	11	36	56	170	464	849	342	344	122	286	134.4%	2500.0%
	Total	**477**	**1,887**	**10,549**	**81,154**	**159,364**	**253,885**	**304,965**	**321,925**	**255,659**	**160,346**	**-37.3%**	**33515.5%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%p	
	Percentage female	69.2%	61.4%	52.0%	47.7%	48.4%	49.0%	49.2%	49.0%	48.9%	48.7%	-0.2%p	-20.5%p

Source: OCR

Perhaps public perception of level 2 vocational qualifications has a part to play in the decline in student completions. For example, research conducted by YouGov found that young people, teachers and head teachers were united in their disagreement that BTECs (level 1/ level 2) are valued as highly as GCSEs by higher education institutions. Specifically, 71% of teachers and 67% of young people disagreed that BTECs at levels 1 and 2 were valued as highly as GCSEs. This disagreement is higher than was reported by higher education institutions (51%), the general public (49%), employers (42%) and even parents (41%).[635]

635 YouGov: Perceptions of A levels, GCSEs and Other Qualifications in England – Wave 13, Ofqual June 2015, p13

7.11 Scottish qualifications

The 2015 examination period is the second and final year that Scottish pupils will sit either the old intermediate 2 or new national 5 qualifications, which were introduced for the first time in 2014. From 2015, the new national 5 will have completely replaced the former qualifications.

Students are also eligible to undertake lower national 4 qualifications, which roughly correspond to a GCSE at grade D-G. However, as national 4s are not subject to external examination or assessment, it is unlikely that they will be well-regarded by educational institutions, employers and the general public.[636]

As expected, the number of people entering for and achieving intermediate 2 qualifications has rapidly declined as more students sit national 5 examinations. The all-subject average decline in intermediate 2 entrants and achievements at grade A-D was just under 90%, whilst the entrants and A-D achievements for national 5 qualifications increased by a third, reaching just shy of a quarter of a million (248,584).

In terms of success rate, 86.3% of pupils taking national 5 qualifications achieved a grade A-D, compared with 80.6% for intermediate 2 qualifications. However, the A-D achievement rate for both types of qualifications decreased between 2014 and 2015, falling by 1.1 percentage points for national 5 qualifications and 4.8 percentage points for intermediate 2 qualifications.

Since physics is such an important subject for progression to higher level engineering-related study, it is encouraging to see an increase in the A-D achievement rate in 2015: up by 6.7 percentage points to 82.6%. This rise brings the achievement rate more in line with the 90.3% of pupils sitting the intermediate 2 exam who acquired an A-D grade in the same year. Similarly, the A-D achievement rate for national 5 biology and chemistry qualifications also increased in this year by 5.9% and 0.3% respectively.

However, despite the recent increase in achievement rates for physics, biology and chemistry, the A-D achievement rate for national 5 qualifications in these three core science subjects is below the all-subject average. This is in contrast to both intermediate 2 and GCSEs qualifications, where achievement in physics, biology and chemistry is higher than the overall rate for all subjects.

Table 7.10: Attainment in selected STEM National 5 qualifications (2014/15) – Scotland[637, 638]

		2014	2015	Change over 1 year
Administration and IT	Entrants	4,267	5,619	31.7%
	Percentage A-D	86.2%	85.9%	-0.3%p
	Number A-D	3,680	4,829	31.2%
Biology	Entrants	16,146	21,635	34.0%
	Percentage A-D	76.4%	82.3%	5.9%p
	Number A-D	12,332	17,809	44.4%
Chemistry	Entrants	14,157	16,659	17.7%
	Percentage A-D	80.7%	81%	0.3%p
	Number A-D	11,427	13,491	18.1%
Computing science	Entrants	5,853	7,663	30.9%
	Percentage A-D	90.2%	90.2%	0.0%p
	Number A-D	5,277	6,915	31.0%
Design and manufacture	Entrants	4,135	5,169	25.0%
	Percentage A-D	94.6%	91.5%	-3.2%p
	Number A-D	3,910	4,731	21.0%
Engineering science	Entrants	1,296	1,808	39.5%
	Percentage A-D	87.8%	91.8%	4.5%p
	Number A-D	1,138	1,659	45.8%
Fashion and textile technology	Entrants	363	475	30.9%
	Percentage A-D	98.3%	98.9%	0.7%p
	Number A-D	357	470	31.7%
Health and food technology	Entrants	1,763	1,963	11.3%
	Percentage A-D	78.2%	85.5%	9.3%p
	Number A-D	1,378	1,678	21.8%
Lifeskills mathematics	Entrants	223	2,739	1128.3%
	Percentage A-D	66.4%	42.2%	-36.4%p
	Number A-D	148	1,157	681.8%
Mathematics	Entrants	22,536	36,475	61.9%
	Percentage A-D	77.7%	69.3%	-10.8%p
	Number A-D	17,504	11,208	-36.0%
Music technology	Entrants	250	498	99.2%
	Percentage A-D	96.4%	97.2%	0.8%p
	Number A-D	241	484	100.8%
Physics	Entrants	11,932	14,942	25.2%
	Percentage A-D	77.4%	82.6%	6.7%p
	Number A-D	9,232	12,339	33.7%
All subjects	Entrants	213,595	288,016	34.8%
	Percentage A-D	87.3%	86.3%	-1.1%p
	Number A-D	186,436	248,584	33.3%

Source: Scottish Qualifications Authority

636 The Telegraph: Scottish parents and pupils 'do not attach much value' to new National qualifications, 22nd February 2014 637 Excludes those with fewer than 100 A-D grades 638 National Course (National 5) statistics relate to information as of August and are therefore subject to change later in the year. These statistics are course-based analyses, i.e. results are dependent on both the learner's course assessment result (where applicable) and their successful completion of the related units.

Table 7.11: Attainment in selected STEM intermediate 2 qualifications (2014/15) – Scotland[639]

		2014	2015	Change over 1 year
Biology	Entrants	7,013	444	-93.7%
	Percentage A-D	79.1%	75.5%	-3.6%p
	Number A-D	5,548	335	-94.0%
Chemistry	Entrants	3,839	464	-87.9%
	Percentage A-D	79.8%	86.6%	6.8%p
	Number A-D	3,064	402	-86.9%
Computing	Entrants	2,092	232	-88.9%
	Percentage A-D	80.4%	75.0%	-5.4%p
	Number A-D	1,681	174	-89.6%
Engineering craft skills	Entrants	829	116	-86.0%
	Percentage A-D	95.2%	98.3%	3.1%p
	Number A-D	789	114	-85.6%
Information systems	Entrants	479	77	-83.9%
	Percentage A-D	79.7%	74.0%	-5.7%p
	Number A-D	382	57	-85.1%
Mathematics	Entrants	18,297	2,299	-87.4%
	Percentage A-D	77.4%	62.8%	-14.6%p
	Number A-D	14,155	1,443	-89.8%
Physics	Entrants	3,680	352	-90.4%
	Percentage A-D	80.4%	90.3%	9.9%p
	Number A-D	2,958	318	-89.2%
Product design	Entrants	885	96	-89.2%
	Percentage A-D	83.6%	90.6%	7.0%p
	Number A-D	740	87	-88.2%
Technological studies	Entrants	191	21	-89.0%
	Percentage A-D	83.8%	95.2%	11.4%p
	Number A-D	160	20	-87.5%
All subjects	Entrants	97,122	10,678	-89.0%
	Percentage A-D	85.4%	80.6%	-4.8%p
	Number A-D	82,983	8,603	-89.6%

Source: Scottish Qualifications Authority

7.12 Teacher workforce

As the influential educator Sir Ken Robinson remarked, at the heart of all education is the relationship between a teacher and learner.[640] Therefore, it is important to consider not only pupil characteristics, but also the quality of the teacher workforce.

Currently, teaching in the UK is not served by any single professional body. Rather, the teacher workforce is comprised of a diverse array of teaching unions, councils and professional bodies. Just for STEM subjects, there are several subject-specific associations, such as the Association for Science Education, the Association of Teachers of Mathematics, and the Design and Technology Association.

In 2014, the Prince's Teaching Institute issued a call for a new college of teaching, which would be a member-driven professional body for teachers[641] aimed at consolidating accreditation of CPD and teacher standards.

As mentioned in last year's report, on 1 May 2014, the Secretary of State for Education announced a review of Initial Teacher Training (ITT). The review found that overall the quality of ITT in the UK was good, reporting that 1,855 (14%) of teachers were trained by outstanding ITT partnerships, 10,870 (82%) were trained by good ITT partnerships and only 505 (4%) were trained by ITT partnerships requiring improvement. Key areas identified as requiring further improvement included classroom management, subject knowledge and a greater understanding of child and adolescent development.[642]

7.12.1 Teacher workforce in England

Table 7.12 shows the headcount of teachers by the STEM subject they teach. The data reveals that in 2014 there were 229,000 teachers serving Key Stages 3 to 4, of whom mathematics teachers constituted 14.6% (33,400) – the largest number of any STEM subject. Engineering had the lowest number of teachers, with a head count of only 1,600, although this is not surprising, considering the relatively low number of students studying for this degree. However, entries to engineering increased by over third in 2015 so the number of experienced teachers will need to increase to ensure that quality of provision is maintained.

It is also concerning that the number of those teaching physics (6,400) is significantly lower than the headcount for chemistry (7,500) and biology (8,800), although the numbers of entries for these three subjects are generally equivalent.

639 Excludes subjects with fewer than 100 A-D grades 640 Ken Robinson RSA speech: How to change education – from the ground up, 1st July 2013 641 The Prince's Teaching Institute: A new, member-driven College of Teaching. A blueprint. 2014 642 Sir Andrew Carter: Carter review of initial teacher training (ITT), January 2015, p6

Modelling by the Department for Education (DfE) and the Institute of Physics (IoP) estimated that around 1,000 new physics teachers need to be recruited every year for at least the next decade to fulfil projected demand. However, according to Table 7.12, there were only 200 more physics teachers in service in 2014 than the preceding year, when a head count of 6,200 was reported.[643] In response to this shortage, the government has announced plans to deliver up to 2,500 new maths and physics teachers. It aims to do this by providing subject-specific training to 15,000 non-specialists, attracting new graduates and bringing former teachers back into the classroom through one-on-one support programs.[644]

Furthermore, the government aims to attract mid-career skilled professionals in sectors such as engineering or medicine. New part-time training routes will allow them to retrain as teachers whilst continuing to work or look after a family. To achieve this, it has allocated grant funding of up to £20,000 to school partnerships, with the first trainees due to enter the classroom in September 2016.[645]

Another initiative designed to increase the number of qualified STEM teachers includes giving up to £15,000 to top science and maths undergraduates during their studies, in return for a commitment to teach for three years after graduation.

In addition, from 2016, brand new physics degrees will be piloted in 10 top universities that will allow students to obtain a teaching qualification in addition to their degree course. These courses will be accredited by the Institute of Physics and won't require students to undertake an additional year's teacher training on top of their degree.[646]

Finally, the government has renewed its commitment to support the Stimulating Physics Network by investing £4.3 million from over 2014 to 2016.[647] Directed by the Institute of Physics, the Stimulating Physics Network provides professional development for teachers and aims to boost progression to A level physics study.

The qualification level of engineering teachers is worth considering. At 81.6%, engineering has more teachers with no relevant post A level qualification than any other STEM subject (Figure 7.5). In fact, only 15.1% of engineering teachers had a degree in the subject – the lowest of any STEM subject.

Although not a substitute for a full engineering degree, relevant industrial experience can provide teachers with an understanding and appreciation of engineering in the workplace, making them better placed to inspire their students. As such, the Education and Training Foundation, Institute of Education and the Association of Employment and Learning Providers are developing Teach Too, which aims to encourage those working in industry to commit some of their time to vocational teaching, and likewise to enable teachers to spend time in industry.[650]

It is also interesting to note that, with the exception of engineering and ICT, mathematics teachers are the least likely to have a degree in the subject, with only 44.5% having one.

This is concerning because research conducted by the Education and Training foundation found that 43% of teachers lacked confidence in teaching all elements of GCSE mathematics. Furthermore, only 55% of teachers with GCSE A-C or equivalent qualifications in mathematics disagreed that they feel threatened when asked difficult questions by pupil. However, when teachers with a mathematics or mathematically-oriented degree were asked the same question, 90% disagreed and 78% strongly disagreed.[651]

The Sutton trust has conducted research revealing that the type of school has a significant impact on the educational attainment of the teachers employed there. For example, state school teachers were more likely to have Bachelors of Education degrees than independent school teachers. However, independent school teachers were more likely to have higher level degrees such as master's degrees and PhDs.

In secondary schools, independent school teachers are more likely than state school teachers to have relevant postgraduate qualifications. This was especially true in subjects experiencing a shortage of teachers such a physics and maths.[652]

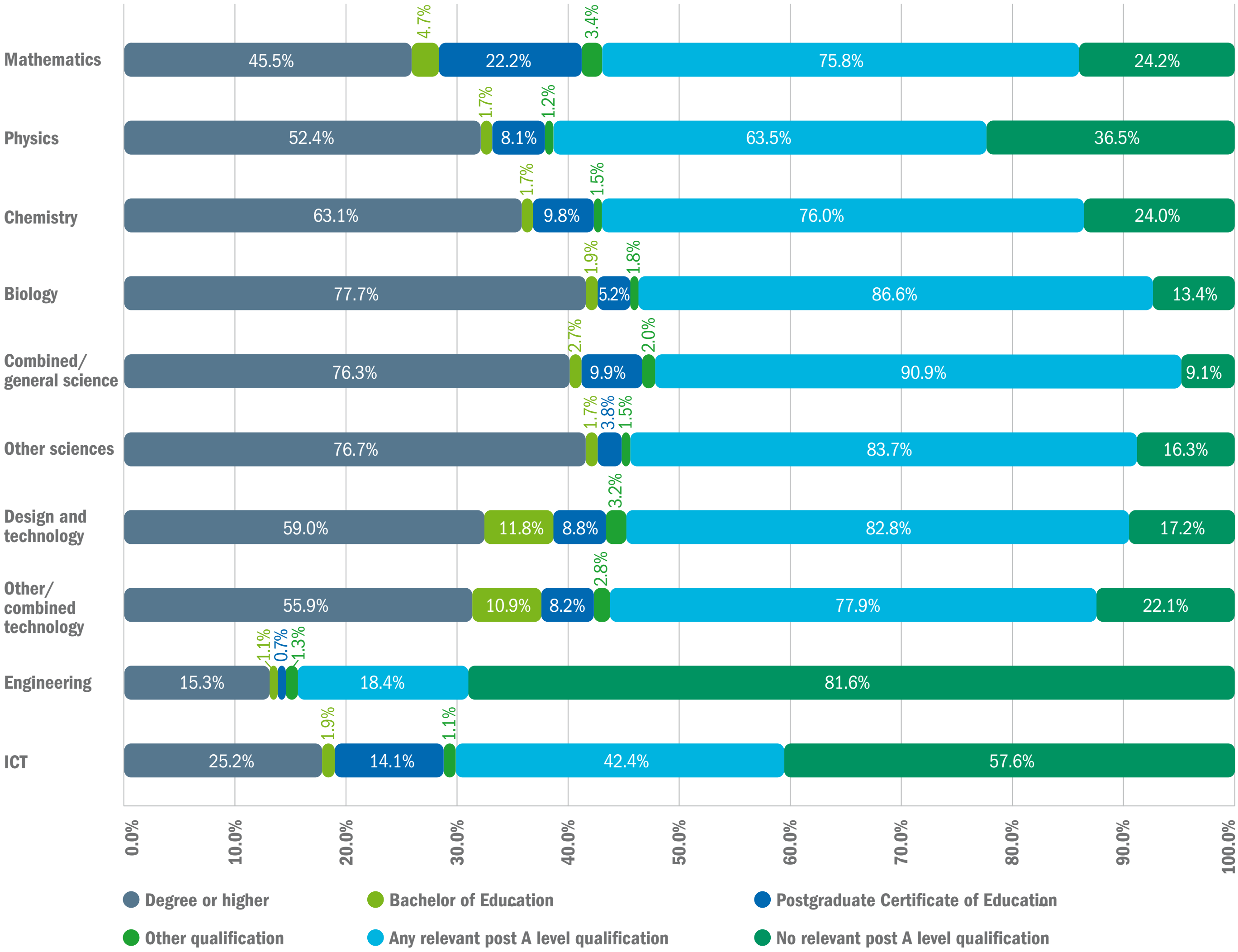
Table 7.12: Head count of teachers by STEM subject and Key Stage in all publicly funded secondary schools (2014) – England[648]

				Number of teachers	
		Head count of in service teachers	**Key Stage 3**	**Key Stage 4**	**Key Stage 5**
Mathematics		33,400	29,400	27,500	13,600
Physics		6,400	1,300	3,600	4,500
Chemistry		7,500	1,400	4,000	5,500
Biology		8,800	1,600	4,400	6,800
Combined/ general science		32,300	28,900	25,800	2,900
Other sciences		2,300	400	1,200	1,200
Design and technology[649]		12,700	5,700	10,300	3,300
Of which:	Electronics / systems and control	1,000	400	700	200
	Food technology	4,700	2,400	3,500	700
	Graphics	3,300	1,100	2,400	900
	Resistant materials	4,000	1,600	3,000	500
	Textiles	2,900	1,100	2,100	1,100
Other/combined technology		14,300	13,000	3,500	2,400
Engineering		1,600	300	1,200	600
Information and communication technology		14,000	11,500	9,400	5,100
Total headcount (STEM and non-STEM subjects)		229,000	202,000	201,900	119,900

Source: Department for Education

643 Engineering UK: The state of engineering UK, January 2015, p83. 644 Department for Education: Major push to get more maths and physics teachers into our classrooms. 11th March 2015 645 *Ibid.* 646 *Ibid.* 647 *Ibid.* 648 Teachers were counted once against each subject that they were teaching, regardless of the amount of time they spend teaching the subject. Teachers were counted under each Key Stage they were recorded as teaching to; a Mathematics teacher who taught all years (7-13) would be included under Number of teachers of Key Stage 3, Key Stage 4 and Key Stage 5. 649 Includes construction and built environment. 650 http://teachtoo.org/ accessed 12th of September 2015 651 Education and Training Foundation (ETF) – The qualifications of English and mathematics teachers – Report prepared by frontier economic, September 2014, p19. 652 The Sutton Trust: Teaching by degrees – the university backgrounds of state and independent school teachers, 2015, p4

Figure 7.5: Highest post A level qualifications held by publicly-funded secondary school teachers (head count) in the STEM subjects they taught (2013) – England[653, 654, 655, 656]



Source: Department for Education

7.12.2 Teacher workforce in Wales

Table 7.13 shows the proportion of teachers registered with the General Teaching Council Wales for each STEM subject who were trained in that subject. Encouragingly, 77.9% of mathematics teachers were trained in that subject. However, this is only the case for a minority of physics teachers (45.3%). Physics also had the lowest number of trained teachers, with only 169 compared with over 200 for chemistry and biology.

Table 7.13: Number of teachers registered with General Teaching Council Wales by STEM subject taught versus subject trained (2015) – Wales

	Total teaching subject	Percentage known to be trained in subject	Number known to be trained in subject
Biology	431	56.6%	244
Chemistry	411	51.6%	212
Mathematics	1,477	77.9%	1,151
Physics	373	45.3%	169
Science	1,147	33.2%	362

Source: General Teaching Council for Wales[657]

653 Where a teacher has more than one post A level qualification in the same subject, the qualification level is determined by the highest level reading from left (degree or higher) to right (other qualification). For example, teachers shown under PGCE have a PGCE but not a degree. 654 Not including qualifications in Special Educational Needs provision. 655 Teachers are counted once against each subject which they are teaching. Head counts are used, so a teacher teaching French and German would be counted once in each. 656 Other qualification: includes Certificate of Education, non-UK qualifications where the level was not provided and other qualification at National Qualifications Framework (NQF) level 4 or 5 and above e.g. diplomas or higher education and further education, foundation degrees, higher national diplomas and certificates of higher education. 657 Annual Statistics Digest, General Teaching Council for Wales, March 2015, p14

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7.12.3 Teacher workforce in Scotland

Table 7.14 shows the proportion of teachers for STEM subject by gender in Scotland. It is encouraging that more than nine out of ten physics teachers were teaching it as their main subject: a figure higher than the all-subject average of 71.5%. However, unlike mathematics, biology and chemistry, female physics teachers were slightly less likely than males to be teaching it is as their main subject: 87.5% compared with 92.2%.

7.13 Changes in the science and maths qualifications landscape

Authored by Peter Main, Education Adviser, Institute of Physics

The most common university destination for students achieving A levels in physics and mathematics is engineering (Table 7.15). Indeed, five of the top ten destinations for such students are explicitly engineering (mechanical; civil; electronic & electrical; aerospace; and chemical, process & energy). Four of the others – mathematics, physics, chemistry and computer science – have strong links with engineering, particularly in terms of subsequent employment. Only pre-clinical medicine is an outsider. Consequently, recent changes in the structure and detail of these qualifications are likely to have an effect on both the number of students taking engineering courses and the qualities they possess.

Before considering the most recent changes, it is interesting to consider some lessons from history. In the 1950s, only around 20% of the relevant cohort took A levels. But, of those, one in ten of all A level entries – about 12,000 in all – were for physics. Although the sciences were not compulsory at O level, around 35,000 took O level physics, with an impressive one in three conversion to the A level. As the benefits of education were spread more widely, A level numbers increased inexorably so that, by the mid-80s, the total number of entries had risen to 600,000. Remarkably, physics A level held at almost the same proportion of entries at around 50,000. Equally remarkably, the physics O level entries also increased year-on-year to around 180,000. Then it was decided that it was unacceptable for students to drop the sciences at age 16. O levels, and their companion qualifications, CSEs, were abolished in favour of GCSEs and the sciences were made compulsory for all students (Figure 7.6).

Table 7.14: Secondary school teachers by main subject taught and other subjects taught and gender (2014) – Scotland

	Main subject taught			Including where the subject is not the main subject			Percentage teaching main subject		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Mathematics	1,349	1,055	2,404	1,435	1,132	2,567	94.0%	93.2%	93.7%
Biology	854	325	1,180	979	385	1,364	87.2%	84.4%	86.5%
Chemistry	583	353	936	685	430	1,114	85.1%	82.1%	84.0%
General science	64	65	129	1,052	782	1,833	6.1%	8.3%	7.0%
Physics	246	578	824	281	627	909	87.5%	92.2%	90.6%
All subjects	14,010	7,953	21,963	19,765	10,940	30,705	70.9%	72.7%	71.5%

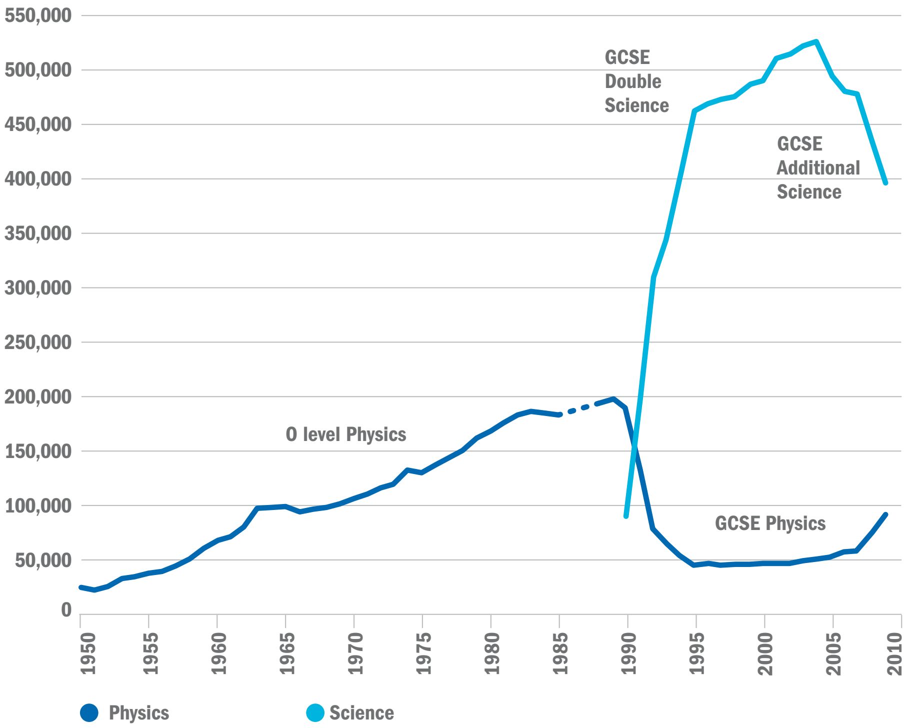
Source: Scottish Government

Table 7.15: University course destinations of students with mathematics and physics A levels (2013/14)

Overall		Male		Female	
Course destination	%	**Course destination**	%	**Course destination**	%
Physics	12.4	Mechanical Engineering	13.4	Mathematics	11.7
Mechanical engineering	11.5	Physics	13	Physics	10.6
Mathematics	10.7	Mathematics	10.4	Pre-clinical Medicine	5
Civil engineering	4.7	Computer Science	5.4	Mechanical Engineering	4.7
Computer science	4.5	Electronic and Electrical Engineering	5	Combs of 3 subjects, or other general courses	4.7
Electronic and electrical engineering	4.3	Civil Engineering	4.9	Chemistry	4.5
General engineering	4.2	Aerospace Engineering	4.7	Chemical, Process and Energy Engineering	3.9
Aerospace engineering	4.1	General Engineering	4.4	Civil Engineering	3.8
Chemical, process and energy engineering	3.6	Chemical, Process and Energy Engineering	3.6	General Engineering	3.5
Chemistry	3.5	Chemistry	3.3	Architecture	3.2

Source: Higher Education Statistics Agency

Figure 7.6 O level and GCSE entries in physics and science (1950-2009)



Source: Gatsby[658]

The motivation for this change was partly to increase the numbers of students taking science A levels. In its immediate aftermath, total A level entries continued to rise to above 800,000 in 2010, but physics entries plummeted, hitting a low of 27,000 in 2007 – a mere 1 in 80 of all entries. There are many possible reasons for this, including a fall in the number of specialist teachers and an increase in the choice available. But what happened was the precise opposite of what was intended.

The next few years see the introduction of a number of reforms to both A levels and GCSEs. The changes have been complicated by a staggered timetable. For example, the new A levels in some subjects, including all the sciences, will have first teaching in 2015, while others will not be introduced until later. The new mathematics A level does not appear until 2017, which has more or less precluded the possibility of any linkage between maths and the sciences.

Even more regrettably, the timetable for change at GCSE is not well correlated with that for A level. For the sciences, in 2015 there will be students progressing from the old science GCSEs to the new science A levels, which are allegedly more mathematical, but the old mathematics A level. From the outside, it is difficult to understand the logic behind this ad hoc approach to curriculum reform.

Perhaps the most controversial aspect of the current reforms has been the abolition of the formal linkage between the AS and A level qualifications. Since the turn of the millennium, A levels have been split into an AS part in the first year, followed by A2 in the second. The two components were separately assessed and the marks combined to determine the final grade. It was also possible to cash-in the AS at the end of the first year without progressing to A2. The rationale for this structure was that it gave students a broader diet of subjects post-16, allowing them to sample courses before deciding whether to progress to the full A level. AS qualifications are also popular with university admissions tutors as the grades are much better indicators of the subsequent A level achievement than the GCSE alternative.

The coalition government's motivation to change the system was strong. Firstly, it was concerned at the modularisation of subjects and wanted A levels to be two-year qualifications with a single set of assessments at the end of that period. Secondly, they were concerned at the loss of teaching time due to the AS examinations at the end of the first year, and at the way in which AS resits were often seen as the norm as students and schools, with one eye on the league tables, wanted to boost grades.

When the reforms were first mooted, the proposal was that the AS should be completely separated from the A level as a two-year qualification. This line has softened so that, in the sciences at least, the first year of the A level will be very similar to the AS. This is good, as it allows co-teaching; one of the major complaints from schools concerning the original proposal was that it would create extra work for physics teachers, already in short supply, if the classes had to be taught in parallel.

However, that does not mean that the situation will carry on as before. Students who want to do the AS with the possibility of staying on for the A level now have to enter for both qualifications, which means extra cost for schools. There are two other factors relevant in this context. One is that the funding model for post-16 education has changed. Previously, schools and colleges were funded in terms of the number of qualifications taken. If a student took four AS levels as opposed to three, the institution received extra money. Now, funding is in terms of programmes and the money received per student is exactly the same regardless of whether, say, they take three or four qualifications. There are only financial disincentives for schools to offer AS levels.

The second factor is the increasing emphasis on performance-related pay for teachers. If teachers receive more money for their students' receiving higher grades, they are going to be much less likely to want weaker students to register for qualifications in their subjects.

Financial constraints are not the only factors that determine what happens in schools. Many teachers will continue to maximise the number of students taking their subjects, and many schools – particularly the more affluent – will continue to allow students to enter both AS and A level. But we are already hearing of some that will not, and the most worrying aspect is that the subjects that are most likely to suffer are those that require expensive laboratory space and those that have shortages of teachers. The sciences fall into this category and, while there should be no problem with mathematics, there are very serious concerns about further mathematics. Further maths has been one of the great success stories of recent years, with A level numbers increasing from just over 5,000 in 2003 to 14,000 in 2014, and AS from 3,000 to almost 25,000 over the same period. But there is a serious risk that there will be a substantial drop if AS levels cease to be the norm, which would be bad news for all mathematical disciplines, including engineering.

658 Physics participation and policies: lessons from abroad, Gatsby, December 2009, p7; http://www.gatsby.org.uk/uploads/education/reports/pdf/14-physics-participation-and-policies-dec-2009.pdf

The other controversial aspect of the A level reforms has been the change in the way that practical work is assessed in the sciences. Until 2014, practical work was assessed by some in-school activity, such as a laboratory test, a controlled assessment or a project. Generally, these were marked by teachers but were subject to external moderation. The marks obtained then contributed directly to the final grade. When the A levels were reformed in England, Ofqual expressed two serious concerns about this process. The first was that the marks for practical work were, on average, higher than those for the theory papers, and the second was that there was widespread "malpractice" or, in its blunter form, cheating.

The reforms that finally emerged had a number of positive features. There was a greater emphasis on practical skills, including keeping a lab notebook. There is a requirement to carry out a minimum number of experiments over the two years. And teachers must confirm mastery of skills by the students. Less positively, the new arrangements make it difficult for specifications to include project work and there is no plan to moderate teacher assessment: schools will be visited to ensure that their book-keeping and methodology are up to scratch, but there will be no attempt to moderate the actual assessment.

The most controversial aspect of the new arrangements is that the practical marks will no longer contribute to the overall mark for the A level. Instead, students passing the assessment will have "endorsements" added to their certificates. At the time of writing, it is not yet clear if those failing the practical work assessment will also have that fact recorded on their certificates or if there will just be an absence of a pass. Some commentators think this might be an irrelevant question anyway, because teachers will ensure that their students do the required experiments and achieve the specified skills, so the pass rate will be very close to 100%.

It is not clear how university admissions tutors will treat the new endorsements. One or two universities have stated that they will require the endorsement for all students that have science A levels as part of their offers. Some say they will only request them for STEM subjects. Whereas others will not bother at all, citing equality of opportunity in that it would be unfair to ask for something in addition to the A level grade. There are also concerns that students from less well-resourced schools might find it tougher to pass the practical element, so that requiring it might lead to unfairness. In the end, it may come down to individual admissions tutors. However, if schools believe that universities, by not insisting on the endorsement, do not value practical work, there is a danger that schools will not value it either. Hard-pressed school management teams might be tempted, in extremis, to look at their expensive science laboratories and decide they are luxuries rather than necessities. More likely, perhaps, they will reduce lab activities to the minimum required for the students to cover the skills. And that would not be a desirable outcome at all for science and engineering.

In summary, the new structure of A levels has many positive features. The removal of modules, and their associated resits, should release more teaching time and allow students to appreciate better the coherence of their subjects. And the new, skills-centred practical work regime has the potential to produce students better versed in the important competencies. But there are real uncertainties. How many schools will continue to offer AS levels in science and mathematics? Will the changes to AS mean that fewer students, particularly girls, enrol for subjects seen as "difficult", notably mathematics, further mathematics and physics? And will the changes in the assessment of practical work eventually lead to such activities being seen as dispensable. Before the election, in an unusual move, the Secretary of State for Education, Nicky Morgan, made it clear that she was not greatly enamoured with some of the changes, notably the assessment of lab work. She is still Secretary of State so there could be interesting times ahead. In the meantime, A levels in Wales and Northern Ireland continue more or less as they were, so that we find ourselves in the odd position of having qualifications with the same name but with different structures and assessment.

Part 2 - Engineering in Education and Training
8.0 AS, A levels and equivalent qualifications

A levels and other qualifications at level 3 are an important bridge connecting compulsory and tertiary education. It is at this point that the first of several leaks in the supply of future female engineers arises. Whilst 48.8% (65,221) of those studying physics at GCSE are female, this figure drops to 23.6% (15,192) at AS level and only 21.5% (7,801) at A level. This decline occurs despite higher female attainment, which means some of the best and brightest students are being lost at this early stage.

The ages between 16 and 18 are critical in ensuring the supply of a future engineering workforce.

This is the stage when gender disparities begin to emerge in key STEM subjects, and many female pupils drop out of key STEM subjects that lead to higher engineering-related study. At GCSE, there are roughly equal proportions of male and female pupils pursuing three separate science subjects. However, female pupils account for less than a quarter of physics entries at AS level.

Furthermore, young adults aged between 16 and 18 in England are significantly less likely to be participating in education or training than their counterparts in similar developed countries. They were also found to be less likely to use numeracy skills in their daily lives.[659] However, at the age of 15, the performance of pupils in England is in line with the OECD average.[660] This suggests that it is post-16 when pupils' level of educational development can being to stall.

In response to these issues, the government has introduced a plethora of reforms to post-16 study. These include substantial reforms to AS and A levels. From September 2015, new AS and A levels will be introduced to schools in England, with the first results being announced for the new AS levels in 2016, and new A levels in 2017. In contrast to previous AS and A levels, the reformed qualifications will be predominantly assessed by exam at the end of the course and follow a linear rather than modular structure.[661]

Notably, AS and A levels will be decoupled, meaning that results from AS levels will no longer constitute 50% of an A level, as was the case previously. New AS and A levels in biology, chemistry, computer science and physics will be taught from September 2015, with mathematics, further mathematics, information and communications technology and statistics due to follow in 2017.[662]

It is too early to ascertain the impact of AS/A level decoupling on uptake and perceptions of these qualifications, or to see how these

659 Department for Business, Innovation and skills: Comparative analysis of young adults in England in the International Survey of Adult Skills 2012, December 2014, p9. 660 *Ibid.* 661 OfQual: Get the facts: AS and A level reform, 14 May 2015 662 *Ibid.*

changes will influence progression onto higher education. A recent UCAS survey revealed that approximately 50% of sixth forms intend to provide new AS levels in all subjects. The remaining half have decided to offer only some subjects, no AS levels whatsoever or are still undecided.[663] Furthermore, from 2017, UCAS has decided to lower the tariff contribution of new AS levels from 50% of an A level to 40%.[664]

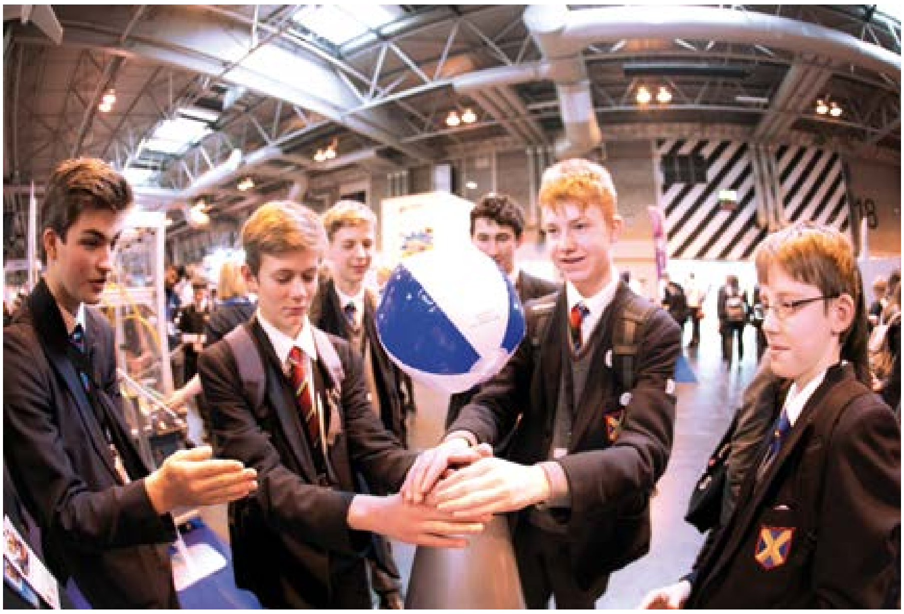
In 2014, the Department for Education noted that 40% of pupils do not achieve GCSE grades A* to C in English and mathematics by age 16. Furthermore, 90% of this cohort failed to achieve such grades by age 19.[665] In response, the government has made it a condition of funding that from August 2015, full-time 16- to 19-year-old students with prior achievement of grade D in English and/or mathematics will be required to study an approved GCSE in these subjects.[666]

Research commissioned by the Nuffield Foundation in 2010 found that England, Wales and Northern Ireland had the lowest level of post-16 participation in maths of 24 OECD countries: only 1 in 5 students study some form of mathematics after their GCSEs.[667] Levels of participation were found to be higher in Scotland, where just below 50% of pupils studied maths after the age of 16. However, this figure was still lower than the average of the 24 countries studied, of which 18 had over 50% post-16 mathematics participation, while eight had participation rates of over 95%.[668]

However, at present there is little scope for most students to continue studying mathematics from the age of 16. As a recent report from the Nuffield Foundation notes, "A level mathematics is difficult, and perceived as such. This is reinforced in the guidance that students receive, with those who do not achieve A* or A grades at GCSE mathematics often being discouraged by teachers to choose A level mathematics."[669] This poses a significant barrier to pupils who may benefit from a higher maths qualifications, despite not excelling to the extent required by A level study.

To bridge the gap between pre- and post-16 maths participation, the government is set to introduce a new core maths qualification. This is targeted at the 40% of pupils who achieve a C or better at GCSE level, but are not suitable to study A level maths. The government estimates that this will provide 200,000 students a year the opportunity to study maths in post-16 education.[670]

The new qualification is due to be rolled out nationally in 2015 and will be half an A level in size, though taught over two years to allow gradual building of competence. Content will be oriented towards the application of mathematics, problem-solving and modelling and will lead to a level 3 qualification. It is important to note, however, that it will not be considered an AS level.[671]



8.1 Benefits of STEM A levels

STEM A levels have several benefits, both as a means of progressing onto higher level study and in their own right.

London Economics conducted a study of young people whose highest qualifications were A levels. Its research showed that having one STEM A level boosts earnings by approximately 15 percentage points over those with non-STEM A levels, and 20.3 percentage points over those with only GCSEs.[672] Furthermore, such earnings premiums are even greater for women. Compared with GCSEs/O levels, women achieving two or more STEM A levels can expect an earnings return of 33.1%, whilst those with one STEM A level can expect a return of 29.4%.[673]

STEM A levels also hold additional merit in facilitating entry to higher education and, in particular, to prestigious universities. In 2012, the Russell Group identified A levels in biology, chemistry, physics, mathematics and further mathematics to be key facilitating subjects, which increase the chances of pupils attending elite universities including Oxford and Cambridge.[674]

However, uptake of these facilitating STEM A level subjects is not equal across society. Research conducted by the university of Oxford and the Sutton Trust found that only a third of gifted but disadvantaged students entered one or more A levels in facilitating subjects, compared to three fifths of gifted and more advantaged students. Furthermore, 41% of advantaged students achieved an A*-B grade in these subjects, compared with only 18% of disadvantaged students.[675]

8.2 AS level entrant numbers

Table 8.1 shows that entries to AS levels (as an all-subject average) declined in 2015, with 1.9% fewer pupils sitting the exams than in 2014. Physics entrants declined by 0.6%, though this figure was lower than the decline seen in chemistry (down 1.2%) and biology (down 1.3%). In contrast, the number of pupils sitting AS examinations in mathematics increased by 2.2%, with further mathematics entries experiencing even greater growth of 10.1%.

However, the percentage of females studying AS levels in subjects important for further engineering study fell, with physics and mathematics seeing a marginal 0.1% percentage point decline, and further mathematics falling by 0.3 percentage points. Over a 10-year period, the proportion of females studying AS level physics has dropped by 0.9 percentage points, and as a result, less than a quarter (23.6%) of AS level physics entries in 2015 were from female pupils.

Computing saw the largest growth in entrants, with numbers increasing by 16.6% on the previous year. Furthermore, the percentage of female entrants grew by 0.4%, which is small but encouraging for this male-dominated subject where only 9.5% of entrants were women.

663 The Council for Independent Education: The new A level and GCSE exams 14th May 2015. **664** UCAS: Tarrif 2017, available at https://www.ucas.com/ucas/undergraduate/getting-started/entry-requirements/tariff. **665** Department for Education: Written statement to Parliament Maths and English provision in post-16 education, 2 July 2014 **666** Education Funding Agency: 16 to 19 funding: maths and English condition of funding: December 2014 **667** Nuffield Foundation and King's College London: Is the UK an Outlier? An international comparison of upper secondary mathematics, December 2010. **668** The Nuffield Foundation and King's College London: Mathematics after 16: the state of play, challenges and ways ahead, 2014, p5 **669** *Ibid*, p12 **670** Department for Education: Written statement to Parliament Maths and English provision in post-16 education, 2 July 2014 **671** The Nuffield Foundation: Mathematics after 16: the state of play, challenges and ways ahead, 2014, p19 **672** London Economics: The earnings and employment returns to A levels, February 2015, piii **673** *Ibid*, piii **674** Russell Group: Informed choices: A Russell Group Guide to make decisions about post-16 education. 2012 **675** University of Oxford and Sutton Trust: Subject to background what promotes better achievement for bright but disadvantaged students? March 2015, p5.

Table 8.1: GCE AS level STEM subject entrant volumes (2006-2015) – all UK candidates

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change over 1 year	Change over 10 years
Biology	Total entrants	72,246	73,572	72,239	79,112	83,408	102,532	102,387	103,905	105,251	103,859	-1.3%	43.8%
	% Female	58.8%	58.1%	57.2%	56.7%	56.1%	55.1%	56.3%	57.3%	59.1%	60.0%	0.9%p	1.2%p
Chemistry	Total entrants	50,855	52,835	54,157	58,473	62,232	79,874	82,390	85,631	88,673	87,621	-1.2%	72.3%
	% Female	49.5%	49.5%	49.0%	48.2%	47.9%	47.0%	47.9%	48.3%	49.2%	49.6%	0.4%p	0.0%p
Computing	Total entrants	9,208	8,719	7,821	7,564	7,223	8,097	7,719	8,886	11,582	13,510	16.6%	46.7%
	% Female	11.3%	11.0%	11.1%	10.2%	9.5%	9.5%	8.2%	8.7%	9.5%	9.9%	0.4%p	-1.4%p
ICT	Total entrants	21,790	20,422	19,266	19,696	19,910	21,100	18,961	17,421	17,027	16,078	-5.6%	-26.2%
	% Female	37.3%	38.2%	37.6%	37.0%	36.9%	36.4%	35.8%	34.3%	32.7%	32.9%	0.2%p	-4.5%p
Mathematics	Total entrants	70,805	77,387	84,613	103,312	112,847	141,392	148,550	150,787	161,711	165,311	2.2%	133.5%
	% Female	41.0%	41.4%	41.7%	41.8%	41.0%	40.9%	40.3%	39.5%	39.4%	39.3%	-0.1%p	-1.7%p
Further mathematics	Total entrants	6,292	7,426	8,945	13,164	14,884	18,555	20,954	22,601	24,530	27,034	10.2%	329.7%
	% Female	35.0%	33.8%	34.7%	35.3%	34.8%	32.8%	31.7%	30.1%	29.6%	29.2%	-0.3%p	-5.8%p
Physics	Total entrants	36,258	37,323	38,129	41,955	45,534	58,190	59,172	61,176	64,790	64,377	-0.6%	77.6%
	% Female	24.5%	24.7%	24.1%	23.6%	23.7%	23.3%	23.4%	23.4%	23.7%	23.6%	-0.1%p	-0.9%p
Other science subjects	Total entrants	9,801	9,343	9,529	6,947	6,873	7,064	6,550	6,518	6,432	5,667	-11.9%	-42.2%
	% Female	32.5%	33.6%	34.8%	29.7%	29.3%	27.6%	27.3%	27.3%	26.7%	26.4%	-0.2%p	-6.1%p
Design and technology/ technology subjects	Total entrants	23,099	22,702	22,953	25,120	25,201	28,674	25,661	23,314	23,774	22,193	-6.7%	-3.9%
	% Female	41.5%	41.5%	41.4%	42.4%	42.1%	42.2%	40.7%	39.2%	38.8%	37.7%	-1.2%p	-3.9%p
All subjects	Total entrants	1,086,634	1,114,424	1,128,150	1,177,349	1,197,490	1,411,919	1,350,345	1,345,509	1,412,934	1,385,901	-1.9%	27.5%
	% Female	54.5%	54.5%	54.3%	53.9%	53.5%	53.3%	53.3%	53.3%	53.7%	53.8%	0.1%p	-0.7%p

Source: Joint Council for Qualifications

Considering the UK by home nation, Table 8.2 reveals that, in contrast to England and Wales, Northern Ireland saw entries to AS level examinations grow by 2.7%. The number of entries to physics grew, though only by 1.5% – below the all-subject average increase, and considerably lower than the 4.3% growth seen in biology and the 9.4% increase in mathematics.

Entrants to computing saw the largest increase, with numbers increasing almost by half in Northern Ireland, and by 15.8% and 18.5% in England and Wales respectively.

Table 8.2: GCE AS level STEM subject entrant volumes by home nation (2014-2015) – all UK candidates

		2014		2015		Change over 1 year	
		Entrants	Percentage of all subjects	Entrants	Percentage of all subjects	Entrants	Percentage of all subjects
Biology	England	96,252	7.3%	94,671	7.4%	-1.6%	0.0%p
	Wales	4,365	8.2%	4,355	8.3%	-0.2%	0.0%p
	Northern Ireland	4,634	10.1%	4,833	10.3%	4.3%	0.2%p
Chemistry	England	81,726	6.2%	80,635	6.3%	-1.3%	0.1%p
	Wales	3,708	7.0%	3,735	7.1%	0.7%	0.1%p
	Northern Ireland	3,239	7.1%	3,251	6.9%	0.4%	-0.2%p
Computing	England	10,800	0.8%	12,508	1.0%	15.8%	0.2%p
	Wales	520	1.0%	616	1.2%	18.5%	0.2%p
	Northern Ireland	262	0.6%	386	0.8%	47.3%	0.2%p
ICT	England	13,586	1.0%	12,384	1.0%	-8.8%	-0.1%p
	Wales	1,502	2.8%	1,583	3.0%	5.4%	0.2%p
	Northern Ireland	1,939	4.2%	2,111	4.5%	8.9%	0.3%p
Mathematics	England	151,945	11.6%	155,132	12.1%	2.1%	0.5%p
	Wales	5,087	9.6%	5,060	9.6%	-0.5%	0.0%p
	Northern Ireland	4,679	10.2%	5,119	10.9%	9.4%	0.7%p
Further mathematics	England	23,848	1.8%	26,327	2.0%	10.4%	0.2%p
	Wales	411	0.8%	471	0.9%	14.6%	0.1%p
	Northern Ireland	271	0.6%	236	0.5%	-12.9%	-0.1%p
Physics	England	59,450	4.5%	59,006	4.6%	-0.7%	0.1%p
	Wales	2,672	5.0%	2,662	5.0%	-0.4%	0.0%p
	Northern Ireland	2,668	5.8%	2,709	5.8%	1.5%	-0.1%p
Other science subjects	England	5,797	0.4%	5,027	0.4%	-13.3%	-0.1%p
	Wales	521	1.0%	494	0.9%	-5.2%	0.0%p
	Northern Ireland	114	0.2%	146	0.3%	28.1%	0.1%p
Design and technology/ technology subjects	England	21,249	1.6%	19,586	1.5%	-7.8%	-0.1%p
	Wales	1,112	2.1%	1,192	2.3%	7.2%	0.2%p
	Northern Ireland	1,413	3.1%	1,415	3.0%	0.1%	-0.1%p
All subjects	England	1,314,086		1,286,125		-2.1%	0.0%p
	Wales	53,097		52,771		-0.6%	0.0%p
	Northern Ireland	45,751		47,005		2.7%	0.0%p

Source: Joint Council for Qualifications

Table 8.3 shows the top 10 most popular AS subjects in 2015. Physics is the least popular of all the STEM subjects. However, its ranking has increased since 2014, from 8th to 7th place.

Table 8.3: Top 10 GCE AS subjects (2015) – all UK candidates

Ranking	Subject	Percentage of total	Number of candidates
1 (1)	Mathematics	11.93%	165,311
2 (2)	English	8.98%	124,452
3 (3)	Biology	7.49%	103,859
4 (4)	Psychology	7.47%	103,476
5 (5)	Chemistry	6.32%	87,621
6 (6)	History	5.82%	80,694
7 (8)	Physics	4.65%	64,377
8 (7)	Art and design subjects	4.50%	62,375
9 (10)	Sociology	4.16%	57,589
10 (9)	Geography	4.03%	55,801

Source: Joint Council for Qualifications

8.3 AS level A-C achievement rates

As Table 8.4 shows, the proportion of pupils achieving a grade A-C at AS level increased for almost all subjects in 2015, with an all-subject average growth of 1.2%. However, this growth is with the discouraging exception of physics, which saw the number of pupils acquiring a good AS level fall by 0.6%.

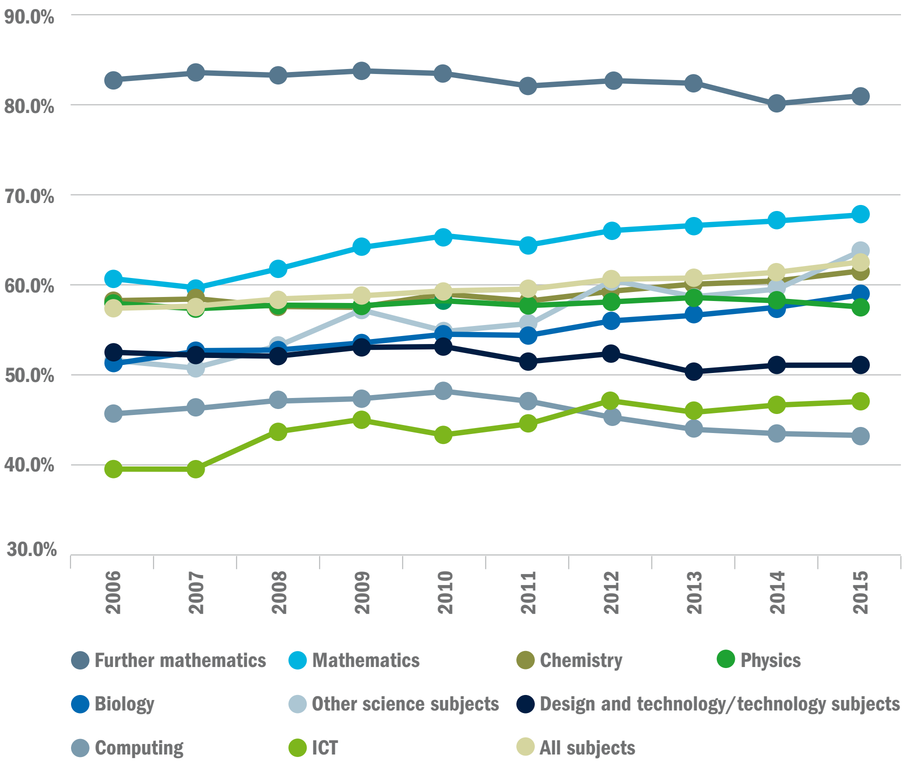
This fall is concerning. As Table 8.4 shows, with an A-C pass rate of only 57.5%, the proportion of pupils acquiring good grades in physics is lower than for most other STEM subjects, including chemistry, biology, mathematics and further mathematics.

Table 8.4: GCE AS level STEM subject A-C achievement rates (2006-2015) – all UK candidates

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change over 1 year	Change over 10 years
Further mathematics	82.8%	83.4%	83.1%	83.6%	83.5%	82.0%	82.6%	82.3%	80.0%	80.9%	0.9%p	-1.9%p
Mathematics	60.6%	59.6%	61.7%	64.1%	65.4%	64.4%	66.0%	66.5%	67.0%	67.6%	0.6%p	7.0%p
Chemistry	58.1%	58.5%	57.7%	57.3%	59.2%	58.1%	59.1%	59.9%	60.3%	61.4%	1.1%p	3.3%p
Physics	57.6%	57.3%	57.7%	57.7%	58.1%	57.5%	58.1%	58.5%	58.1%	57.5%	-0.6%p	-0.1%p
Other science subjects	51.6%	50.7%	53.2%	57.0%	54.6%	55.5%	60.2%	58.6%	59.6%	63.7%	4.1%p	12.1%p
Biology	51.2%	52.3%	52.7%	53.3%	54.5%	54.1%	55.9%	56.4%	57.3%	58.8%	1.5%p	7.6%p
Design and technology/ technology subjects	52.4%	52.3%	52.0%	52.9%	53.2%	51.5%	52.4%	50.3%	51.1%	51.1%	0.0%p	-1.3%p
Computing	45.7%	46.1%	47.1%	47.2%	48.0%	47.0%	45.4%	43.8%	43.3%	43.2%	-0.1%p	-2.5%p
ICT	39.5%	39.5%	43.7%	45.0%	43.3%	44.6%	46.9%	45.8%	46.4%	47.1%	0.7%p	7.6%p
All subjects	57.3%	57.6%	58.5%	58.7%	59.1%	59.4%	60.6%	60.8%	61.4%	62.6%	1.2%p	5.3%p

Source: Joint Council for Qualifications

Figure 8.1: GCE AS level STEM subject A-C achievement rates (2006-2015) – all UK candidates



Source: Joint Council for Qualifications

Considering A-C pass rates by gender, with the exception of chemistry, female pupils outperform their male counterparts for all subjects, including male dominated ones such as physics and computing (Table 8.5). Of all females sitting AS examinations in physics, 61.1% can expect to achieve an A-C grade, compared with only 56.4% of males. Such findings discredit popular perceptions that males posses greater natural ability in science and especially physics. However, interestingly, recent research conducted in the US found that disciplines in which people perceive innate ability to be important are more likely to suffer from a shortage of females.[676]

Table 8.5: Number of AS level A-C passes by gender (2014-2015) – all UK candidates

		2014			2015			
		Total number of students	**Percentage A-C**	**Calculated number of students obtaining a grade A-C**	**Total number of students**	**Percentage A-C**	**Calculated number of students obtaining a grade A-C**	**Percentage change in students obtaining a grade A-C**
Biology	Total	105,251	57.3%	60,309	103,859	58.8%	61,069	1.3%
	Male	43,032	55.8%	24,012	41,550	57.4%	23,850	-0.7%
	Female	62,219	58.3%	36,274	62,309	59.8%	37,261	2.7%
Chemistry	Total	88,673	60.3%	53,470	87,621	61.4%	53,799	0.6%
	Male	45,084	60.5%	27,276	44,188	61.8%	27,308	0.1%
	Female	43,589	60.1%	26,197	43,433	61.0%	26,494	1.1%
Computing	Total	11,582	43.3%	5,015	13,510	43.2%	5,836	16.4%
	Male	10,485	42.9%	4,498	12,171	42.8%	5,209	15.8%
	Female	1,097	46.7%	512	1,339	46.5%	623	21.6%
ICT	Total	17,027	46.4%	7,901	16,078	47.1%	7,573	-4.2%
	Male	11,463	42.3%	4,849	10,791	42.0%	4,532	-6.5%
	Female	5,564	54.9%	3,055	5,287	57.5%	3,040	-0.5%
Mathematics	Total	161,711	67.0%	108,346	165,311	67.6%	111,750	3.1%
	Male	97,999	66.2%	64,875	100,327	67.1%	67,319	3.8%
	Female	63,712	68.3%	43,515	64,984	68.5%	44,514	2.3%
Further mathematics	Total	24,530	80.0%	19,624	27,034	80.9%	21,871	11.4%
	Male	17,276	79.5%	13,734	19,132	80.6%	15,420	12.3%
	Female	7,254	81.3%	5,898	7,902	81.4%	6,432	9.1%
Physics	Total	64,790	58.1%	37,643	64,377	57.5%	36,985	-1.7%
	Male	49,457	57.1%	28,240	49,197	56.4%	27,747	-1.7%
	Female	15,333	61.5%	9,430	15,180	61.1%	9,275	-1.6%
Other science subjects	Total	6,432	59.6%	3,833	5,667	63.7%	3,610	-5.8%
	Male	4,716	59.7%	2,815	4,169	63.2%	2,635	-6.4%
	Female	1,716	59.1%	1,014	1,498	65.1%	975	-3.8%
Design and technology/ technology subjects	Total	23,774	51.1%	12,149	12,063	45.8%	5,525	-54.5%
	Male	14,539	46.4%	6,746	14,539	46.4%	6,746	0.0%
	Female	9,235	58.4%	5,393	7,523	57.1%	4,296	-20.3%
All subjects	Total	1,412,934	61.4%	867,541	1,385,901	62.6%	867,574	0.0%
	Male	654,479	58.4%	382,216	640,019	59.6%	381,451	-0.2%
	Female	758,455	64.1%	486,170	745,882	65.2%	486,315	0.0%

Source: Joint Council for Qualifications

676 Science volume 347: Expectations of brilliance underlie gender distributions across academic disciplines, January 2015

8.4 A level entrant numbers

Table 8.6 shows that the number of entrants to A levels increased by 2.0%, with a total of 850,749 pupils sitting the examinations in 2015. Entrants to physics fell by 1.1% – with nearly 500 fewer pupils sitting the exam in 2015 than in 2014 – although the number of females rose by 0.4 percentage points. However, only 21.5% of A level physics entrants were female, below AS level entrants for the same subject (23.6% female). Computing saw the largest increase in entrants, with numbers growing by 29.1%.

Table 8.6: GCE A level STEM subject entrant numbers (2006-2015) – all UK candidates

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change over 1 year	Change over 10 years
Biology	Total entrants	54,890	54,563	56,010	55,485	57,854	62,041	63,074	63,939	64,070	63,275	-1.2%	15.3%
	% Female	58.8%	58.7%	58.1%	57.3%	56.4%	56.6%	56.5%	57.8%	58.9%	60.6%	1.7%p	1.7%p
Chemistry	Total entrants	40,064	40,285	41,680	42,491	44,051	48,082	49,234	51,818	53,513	52,644	-1.6%	31.4%
	% Female	49.1%	49.8%	48.7%	48.4%	47.8%	47.3%	47.2%	47.9%	48.4%	49.1%	0.8%p	0.0%p
Computing	Total entrants	6,233	5,610	5,068	4,710	4,065	4,002	3,809	3,758	4,171	5,383	29.1%	-13.6%
	% Female	9.7%	10.2%	9.5%	9.6%	8.9%	7.5%	7.8%	6.5%	7.5%	8.5%	0.9%p	-1.2%p
ICT	Total entrants	14,208	13,360	12,277	11,948	12,186	11,960	11,088	10,419	9,479	9,124	-3.7%	-35.8%
	% Female	36.3%	37.3%	38.0%	38.6%	38.1%	39.1%	38.6%	37.7%	36.1%	35.7%	-0.4%p	-0.6%p
Mathematics	Total entrants	55,982	60,093	65,593	72,475	77,001	82,995	85,714	88,060	88,816	92,711	4.4%	65.6%
	% Female	39.1%	40.0%	39.4%	40.6%	40.6%	40.0%	40.0%	39.3%	38.7%	38.8%	0.1%p	-0.3%p
Further mathematics	Total entrants	7,270	7,872	9,091	10,473	11,682	12,287	13,223	13,821	14,028	14,993	6.9%	106.2%
	% Female	29.8%	29.4%	30.4%	31.3%	31.9%	31.2%	30.0%	28.6%	28.3%	27.9%	-0.5%p	-1.9%p
Physics	Total entrants	27,368	27,466	28,096	29,436	30,976	32,860	34,509	35,569	36,701	36,287	-1.1%	32.6%
	% Female	21.8%	22.2%	21.9%	22.2%	21.5%	20.8%	21.3%	20.7%	21.1%	21.5%	0.4%p	-0.3%p
Other science subjects	Total entrants	4,209	4,544	4,555	4,496	3,361	3,277	3,375	3,477	3,486	3,481	-0.1%	-17.3%
	% Female	27.1%	27.7%	27.0%	27.8%	21.5%	22.8%	22.6%	23.1%	22.8%	24.2%	1.4%p	-2.9%p
Design and technology/ technology subjects	Total entrants	18,684	17,417	17,396	17,442	18,417	18,249	17,105	14,374	13,691	13,240	-3.3%	-29.1%
	% Female	40.7%	41.9%	41.3%	41.5%	43.7%	42.2%	42.7%	41.4%	40.8%	40.5%	-0.4%p	-0.2%p
All subjects	Total entrants	805,698	805,657	827,737	846,977	853,933	867,317	861,819	850,752	833,807	850,749	2.0%	5.6%
	% Female	54.2%	54.2%	54.1%	53.9%	53.9%	53.7%	54.1%	54.2%	54.4%	54.9%	0.5%p	0.7%p

Source: Joint Council for Qualifications

Table 8.7 shows the proportion of students who progressed from AS to A levels (assuming that those who took A levels in 2015 took AS level examinations in the same subjects in the preceding year).

Taking an average across all subjects, females were more likely to progress to A level study than their male counterparts, at 61.6% to 58.6%. However, this pattern did not hold true for several key facilitating subjects, including physics, mathematics and further mathematics, where females were less likely than males to continue their studies at A level. Only 50.8% of female physics students went on to study the subject at A level, compared with 57.6% of males. At 6.8 percentage points, this was the largest gap in male/female progression rates of any subject, with the exception of ICT, where females were 7.4% percentage points more likely to progress to A level than males. Computing had the lowest overall progression rate at 46.5%, with only 41.6% of females and 47.0% of males continuing onto A level study.

Table 8.8 shows that, in 2015, mathematics was the most popular STEM subject at A level in England, Wales and Northern Ireland, attracting over 10% of pupils in all three nations. Physics was most popular in Northern Ireland, with 4.9% of pupils sitting the A level exam. However, across all nations, it was the least popular of all facilitating STEM subjects, with the exception of further mathematics. Entrants to computing saw the largest growth across all home nations, although curiously entrants to 'other sciences' grew by the largest amount of any subject in any nation, with 63.2% more pupils sitting the exam in Northern Ireland in 2015 than in 2014.

Table 8.7: Entrants to A level STEM subjects compared with entrants in AS level STEM subjects, by gender (2014-2015) – all UK candidates

		AS level entrant numbers 2014	A level entrant numbers 2015	A level entrant numbers as a proportion of AS level entrant numbers
Biology	Total	105,251	63,275	60.1%
	Male	43,032	24,955	58.0%
	Female	62,219	38,320	61.6%
Chemistry	Total	88,673	52,644	59.4%
	Male	45,084	26,771	59.4%
	Female	43,589	25,873	59.4%
Computing	Total	11,582	5,383	46.5%
	Male	10,485	4,927	47.0%
	Female	1,097	456	41.6%
ICT	Total	17,027	9,124	53.6%
	Male	11,463	5,870	51.2%
	Female	5,564	3,254	58.5%
Mathematics	Total	161,711	92,711	57.3%
	Male	97,999	56,774	57.9%
	Female	63,712	35,937	56.4%
Further mathematics	Total	24,530	14,993	61.1%
	Male	17,276	10,816	62.6%
	Female	7,254	4,177	57.6%
Physics	Total	64,790	36,287	56.0%
	Male	49,457	28,500	57.6%
	Female	15,333	7,787	50.8%
Other science subjects	Total	6,432	3,481	54.1%
	Male	4,716	2,640	56.0%
	Female	1,716	841	49.0%
Design and technology/ technology subjects	Total	23,774	13,240	55.7%
	Male	14,539	7,884	54.2%
	Female	9,235	5,356	58.0%
All subjects	Total	1,412,934	850,749	60.2%
	Male	654,479	383,350	58.6%
	Female	758,455	467,399	61.6%

Source: Joint Council for Qualifications

Table 8.8: Entrants to A level STEM subjects by UK home nation (2014-2015) – all UK candidates

		2014		2015		Change over 1 year	
		Entrants	Percentage of all subjects	Entrants	Percentage of all subjects	Entrants	Percentage of all subjects
Biology	England	58,111	7.6%	57,384	7.3%	-1.3%	-0.3%p
	Wales	2,801	7.9%	2,780	7.7%	-0.7%	-0.2%p
	Northern Ireland	3,158	10.0%	3,111	9.6%	-1.5%	-0.4%p
Chemistry	England	49,151	6.4%	48,467	6.2%	-1.4%	-0.2%p
	Wales	2,517	7.1%	2,334	6.5%	-7.3%	-0.6%p
	Northern Ireland	1,845	5.8%	1,843	5.7%	-0.1%	-0.1%p
Computing	England	3,826	0.5%	4,925	0.6%	28.7%	0.1%p
	Wales	239	0.7%	290	0.8%	21.3%	0.1%p
	Northern Ireland	106	0.3%	168	0.5%	58.5%	0.2%p
ICT	England	7,171	0.9%	6,778	0.9%	-5.5%	0.0%p
	Wales	874	2.5%	848	2.4%	-3.0%	-0.1%p
	Northern Ireland	1,434	4.5%	1,498	4.6%	4.5%	0.1%p
Mathematics	England	82,024	10.7%	85,648	10.9%	4.4%	0.2%p
	Wales	3,727	10.6%	3,735	10.4%	0.2%	-0.2%p
	Northern Ireland	3,065	9.7%	3,328	10.3%	8.6%	0.6%p
Further mathematics	England	13,403	1.7%	14,298	1.8%	6.7%	0.1%p
	Wales	435	1.2%	514	1.4%	18.2%	0.2%p
	Northern Ireland	191	0.6%	181	0.6%	-5.2%	0.0%p
Physics	England	33,599	4.4%	33,207	4.2%	-1.2%	-0.2%p
	Wales	1,553	4.4%	1,548	4.3%	-0.3%	-0.1%p
	Northern Ireland	1,549	4.9%	1,532	4.7%	-1.1%	-0.2%p
Other science subjects	England	3,131	0.4%	3,085	0.4%	-1.5%	0.0%p
	Wales	298	0.8%	303	0.8%	1.7%	0.0%p
	Northern Ireland	57	0.2%	93	0.3%	63.2%	0.1%p
Design and technology/ technology subjects	England	12,016	1.6%	11,491	1.5%	-4.4%	-0.1%p
	Wales	736	2.1%	727	2.0%	-1.2%	-0.1%p
	Northern Ireland	939	3.0%	1,022	3.2%	8.8%	0.2%p
All subjects	England	766,715		782,325		2.0%	
	Wales	35,492		36,034		1.5%	
	Northern Ireland	31,600		32,390		2.5%	

Source: Joint Council for Qualifications

Looking at which A level subjects saw the largest percentage growth in entrants shows that only three STEM subjects made the top ten: computing, further mathematics and mathematics. As one of the smallest A level subjects in terms of entrants, the rapid growth of computing (up 29.1%) is encouraging, but not surprising. Mathematics, however, is still the most popular of all subjects, with 92,711 entrants in 2015. This makes its 4.4% growth all the more significant.

Table 8.9: Top 10 A level subjects as percentage increase in the number of entrants (2014-2015) – all UK candidates

		2014	2015	Change over 1 year
1	Computing	4,171	5,383	29.1%
2	Spanish	7,601	8,694	14.4%
3	Geography	33,007	37,195	12.7%
4	Political studies	13,761	15,103	9.8%
5	History	52,131	55,848	7.1%
6	Mathematics (further)	14,028	14,993	6.9%
7	Religious studies	24,213	25,773	6.4%
8	Sociology	30,594	32,258	5.4%
9	English	85,336	89,499	4.9%
10	Mathematics	88,816	92,711	4.4%

Source: Joint Council for Qualifications

8.5 A level A*-C achievement rates[677]

Table 8.10 shows the percentage of A level students achieving a grade A*-C from 2006 to 2015. Achievement rates at A level are generally higher than for the same subjects at AS level. Overall, 77.3% of students sitting A level exams can expect to achieve grades between A* to C, compared with only 62.6% of those sitting AS level exams.

However, the achievement rate for several key facilitating STEM A levels has declined over the last year, falling by 0.7% percentage points for physics and mathematics. Computing saw the largest drop in the proportion of pupils achieving an A*-C grade, with the rate falling by 1.3 percentage points.

Furthermore, at 71.5%, the A*-C achievement rate is still lower for physics than for other STEM subjects, including biology (71.9%), chemistry (78.2%), mathematics (79.8%) and further mathematics (87.8%).

Research conducted by King's College London for the Nuffield Foundation calculated physics to be the third most difficult subject at A level. However, the same analysis found both chemistry and further mathematics to be more difficult.[678] This suggests the lower A*-C achievement rate for physics is not down to increased content difficulty, but either due to a lower-ability cohort, poorer teaching or more stringent assessment criteria compared with other STEM subjects.

Table 8.11 displays the calculated number of pupils achieving A levels at grades A*-C by gender. The A*-C achievement rate for females is higher across all STEM subjects and all subjects in general, with 79.6% of females on average achieving a good A level, compared with 74.5% of males.

Although the overall number of pupils achieving of A*to C grades has declined by 5.4% between 2014 and 2015, the decline was less marked for females. In 2015, 4.6% fewer females achieved a good A level, compared with 6.5% fewer males.

Mathematics saw considerable growth, with 2,486 more students achieving A levels at grade A*-C in 2015 than in 2014. However, the number of students gaining a good A level in physics declined by 553 (2.1%) over this same period.

Table 8.10: Proportion achieving grade A*-C at GCE A level (2006-2015) – all UK candidates

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change over 1 year	Change over 10 years
Further mathematics	87.9%	88.5%	88.9%	88.9%	89.8%	89.5%	89.4%	89.9%	87.8%	87.7%	-0.1%p	-0.2%p
Mathematics	79.9%	80.7%	81.3%	81.8%	81.7%	81.8%	81.6%	81.3%	80.5%	79.8%	-0.7%p	-0.1%p
Chemistry	74.2%	75.2%	76.3%	76.2%	75.8%	78.2%	79.1%	79.5%	78.0%	78.2%	0.2%p	4.0%p
Physics	68.9%	70.2%	70.6%	70.8%	72.9%	73.5%	74.0%	73.9%	72.2%	71.5%	-0.7%p	2.6%p
Biology	66.3%	67.7%	69.2%	70.2%	70.3%	73.3%	73.7%	73.7%	72.0%	71.9%	-0.1%p	5.6%p
Design and technology/ technology subjects	67.6%	68.6%	68.6%	69.1%	69.6%	70.2%	69.9%	70.1%	68.8%	68.4%	-0.4%p	0.8%p
Computing	57.8%	58.7%	59.0%	59.9%	61.3%	62.6%	60.8%	61.1%	61.3%	60.0%	-1.3%p	2.2%p
ICT	50.6%	53.0%	55.8%	56.9%	60.2%	60.6%	62.8%	65.1%	60.6%	58.6%	-2.0%p	8.0%p
Other science subjects	64.9%	67.4%	66.2%	69.0%	76.3%	75.2%	76.4%	76.3%	76.0%	77.6%	1.6%p	12.7%p
All Subjects	71.3%	72.8%	73.9%	75.1%	75.4%	76.2%	76.6%	77.2%	76.7%	77.3%	0.6%p	6.0%p

Source: Joint Council for Qualifications

677 Although Grades A* to G are considered a pass, only the A*-C achievement rate is considered as these are the grades which most universities will consider when enrolling students. 678 The Nuffield Foundation: Mathematics after 16: the state of play, challenges and ways ahead, 2014, p12.

Table 8.11: Number of GCE A level A*-C passes by gender (2014-2015) – all UK candidates

		2014			2015				
		Total number of students	Percentage A*-C	Calculated number of students obtaining a grade A*-C	Total number of students	Percentage A*-C	Calculated number of students obtaining a grade A*-C	Change in number of students obtaining grades A*-C	Percentage change in numbers of students obtaining a grade A*-C
Biology	Total	64,070	72.0%	46,130	63,275	71.9%	45,495	-635	-1.4%
	Male	26,346	70.9%	18,679	24,955	70.5%	17,593	-1086	-5.8%
	Female	37,724	72.8%	27,463	38,320	72.8%	27,897	434	1.6%
Chemistry	Total	53,513	78.0%	41,740	52,644	78.2%	41,168	-572	-1.4%
	Male	27,637	77.0%	21,280	26,771	78.0%	20,881	-399	-1.9%
	Female	25,876	79.1%	20,468	25,873	78.3%	20,259	-209	-1.0%
Computing	Total	4,171	61.3%	2,557	5,383	60.0%	3,230	673	26.3%
	Male	3,857	61.1%	2,357	4,927	59.8%	2,946	589	25.0%
	Female	314	64.6%	204	456	62.9%	287	83	40.6%
ICT	Total	9,479	60.6%	5,744	9,124	58.6%	5,347	-397	-6.9%
	Male	6,058	56.9%	3,447	5,870	54.6%	3,205	-242	-7.0%
	Female	3,421	67.2%	2,299	3,254	65.8%	2,141	-158	-6.9%
Mathematics	Total	88,816	80.5%	71,497	92,711	79.8%	73,983	2,486	3.5%
	Male	54,442	79.8%	43,445	56,774	79.4%	45,079	1,634	3.8%
	Female	34,374	81.6%	28,049	35,937	80.4%	28,893	844	3.0%
Further mathematics	Total	14,028	87.8%	12,317	14,993	87.7%	13,149	832	6.8%
	Male	10,053	87.3%	8,776	10,816	87.4%	9,453	677	7.7%
	Female	3,975	89.0%	3,538	4,177	88.6%	3,701	163	4.6%
Physics	Total	36,701	72.2%	26,498	36,287	71.5%	25,945	-553	-2.1%
	Male	28,958	71.1%	20,589	28,500	70.6%	20,121	-468	-2.3%
	Female	7,743	76.4%	5,916	7,787	74.9%	5,832	-84	-1.4%
Other science subjects	Total	3,486	76.0%	3,486	3,481	77.6%	2,701	-785	-22.5%
	Male	2,691	74.8%	2,013	2,640	76.9%	2,030	17	0.9%
	Female	795	80.1%	637	841	79.5%	669	32	5.0%
Design and technology/ technology subjects	Total	13,691	68.8%	9,419	11,491	68.4%	7,860	-1,559	-16.6%
	Male	8,100	65.0%	5,265	6,707	64.4%	4,319	-946	-18.0%
	Female	5,591	74.4%	4,160	4,784	74.3%	3,555	-605	-14.6%
All subjects	Total	833,807	76.7%	639,530	782,325	77.3%	604,737	-34,793	-5.4%
	Male	379,823	74.0%	281,069	352,862	74.5%	262,882	-18,187	-6.5%
	Female	453,984	78.9%	358,193	429,463	79.6%	341,853	-16,340	-4.6%

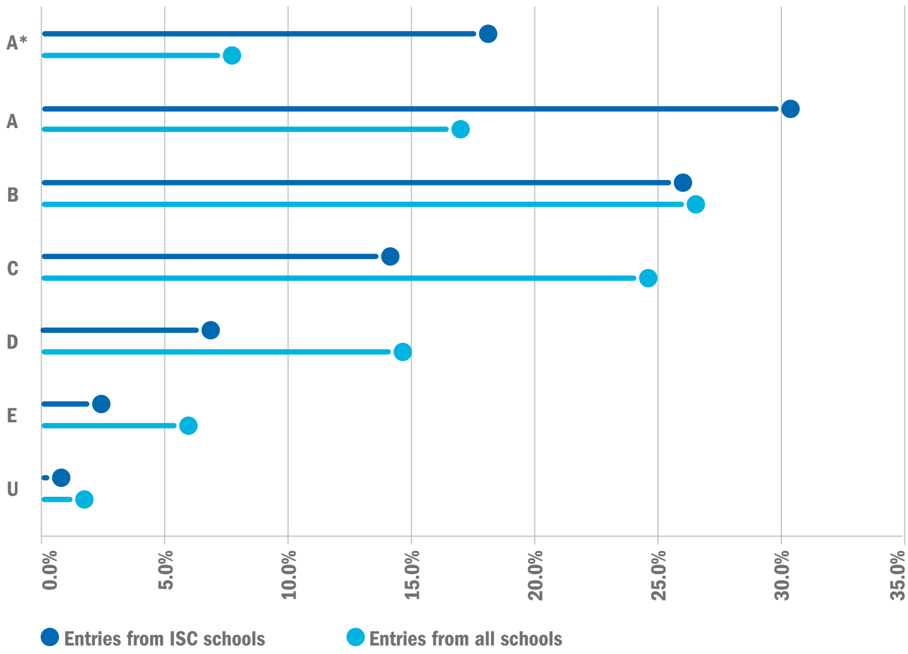
Source: Joint Council for Qualifications

Figure 8.2 displays data from the Independent Schools Council that shows the impact the type of school a pupil attends can have on their A level attainment.[679]

A level exam results from 2015 for 34,747 students who attended schools registered with the Independent Schools Council showed that 18.5% achieve an A* grade, compared with a national average of 8.2%.

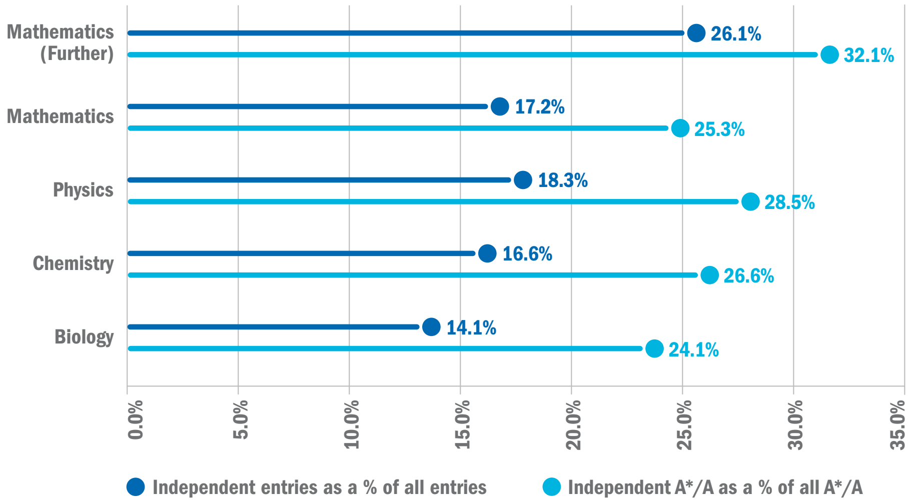
The independent schools sector is responsible for educating around 18% of pupils over the age of 16.[680] However, as Figure 8.3 shows, in 2014 students from independent schools were more likely to sit several key facilitating exams. For example, students from independent schools accounted for over a quarter of total entries to further mathematics, and 18.3% of those sitting physics. Furthermore, such students accounted for 28.5% of all those achieving an A* to A grade in physics, and almost a third of those (32.1%) achieving top grades in further mathematics.

Figure 8.2: Percentage of pupils achieving A*-U A level grades by school type (2015)[681]



Source: Joint Council for Qualifications

Figure 8.3: Independent A level entries and achievement as a percentage of total (2014)



Source: Joint Council for Qualifications

8.6 Vocational qualifications

Vocational qualifications at Key Stage 5 constitute an important part of post-16 education, and for many students offer a viable and more fitting alternative pathway to higher learning and career prospects than A levels.

For example, the proportion of 18-year-olds in England with a BTEC qualification and enrolled in higher education increased to 6.7% in 2014: the highest entry rate recorded. In the same year, 18-year-olds in England were 20% more likely to enter higher education with a BTEC than in 2013, and around 120% more likely than in 2006.[682]

Furthermore, BTEC qualifications offer progression to higher education for the brightest students, both in the UK and abroad. In 2014, the numbers of UK and EU students enrolling on government number-controlled higher education courses with the BTEC-equivalents of A level 'ABB+' grades, grew by 16%.[683]

However, young people do not regard BTEC (level 3) qualifications to be as challenging or valuable as A levels. In a recent survey by YouGov, 70% of young people and 57% of teachers disagreed that BTECs at level 3 are equivalent in challenge to A levels.

In an attempt to raise the recognition of post-secondary vocational education, the government has announced new Tech levels for 16- to 19-year-olds. Teaching for the first of these began in September 2014. Tech levels are new vocational qualifications at level 3 with an increased focus on practical and applied learning relevant to industry work. They are recognised by a relevant trade or professional body, or at least five registered employers representative of the industry sector that the qualification relates to. The first set of results for Tech levels will be reported in 2016 performance tables, which are due to be published in early 2017.[684] Students who take one or more Tech levels, a maths qualification at level 3, and undertake an extended project, achieve the Technical Baccalaureate or TechBacc standard.[685]

Table 8.12 shows the number of students completing level 3 BTECs in selected STEM subjects from 2005/6 to 2014/15. In contrast to the general decline in BTEC completion at level 2, there has been growth at level 3, with 359,340 completions in 2015 – an increase of 3.5%. Those completing level 3 BTECs in engineering increased by nearly 10%, from 16,076 in 2014 to 17,657 in 2015. In fact, uptake in level 3 engineering BTECs has grown rapidly over the last 10 years, with completions tripling since 2005/06. Encouragingly, the percentage of female students completing a BTEC in engineering also grew from 4.6% in 2014 to 5.1% in 2015.

679 Data was collected from 499 Independent Schools Council schools covering a total of 37,155 candidates. 680 Independent schools council: available at http://www.isc.co.uk/research/. 681 Independent Schools Council: A comparison of A level results in 2014 between independent schools and state schools and FE colleges in England, 2014, p1-2 682 UCAS: End of cycle report, December 2014, pii 683 UCAS: Four per cent rise in UK and EU students starting university and college courses. 23rd September 2014 – available at: http://www.ucas.com/news-events/news/2014/four-cent-rise-uk-and-eu-students-starting-university-and-college-courses 684 The Department for Education: 2016 16 to 19 performance tables: inclusion of tech levels, March 2014, p3 685 The Department for Education: 2010 to 2015 government policy: further education and training, March 2015

Table 8.12: Number of students completing selected STEM BTEC subjects at level 3, by gender and age (2005/06-2014/15) – all domiciles

		2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change over 1 year	Change over 10 years
Biology	UK	76	129	145	291	730	760	499	610	658	708	7.6%	831.6%
	International	0	0	0	0	0	0	0	0	0	0		
	Female	48	75	80	157	378	397	269	367	401	442	10.2%	820.8%
	Aged under 19	48	89	97	233	617	657	429	511	568	607	6.9%	1164.6%
	Aged 19-24	21	34	45	55	110	99	70	98	90	100	11.1%	376.2%
	Aged 25+	7	6	3	3	3	4	0	1	0	1		
	Total	**76**	**129**	**145**	**291**	**730**	**760**	**499**	**610**	**658**	**708**	**7.6%**	**831.6%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		
	Percentage female	63.2%	58.1%	55.2%	54.0%	51.8%	52.2%	53.9%	60.2%	60.9%	62.4%	1.5%p	-0.7%p
Chemistry	UK	13	23	27	82	82	68	53	56	70	22	-68.6%	69.2%
	International	0	0	0	0	0	0	0	0	0	0		
	Female	8	7	12	36	29	30	23	23	34	15	-55.9%	87.5%
	Aged under 19	2	3	10	47	51	56	33	37	44	18	-59.1%	800.0%
	Aged 19-24	4	13	11	24	21	11	15	18	19	4	-78.9%	0.0%
	Aged 25+	7	7	6	11	10	1	5	1	6	0		-100.0%
	Total	**13**	**23**	**27**	**82**	**82**	**68**	**53**	**56**	**70**	**22**	**-68.6%**	**69.2%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		
	Percentage female	61.5%	30.4%	44.4%	43.9%	35.4%	44.1%	43.4%	41.1%	48.6%	68.2%	19.6%p	6.6%p
Physics	UK	3	2	18	32	28	31	16	21	36	75	108.3%	2400.0%
	International	0	0	0	0	0	0	0	0	0	0		
	Female	0	2	7	12	8	5	2	4	13	20	53.8%	
	Aged under 19	1	1	6	17	14	28	15	13	29	62	113.8%	6100.0%
	Aged 19-24	2	1	12	11	13	3	1	8	7	13	85.7%	550.0%
	Aged 25+	0	0	0	4	1	0	0	0	0	0		
	Total	**3**	**2**	**18**	**32**	**28**	**31**	**16**	**21**	**36**	**75**	**108.3%**	**2400.0%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		
	Percentage female	0.0%	100.0%	38.9%	37.5%	28.6%	16.1%	12.5%	19.0%	36.1%	26.7%	-9.4%p	26.7%p
Engineering	UK	3,829	4,199	4,643	5,796	7,364	7,501	9,335	13,009	15,652	17,451	11.5%	355.8%
	International	369	161	136	105	73	88	265	146	424	206	-51.4%	-44.2%
	Female	203	176	177	210	308	314	409	526	740	893	20.7%	339.9%
	Aged under 19	1,414	1,866	2,240	2,754	3,226	3,522	5,134	7,637	9,663	10,844	12.2%	666.9%
	Aged 19-24	2,235	2,068	2,128	2,632	3,597	3,505	3,726	4,820	5,596	5,890	5.3%	163.5%
	Aged 25+	545	425	411	514	614	562	740	697	815	921	13.0%	69.0%
	Total	**4,198**	**4,360**	**4,779**	**5,901**	**7,437**	**7,589**	**9,600**	**13,155**	**16,076**	**17,657**	**9.8%**	**320.6%**
	Percentage non-UK	9.6%	3.8%	2.9%	1.8%	1.0%	1.2%	2.8%	1.1%	2.6%	1.2%	-1.5%p	-8.5%p
	Percentage female	4.8%	4.0%	3.7%	3.6%	4.1%	4.1%	4.3%	4.0%	4.6%	5.1%	0.5%p	0.2%p

Table 8.12: Number of students completing selected BTEC subjects at level 3, by gender and age (2005/06-2014/15) – all domiciles – continued

		2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change over 1 year	Change over 10 years
Construction	UK	2,573	2,891	3,586	3,943	3,958	3,099	3,504	3,796	3,757	3,719	-1.0%	44.5%
	International	32	113	61	47	37	34	44	46	104	192	84.6%	500.0%
	Female	286	371	416	457	373	290	291	316	300	327	9.0%	14.3%
	Aged under 19	916	1,084	1,443	1,678	1,707	1,415	1,639	1,802	1,761	1,751	-0.6%	91.2%
	Aged 19-24	1,165	1,342	1,610	1,727	1,637	1,266	1,442	1,521	1,536	1,602	4.3%	37.5%
	Aged 25+	523	577	594	582	651	452	467	518	563	558	-0.9%	6.7%
	Total	**2,605**	**3,004**	**3,647**	**3,990**	**3,995**	**3,133**	**3,548**	**3,842**	**3,861**	**3,911**	**1.3%**	**50.1%**
	Percentage non-UK	1.2%	3.9%	1.7%	1.2%	0.9%	1.1%	1.3%	1.2%	2.8%	4.9%	2.1%p	3.7%p
	Percentage female	11.0%	12.4%	11.4%	11.5%	9.3%	9.3%	8.2%	8.2%	7.8%	8.4%	0.6%p	-2.6%p
All subjects (including STEM and non-STEM)	UK	86,521	106,983	124,385	148,243	179,941	210,967	254,751	314,359	343,957	355,856	3.5%	311.3%
	International	2,144	1,959	2,051	2,064	1,629	1,782	3,693	2,558	3,321	3,484	4.9%	62.5%
	Female	38,754	48,471	55,951	67,105	81,135	95,905	117,424	143,296	156,197	161,598	3.5%	317.0%
	Aged under 19	44,718	56,770	68,419	86,481	106,817	131,064	169,479	218,214	251,475	265,401	5.5%	493.5%
	Aged 19-24	37,811	46,010	51,915	57,757	68,288	75,215	82,007	91,186	88,866	87,311	-1.7%	130.9%
	Aged 25+	6,071	6,135	6,089	6,051	6,450	6,452	6,945	7,506	6,921	6,617	-4.4%	9.0%
	Total	**88,665**	**108,942**	**126,436**	**150,307**	**181,570**	**212,749**	**258,444**	**316,917**	**347,278**	**359,340**	**3.5%**	**305.3%**
	Percentage non-UK	2.5%	1.8%	1.6%	1.4%	0.9%	0.8%	1.4%	0.8%	1.0%	1.0%	0.0%p	-1.5%p
	Percentage female	43.7%	44.5%	44.3%	44.6%	44.7%	45.1%	45.4%	45.2%	45.0%	45.0%	0.0%p	1.3%p

Source: Pearson

Table 8.13 shows that at level 3, in 2013/14 there were 12,648 completions in vocational subjects recorded by OCR, a decline of 5.1%. Students completing level 3 vocational subjects in ICT and computing fell by 11.8% from 7,138 in 2014 to 6,295 in 2015.

Table 8.13: Number of students completing other selected vocational STEM subjects at level 3, by gender and age (2004/05-2013/14) – all domiciles

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 10 years
ICT/ computing	UK	0	0	0	0	82	1,986	3,998	5,663	7,135	6,293	-11.8%	
	International	0	0	0	0	0	4	2	2	3	2	-33.3%	
	Female	0	0	0	0	18	690	1,497	2,023	2,461	2,067	-16.0%	
	Aged under 19	0	0	0	0	56	1,687	3,401	4,978	6,458	5,825	-9.8%	
	Aged 19-24	0	0	0	0	22	300	593	685	676	466	-31.1%	
	Aged 25+	0	0	0	0	4	3	6	2	4	4	0.0%	
	Total	**0**	**0**	**0**	**0**	**82**	**1,990**	**4,000**	**5,665**	**7,138**	**6,295**	**-11.8%**	
	Percentage non-UK					0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	-0.1%p	
	Percentage female					9.9%	14.8%	15.8%	15.2%	14.7%	32.8%	18.13%p	
All subjects (including STEM and non-STEM)	UK	339	983	2,674	3,380	4,562	7,578	9,979	11,789	13,319	12,646	-5.1%	3630.4%
	International	0	8	0	0	0	4	2	2	3	2	-33.3%	
	Female	220	546	1,619	2,004	2,678	3,913	5,000	5,610	6,008	5,828	-3.0%	2549.1%
	Aged under 19	214	681	1,957	2,433	3,239	5,844	7,795	9,815	11,675	11,369	-2.6%	5212.6%
	Aged 19-24	98	271	664	860	1,202	1,614	2,089	1,938	1,634	1,266	-22.5%	1191.8%
	Aged 25+	27	39	53	87	121	124	97	38	13	13	0.0%	-51.9%
	Total	**339**	**991**	**2,674**	**3,380**	**4,562**	**7,582**	**9,981**	**11,791**	**13,322**	**12,648**	**-5.1%**	**3631.0%**
	Percentage non-UK	0.0%	0.8%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%		
	Percentage female	64.9%	55.1%	60.5%	59.3%	58.7%	51.6%	50.1%	47.6%	45.1%	46.1%	1.0%p	-18.8%p

Source: OCR

8.7 Scottish qualifications

Highers and Advanced Highers are single year courses roughly equivalent to AS and A levels. Highers and Advanced Highers are two distinct qualifications; an Advanced Higher does not subsume a Higher, in the same way that new A levels are decoupled from new AS levels.[686] UCAS notes that students generally take four or five Highers at S5, as the predominant route into Scottish higher education. However, students may choose to study for an additional year and sit an Advanced Highers examination for a several reasons, such as not feeling ready to progress onto higher education.[687] Students in possession of 2 or 3 Advanced Highers are able to enter directly into the second year of an honours degree or be exempted from certain subjects during their first year.[688]

In 2015, pupils in Scotland sat new Highers qualifications for the first time. These have been designed to provide a greater depth of learning, more closely aligned with the objectives of Education Scotland's Curriculum for Excellence (CfE). However, the new Higher Qualifications have had a difficult inaugural year, with the Scottish Qualifications Authority (SQA) conceding that the mathematics exam was too difficult compared to previous years', and adjusting grade boundaries to ensure that students sitting the new Highers were not unfairly discriminated against.[689]

From 2015, pupils will be eligible to study a new Advanced Highers examination, although there have been calls to delay its introduction due to pressure on schools and teachers.[690]

Table 8.14 shows the number of entries to the old Higher qualifications and the percentage of students achieving an A grade (roughly equivalent to an A level grade A-C) from 2014 to 2015.

As expected, entries have declined by 51.8% as the newer Highers are phased in. However, averaging all subjects, the percentage of pupils achieving an A grade rose by 2.1%, with the proportion of pupils achieving top grades in physics rising even more, by 2.6%.

Table 8.15 considers entries and attainment of new Higher qualifications in STEM subjects. It shows that the percentage achieving top grades across all subjects (29%), is on a par with the previous version of Highers (29.8%). However, there is a large disparity between the older and new qualifications for several key subjects. For example, 30.0% of students sitting the previous physics Higher exam could be expected to achieve an A grade, compared with only 23.5% of those sitting the newer exam. The lower grade A achievement rate was also the case for students sitting new Highers in biology (new 26.3% vs old 28.5%), and chemistry (new 22.0% vs old 30.6%).

Table 8.14: Attainment in selected STEM old Higher qualifications (2014-2015) – Scotland

Subjects		2014	2015	Change over 1 year
Biology	Entries	10,197	7,127	-30.1%
	Percentage A grade	25.0%	28.5%	3.5%p
	Number A grade	2,547	2,033	-20.2%
Chemistry	Entries	10,716	6,392	-40.4%
	Percentage A grade	30.1%	30.6%	0.5%p
	Number A grade	3,222	1,958	-39.2%
Chemistry (revised)	Entries	702	481	-31.5%
	Percentage A grade	35.3%	30.1%	-5.2%p
	Number A grade	248	145	-41.5%
Computing	Entries	4,468	3,008	-32.7%
	Percentage A grade	24.1%	19.3%	-4.8%p
	Number A grade	1,079	581	-46.2%
Human biology	Entries	3,943	2,840	-28.0%
	Percentage A grade	20.8%	19.3%	-1.5%p
	Number A grade	820	548	-33.2%
Human biology (revised)	Entries	213	176	-17.4%
	Percentage A grade	16.0%	26.1%	10.2%p
	Number A grade	34	46	35.3%
Information systems	Entries	1,059	487	-54.0%
	Percentage A grade	11.6%	16.6%	5.0%p
	Number A grade	123	81	-34.1%
Mathematics	Entries	21,851	10,854	-50.3%
	Percentage A grade	25.3%	25.0%	-0.3%p
	Number A grade	5,536	2,714	-51.0%
Physics	Entries	9,098	5,401	-40.6%
	Percentage A grade	27.4%	30.0%	2.6%p
	Number A grade	2,490	1,620	-34.9%
Physics (revised)	Entries	1,111	717	-35.5%
	Percentage A grade	36.0%	36.8%	0.8%p
	Number A grade	400	264	-34.0%
Product design	Entries	2,369	616	-74.0%
	Percentage A grade	12.8%	17.5%	4.7%p
	Number A grade	303	108	-64.4%
Technological studies	Entries	772	143	-81.5%
	Percentage A grade	37.7%	37.1%	-0.6%p
	Number A grade	291	53	-81.8%
All subjects	Entries	191,850	92,555	-51.8%
	Percentage A grade	27.7%	29.8%	2.1%p
	Number A grade	53,175	27,558	-48.2%

Source: Scottish Qualifications Authority

686 UCAS: Expert group report for seeking admission to UCAS tariff, Scottish Highers and Advanced Highers, July 2008, p9. 687 *Ibid.* 688 *Ibid*, p18 689 The Independent: SQA exam results 2015: Exam board admits Higher Maths paper for Scotland's students was 'too hard', 04 August 2015 690 The Telegraph: SNP 'must delay new Advanced Higher for a year', 31st January 2015

Table 8.15: Attainment in selected STEM new Higher qualifications (2015) – Scotland

Subjects		
Biology	Total entries	2,572
	Percentage A grade	26.3%
	Number A grade	677
Administration and IT	Total entries	3,025
	Percentage A grade	42.8%
	Number A grade	1,296
Chemistry	Total entries	4,020
	Percentage A grade	22.0%
	Number A grade	885
Computing science	Total entries	1,182
	Percentage A grade	16.1%
	Number A grade	190
Design and manufacture	Total entries	2,224
	Percentage A grade	18.7%
	Number A grade	416
Engineering science	Total entries	881
	Percentage A grade	25.9%
	Number A grade	228
Fashion and textile technology	Total entries	213
	Percentage A grade	48.4%
	Number A grade	103
Health and food technology	Total entries	943
	Percentage A grade	21.1%
	Number A grade	199
Mathematics	Total entries	10,220
	Percentage A grade	19.7%
	Number A grade	2,015
Music technology	Total entries	280
	Percentage A grade	47.5%
	Number A grade	133
Physics	Total entries	3,662
	Percentage A grade	23.5%
	Number A grade	862
All subjects	Total entries	107,295
	Percentage A grade	29.3%
	Number A grade	31,491

Source: Scottish Qualifications Authority

Table 8.16 shows the entries and achievement of top grades for Advance Highers in STEM subjects. Overall, entries increased by 4.1% to 23,348 in 2015. However, total entries to physics grew by a much lower amount – only 1.2%, from 1,815 to 1,845 in 2015. Furthermore, the percentage of those achieving top grades in this subject decreased slightly, from 80.3% in 2014 to 78.1% in 2015 – falling below the all-subject average of 80.9%. This is in contrast to other STEM subjects such as chemistry and biology, with the proportion of those achieving grades A-C increasing by 3.6% and 3.9% respectively.

Table 8.16: Attainment in selected STEM Advanced Higher qualifications (2014-2015) – Scotland

Subjects		2014	2015	Change over 1 year
Applied mathematics	Total entries	346	403	16.5%
	Percentage A-C grade	81.8%	81.4%	-0.4%p
	Number A-C grade	283	328	15.9%
Biology	Total entries	2,518	2,425	-3.7%
	Percentage A-C grade	73.0%	76.9%	3.9%p
	Number A-C grade	1,837	1,865	1.5%
Chemistry	Total entries	2,393	2,448	2.3%
	Percentage A-C grade	76.4%	80.0%	3.6%p
	Number A-C grade	1,829	1,958	7.1%
Chemistry (revised)	Total entries	278	335	20.5%
	Percentage A-C grade	81.3%	82.7%	1.4%p
	Number A-C grade	226	277	22.6%
Computing	Total entries	440	509	15.7%
	Percentage A-C grade	84.1%	84.9%	0.8%p
	Number A-C grade	370	432	16.8%
Mathematics	Total entries	3,443	3,641	5.8%
	Percentage A-C grade	70.1%	68.6%	-1.5%p
	Number A-C grade	2,414	2,496	3.4%
Physics	Total entries	1,815	1,845	1.7%
	Percentage A-C grade	80.3%	78.1%	-2.2%p
	Number A-C grade	1,458	1,441	-1.2%
All subjects	Total entries	22,430	23,348	4.1%
	Percentage A-C grade	81.0%	80.9%	-0.1%p
	Number A-C grade	18,171	18,899	4.0%

Source: Scottish Qualifications Authority

Part 2 – Engineering in Education and Training
9.0 The further education sector

The number of engineering related achievements in vocational qualifications fell by 17.9% from 1,116,200 in 2012/13 to 916,500 in 2013/14. However, this decline has been centred on lower level qualifications and those that do not fall under the Qualifications and Curriculum framework. In contrast, there has been growth for higher level vocational qualifications, with the number of QCF achievements at level 3 growing by 17.0% to 170,800 and level 4+ achievements increasing 32.6% to 12,600. Several new study programmes such as tech levels and technical baccalaureates have been established, with the aim of providing learners with both vocational and academic training. However, it is not yet clear whether these new qualifications will be held in equal regard to A levels by universities, colleges and employers.

Further education (FE) is a diverse and multi-faceted sector, which aims to meet the needs of a wide variety of learners. Although much debate and discussion centres on academic education, it is well worth noting that 51% of 16- to 19-year-olds in full-time education are undertaking some kind of technical or vocational qualification.[691]

9.1 Further education in the UK

As Table 9.1 details, in 2015 there were 355 colleges in England, of which 60.8% (216) were general further education colleges.

Table 9.1: Further education colleges by nation (2015) – UK

England		335
	General further education colleges	216
	Sixth form colleges	93
	Land-based colleges	14
	Art, design and performing arts colleges	2
	Specialist designated colleges	10
Scotland		26
Wales		15
Northern Ireland		6
UK total		382

Source: Association of Colleges[692]

In 2013/14, around 3.9 million learners were engaged in government-funded education or training in the FE and skills sector – a slight increase on last year's figure of 3.7 million. Of these, around 2.9 million were adults. An estimated 850,000 were apprentices of all ages and 10,500 learners were on traineeships, new frameworks designed to prepare learners to undertake an apprenticeship.[693]

691 Skills Commission: Guide to the Skills System, 6th of July 2015, p20 692 Key Further Education Statistics: Number and list of Colleges June 2015, Association of Colleges, June 2015 [Accessed 13 September 2015]; https://www.aoc.co.uk/about-colleges/research-and-stats/key-further-education-statistics 693 Ofsted: Annual Report 2013/14: further education and skills, December 2014, p7

However, the total number of achievements of FE qualifications has decreased, from over 5,000,000 in 2012/13 to 4,500,000 in 2013/14. This suggests a slight streamlining of the FE sector, with more individuals achieving a smaller number of qualifications.

However, despite the large number of people actively involved in FE, it is still not as highly regarded as academic alternatives. Furthermore, due to the diversity of provision and a lack of clarification of its aims, the sector in general has failed to provide clear and compelling routes to higher level technical and vocational skills development. This situation is particularly concerning in light of the fact that almost 3 in 10 vacancies were reported to be hard to fill in 2013, due to applicants lacking appropriate technical and practical job-specific skills.[694]

The further education sector is undergoing substantial reform and consolidation at present. Although in 2014 Ofsted rated 81% of all providers to be either good or outstanding, up from 64% in 2012, the precise remit of the sector is ill-defined and poorly understood.[695]

The government's reform plan for vocational qualifications in England was published in March 2014.[696] It identified that the large numbers of learning aims offered to adults by a wide range of awarding organisations led to an FE sector that was needlessly complex, causing confusion among learners and employers about the value of different qualifications. As BIS notes, the notion of 'further education' as a generic term for all non-university, post-school education is outdated, and "represents a dangerous conflation of two very different types of training".[697]

The Association of Colleges notes that governmental policy over the last two decades has led to a two-tier system of tertiary education, predicated on the assumption that the FE sector would primarily concentrate on courses below degree level.[698] As a result, higher technical and vocational education is often held in lower regard than traditional academic routes. For example, in a recent survey on perceptions of qualifications, 71% of teachers and 67% of young people disagreed that BTECs (level 1/level 2) are valued as highly as GCSEs by higher education institutes. Furthermore, 70% of young people disagreed that BTECs (level 3) are equivalent in challenge to A levels. The majority of head teachers (52%) and teachers (57%) also had the same opinion.[699] However, recent admissions statistics from UCAS are beginning to challenge the conventional wisdom that

BTECs are a sub-par alternative to traditional academic routes to HE. For example, in 2014 the proportion of the 18-year-old population in England who entered higher education and held a BTEC qualification increased to 6.7%, the highest entry rate recorded.[700]

This artificial divide between FE and HE has arguably compounded the UK's weaknesses in educating and training people for intermediate and advanced level technical skills. With respect to higher level vocational training, it is regrettable to note that England ranks 16th out of 20 OECD countries for the proportion of adults who hold vocational post-secondary qualifications equivalent to a degree or higher.[701]

The OECD found that fewer than one in ten 25- to 40-year-olds in England have a post-secondary vocational qualification as their highest qualification. In contrast, the OECD reports that:

- In the US, over one fifth (22%) of the labour force have associate degrees or post-secondary certificates.
- In Austria, around 20% hold a post-secondary vocational qualification.
- In South Korea, a third of each age cohort studies in a polytechnic.[702]

There is increasing awareness across the political spectrum that the lack of advanced technical skills is having a detrimental impact on the British economy. For example, BIS notes that a lack of advanced technical skills among the workforce is a drag on the UK's productivity.[703]

In response, the government has acted to define a clearer remit for the FE sector. Firstly, its role is to provide vocational education aligned with the requirements of the workplace and employers, with a focus on progression to higher level professional and technical skills. Secondly, it should provide remedial education for those who have not succeeded in the traditional school system.

It is worth noting that BIS estimates that there are 8.1 million adults in England who do not have the numeracy expected of an 11-year-old child leaving primary school.[704] Furthermore, a report by the Institute for Employment Studies found that 30% of the working adults surveyed would consider studying at higher education at some point in the future. However, they want flexibility to study vocational subjects in their locality in the evenings, at weekends or part-time.[705] In addition, the Sutton Trust highlights that almost 40% of BTEC learners are aged 27 or older when they achieve their degree, compared with only about 10% of A level learners. This fact attests to the pivotal role that the FE sector can play in improving social mobility and building ladders for second chance learners.[706]

To achieve this 'dual mandate' and simplify the FE sector, there has been a large shift in the profile of vocational qualification achievements, with the government introducing multiple reforms over successive years. This has led to some confusion over the structure of FE qualifications. The following trouble-shooter is provided to clarify subsequent discussion.

694 *Ibid*, p22 695 Ofsted: Annual Report 2013/14: further education and skills, December 2014, p7 696 Department for Business, Innovation & Skills: Vocational qualification reform plan, 5th March 2014 697 Department for Business, Innovation & Skills: A dual mandate for adult vocational education, a consultation paper, March 2015. p35 698 Association of Colleges: Breaking the Mould Creating higher education fit for the future, 2014, p7 699 OfQual: Perceptions of A Levels, GCSEs and Other Qualifications in England, June 2015, p13. 700 UCAS: End of Cycle Report, December 2014, pii. 701 Department for Business, Innovation & Skills: A dual mandate for adult vocational education, a consultation paper, March 2015, p22 702 *Ibid*, p33 703 Higher Education Policy Institute: Raising productivity by improving higher technical education: Tackling the Level 4 and Level 5 conundrum, 16th July 2015 704 Department for Business, Innovation & Skills: A dual mandate for adult vocational education, a consultation paper, March 2015, p16 705 Institute for Employment Studies: University is Not Just for Young People: Working Adults' Perceptions of and Orientation to Higher Education, 2008, p51 706 The Sutton Trust: Higher Ambitions Summit Rapporteur Report, 2014, p6.

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FE qualifications trouble-shooter

Qualifications relevant to the FE sector, fall under two main frameworks:

- National Qualifications Framework (NQF)
- Qualifications and Credit Framework (QCF)

The NQF was established to aid employers in understanding the relationship and equivalency between different qualifications. However, in 2008 the QCF was launched, which included information on not only the level of qualifications but also their length.[707]

Since the introduction of the QCF, vocational qualifications such as National (and Scottish) Vocational Qualifications (NVQs/SVQs) and Vocational Related Qualifications (VRQs) which fall under the NQF framework have rapidly declined, and have been replaced by qualifications adhering to QCF guidelines. Somewhat confusingly, however, new QCF qualifications may still be nominally identified as NVQs or VRQs, due to the value that such titles may have in a particular market or sector.[708]

N/SVQs

N/SVQs, were introduced in 1987, and measure the **level** of skills and knowledge needed to demonstrate competency in the area of work related to the subject studied. They are only available to those currently in employment, and are measured by performance based assessments such as a portfolio and observation of tasks by an assessor.[709]

VRQs

In contrast to competence-based qualifications such as NVQs, VRQs are knowledge-based, and involve study related to a particular vocation. Assessment usually takes place by written test. NVQs can only be taken whilst at work, but VRQs can be taken at school or college.[710]

QCFs

A QCF is not a qualification, but a framework that denotes the level and length of a qualification. There are three types of QCF qualifications: Awards (1 to 12 credits); Certificates (13 to 36 credits) and Diplomas (37 credits or more). Each credit is roughly equivalent to 10 hours of study.

All three types of QCF can be achieved at any level. This is because the 'type' indicates the size of the qualification, rather than its difficulty. The title of a QCF qualification contains information about its content, size and level (entry level to level 8). This enables a prospective student to assess the suitability of any QCF qualification easily. For example, a BTEC Professional Diploma level 4 is a qualification at level 4 difficulty, which involves 370 or more hours of study.[711]

However, in December 2014, the government announced plans to withdraw QCFs and replace them with a new Framework for Regulated Qualifications (FRQs). The government is currently consulting on the exact features of the new qualifications framework. However, it is intended to be simpler and less prescriptive than QCFs, resulting in more freedom for qualifications to be tailored to the needs of specific employers of local industries.[712]

9.2 New government initiatives

To create a more level playing field between vocational and academic study, and to provide clear and accessible progression routes to higher technical and vocational education, the government has announced a range of new qualifications in recent years:

Tech awards

From September 2015, pupils aged 14 to 16 years old will be eligible to study up to three Technical awards alongside five core GCSEs. Tech awards are vocational qualifications related to the world of work that are designed to provide pupils with an initial step on the path to higher level vocational study, whilst still attaining a firm academic grounding in core subjects at level 2.[713]

Tech levels

Tech levels are level 3 (advanced) qualifications, equivalent to A levels for students wishing to specialise in a technical occupation or occupational group. They are recognised by a relevant trade or professional body, or at least five employers registered with Companies House that are representatives of the industry, sector or occupation to which the qualification relates. In addition, many higher education institutions have also pledged support for Tech levels.[714]

Tech Bacc

The Technical Baccalaureate (Tech Bacc) is not a new qualification, but a programme made up of three core elements. These are a tech level or other advanced (level 3) vocational or work-related qualification (such as a BTEC); a level 3 maths qualification (such as AS level maths or the new core maths); and an extended project qualification (EPQ), designed to develop and test students' skills in extended writing, communication and research. Tech Baccs were introduced for courses starting in September 2014, and performance tables for 16- to 19-year-olds will be available from 2016.

To incentivise provision, Tech Bacc programmes that are equivalent to, or larger than, four A levels will be eligible for a 10% uplift in funding from 2016/17. In addition, Tech Bacc programmes that are equivalent to, or larger than, the full level 3 International Baccalaureate will be eligible for a 20% uplift in funding.[715]

Traineeships

Traineeships were introduced in August 2013 and are designed to prepare young people for apprenticeships or work. They last between six weeks and six months, and include work preparation training, English and maths, and a high-quality work placement.

The core target group for traineeships is young people who:

- are not currently in a job and have little work experience, but who are focused on work or the prospect of it
- are 16 to 19 years old and qualified below level 3, or 19 to 24 years old and have not yet achieved a full level 2
- providers and employers believe have a reasonable chance of being ready for employment or an apprenticeship within six months of engaging in a traineeship.[716]

University technical colleges

University technical colleges (UTCs) are an exciting recent initiative that has the potential to positively impact the uptake and quality of technical STEM education.

UTCs are academy schools for 14- to 18-year-olds, where STEM skills are valued highly. Students take technical courses in STEM subjects alongside a broad general education and a focus on employability skills. UTCs are sponsored by universities, FE colleges and employers, all of whom are involved in the development and delivery of the curriculum. This ensures that students are equipped with high level specialist knowledge that is highly relevant to STEM jobs.[717] In 2014, 50 colleges were open or in development, which created 27,000 opportunities for young people to train as engineers and scientists.[718] Furthermore, the government has pledged to open 20 new UTCs each year.[719]

707 UK Government online article June 2015 – Available at: https://www.gov.uk/what-different-qualification-levels-mean/overview **708** Ofqual: Operating rules for using the term 'NVQ' in a QCF qualification title, 2008, p3 **709** City and Guilds, 2015 – Online article available at: http://www.cityandguilds.com/qualifications-and-apprenticeships/qualifications-explained/nvqs-svqs-keyskills-vocational-skillsforlife **710** OCR: Employers guide to qualifications, 2007, p4. **711** Department for Business, Innovation and Skills: Vocational qualifications commentary, 25th March 2015, p1. **712** OfQual: After the QCF A New Qualifications Framework, March 2015, p3 **713** Department for Education: Press release – Tech Awards to boost vocational education for 14- to 16-year-olds, June 2014 **714** *Ibid*. **715** Department for Education: The Technical Baccalaureate Performance Table Measure, October 2014 **716** Skills Funding Agency: Traineeships, 22 May 2015 **717** The Royal society: Vision for Science and Mathematics Education, June 2014, p35. **718** Department for Education Skills: Perkins Engineering Review Progress Report, November 2014, p3. **719** The Royal society: Vision for Science and Mathematics Education, June 2014, p35

Recognising vocational pathways to professional registration

The engineering profession has always supported and driven high quality vocational pathways to professional registration, and welcomed the requirement for Tech level qualifications in published performance tables to be recognised by a relevant professional engineering institution.[720] This will ensure that they align with the Engineering Council's standards for underpinning knowledge[721] and with the UK Standard for Professional Engineering Competence (UK-SPEC)[722] and the Information and Communications Technology (ICT) Technician Standard,[723] enabling the approval of more pathways leading to Engineering Technician (EngTech), ICT Technician (ICTTech) and Incorporated Engineer (IEng) registration.

UK-SPEC and the ICTTech standards provide a globally-recognised measure of competence and commitment to continuing professional development. For employers, a professionally-registered workforce demonstrates commitment to engineering competence on a global level, and the ability to develop and attract a high quality workforce, ultimately increasing their global competitiveness.

The Engineering Council, together with the professional engineering institutions, have supported awarding organisations to ensure that Tech Level qualifications align with its standards. Those qualifications that have formally gained 'approved for the purposes of professional registration' status can be recognised through the use of the Engineering Council Approved Qualification logo. All approved qualifications are listed on the Engineering Council's website.[724]

Engineering Council approved qualification

Engineering Council cymhwyster cymeradwy

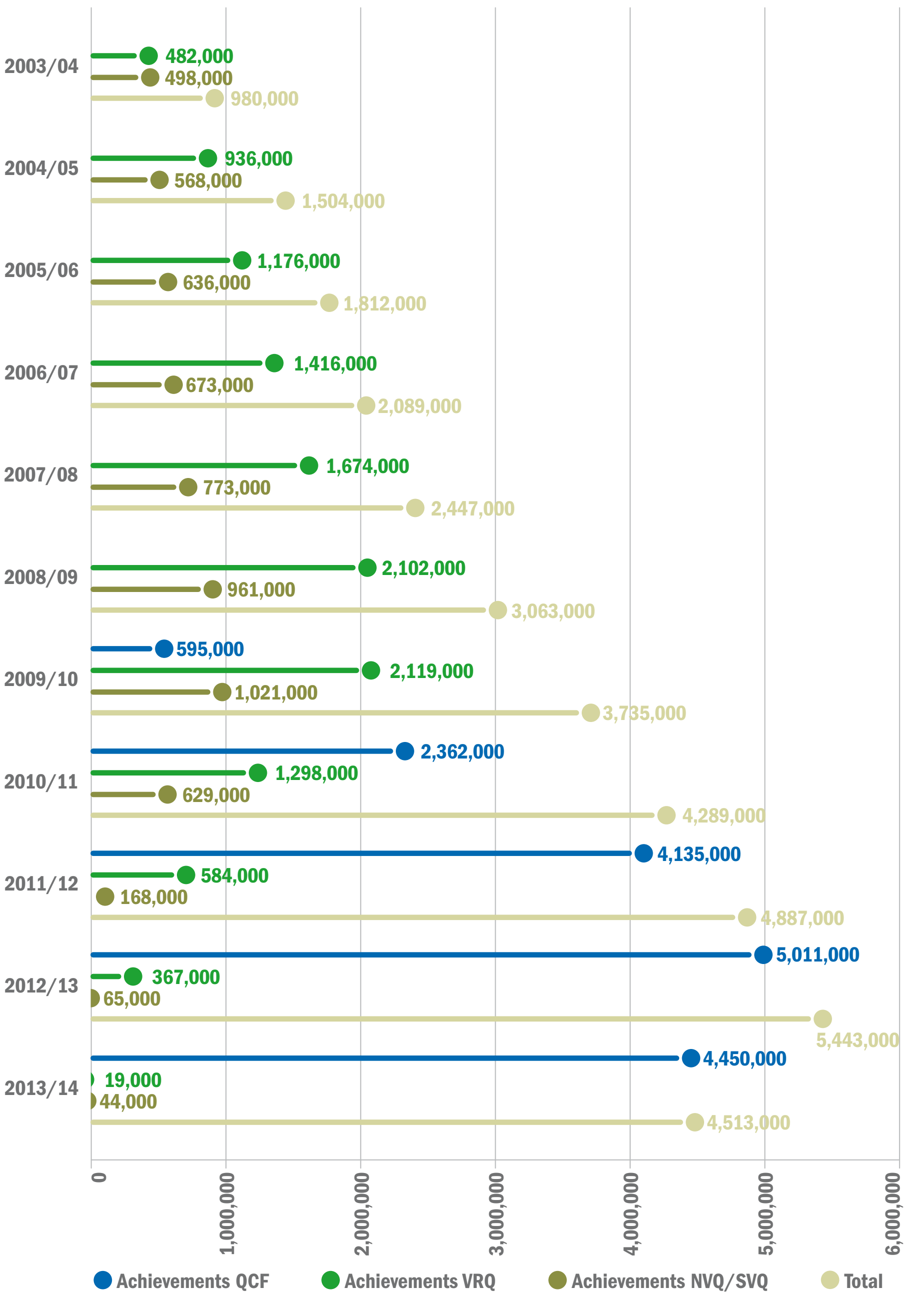
Individuals, education providers and employers globally are increasingly recognising the advantages of professional approval. The UK engineering profession participates in several major international accords, within and outside Europe, which establish the 'tradeability' of engineering and technology qualifications. In each case, the system of approval applied in the UK is fundamental to the acceptance of UK qualifications. With increasing globalisation, such accords and frameworks are assuming growing importance with employers as a means by which they can be confident in the skills and professionalism of the technicians and engineers involved.

9.3 Numbers of vocational qualification achievements

As Figure 9.1 shows, the numbers of N/SVQs and VRQs have dramatically declined since the introduction of the QCF in 2008.[725]

The number of NVQs/SVQs achieved in the UK has decreased from 1.0 million in 2009/10 to 44,000 in 2013/14. In line with NVQs/SVQs, the number of VRQs achieved in the UK also decreased from 2.1 million in 2009/10 to 190,000 in 2013/14. Furthermore, the number of awarding organisations reporting also declined from 49 in 2009/10 to 27 in 2013/14. During this time, there was a surge in the numbers of QCF qualification achievements, which peaked at over 5 million in 2012/13. These consist of 1.9 million QCF Awards, 1.5 million QCF Certificates and 1.1 million QCF Diplomas.

Figure 9.1: Changing profile of qualification achievement in the UK (2003/04-2013/14)



Source: Department for Business, Innovation and Skills

720 www.gov.uk/government/publications/vocational-qualifications-for-14-to-19-year-olds 721 www.engc.org.uk/education-skills/approval-of-qualifications-and-apprenticeship-programmes 722 www.engc.org.uk/ukspec 723 www.engc.org.uk/icttech 724 www.engc.org.uk/techdb 725 Department for Business, Innovation and Skills: Vocational qualifications commentary, 25th March 2015, p1.

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9.3.1 Engineering-related sector subject areas

Engineering-related sector subject areas generally follow the same pattern as all subjects with regard to the dramatic decline in non-QCF qualifications (Table 9.2 and Figure 9.2). Curiously, a significant proportion of information and communication technology achievements are still VRQ, with the numbers totalling 224,100 (41.9%) in 2013/14. However, this figure declined rapidly over the last year, with VRQs only constituting 115,300 (30.8%) of all achievements.

As with all subject areas, the number of achievements across all qualifications has declined this year. Achievements for all engineering-related subjects declined by 17.9%, from 1,116,200 to 916,500.

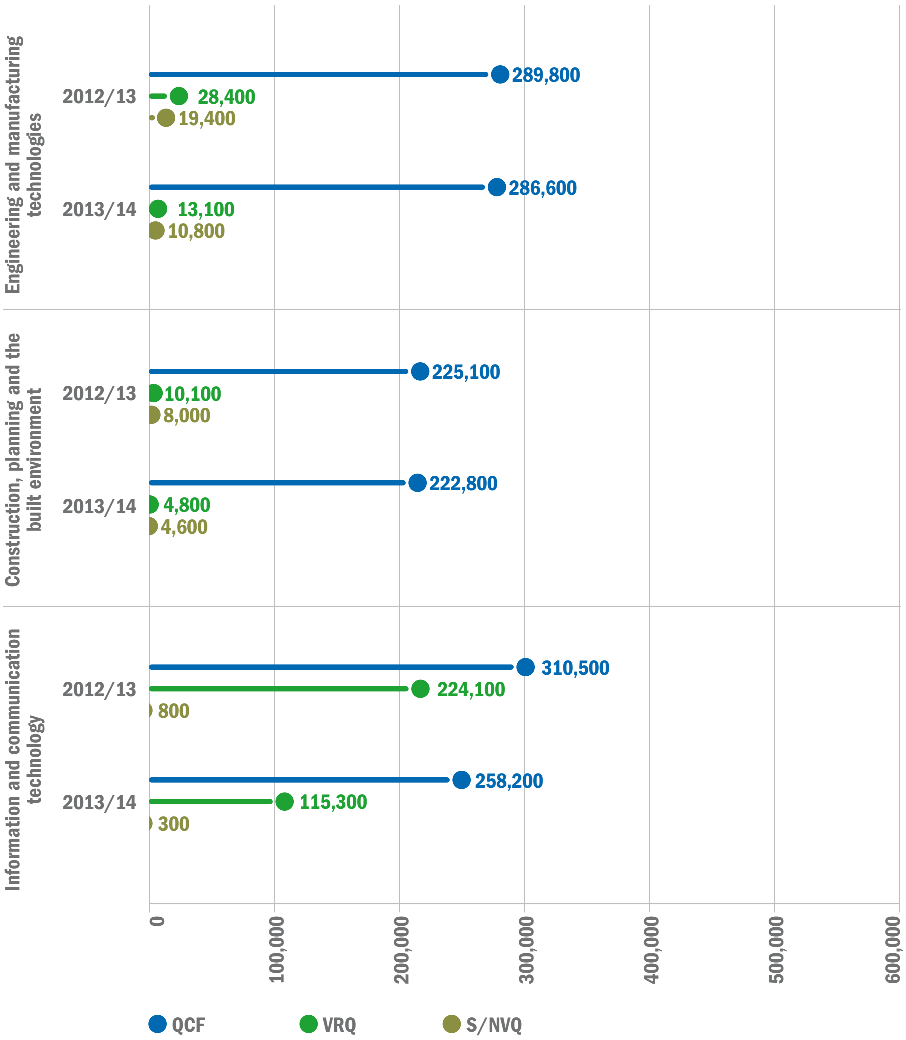
Information and communication technology achievements declined by the largest amount: a 30.2% fall from 535,400 to 373,800.

Table 9.2: Changing profile of qualification achievements in the UK by subject (2012/13-2013/14)

Sector Subject Area	Year	Achievements NVQ/SVQ	Achievements VRQ	Achievements QCF	Total achievements
Engineering and manufacturing technologies	2012/13	19,400	28,400	289,800	337,600
	2013/14	10,800	13,100	286,600	310,500
	Percentage change	-44.3%	-53.9%	-1.1%	-8.0%
Construction, planning and the built environment	2012/13	8,000	10,100	225,100	243,200
	2013/14	4,600	4,800	222,800	232,200
	Percentage change	-42.5%	-52.5%	-1.0%	-4.5%
Information and communication technology	2012/13	800	224,100	310,500	535,400
	2013/14	300	115,300	258,200	373,800
	Percentage change	-62.5%	-48.5%	-16.8%	-30.2%
All engineering related subject areas	2012/13	28,200	262,600	825,400	1,116,200
	2013/14	15,700	133,200	767,600	916,500
	Percentage change	-44.3%	-49.3%	-7.0%	-17.9%

Source: Department for Business, Innovation and Skills

Figure 9.2: Changing profile of qualification achievements in the UK by subject (2012/13-2013/14)



Source: Department for Business, Innovation and Skills

9.4 Level of achievements

Further education's potential for addressing the UK's looming skills shortage has long been under-used. As BIS notes, the requirements of businesses have changed so that there are more jobs requiring skills at higher levels. However, much further education has focused on providing remedial support at a low skill levels. With HE commonly considered as the predominant source of higher skills, there is a vacuum in the provision of higher level vocational and technical skills.[726]

As the former Business Secretary Vince Cable remarked in a 2015 speech: "High level vocational training has fallen through the gap between our HE and FE systems … relative to other countries, we are very behind where we need to be."[727]

Looking at QCF achievements by level, Table 9.3 shows that in 2013/14 only 1.6% (12,600) of engineering-related FE achievements were at level 4 or above, with the bulk (50.5%) at level 2 (387,300).

However, although overall achievements at all levels have declined this year for engineering-related subject areas (down 7.0%), achievements at level 3 and 4+ have experienced considerable growth (level 3 is up by 17.0% and level 4 by 3.26%). Overall, the number of achievements at level 3 have increased by 24,800, and those at level 4+ by 3,100.

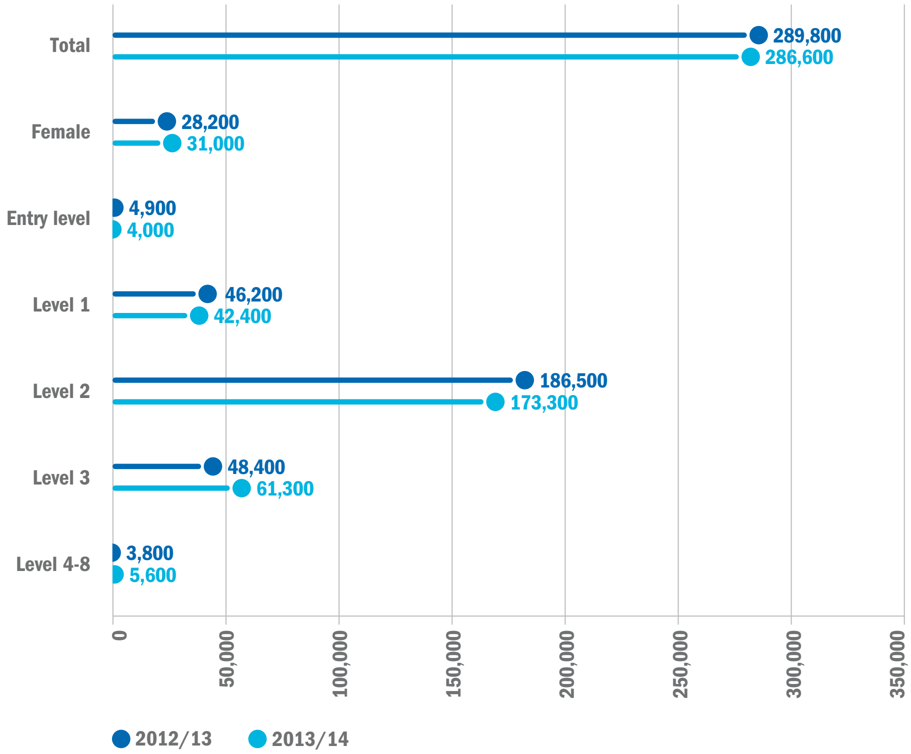
Table 9.3: QCF achievements by subject area, gender and level (2012/13-2013/14) – UK

Year	Subject	Total	Female	Percentage female	Entry level	Level 1	Level 2	Level 3	Level 4-8	Percentage level 4+
Engineering and manufacturing technologies	2012/13	289,800	28,200	9.73%	4,900	46,200	186,500	48,400	3,800	1.3%
	2013/14	286,600	31,000	10.82%	4,000	42,400	173,300	61,300	5,600	2.0%
	Change	-1.1%	9.9%	1.1%	-18.4%	-8.2%	-7.1%	26.7%	47.4%	0.6%
Construction, planning and the built environment	2012/13	225,100	5,800	2.58%	6,000	63,100	102,200	50,000	3,800	1.7%
	2013/14	222,800	5,600	2.51%	4,100	57,200	103,300	54,200	3,900	1.8%
	Change	-1.0%	-3.4%	-0.1%	-31.7%	-9.4%	1.1%	8.4%	2.6%	0.1%
Information and communication technology	2012/13	310,500	126,000	40.58%	28,600	97,500	134,900	47,600	1,900	0.6%
	2013/14	258,200	98,600	38.19%	29,100	60,000	110,700	55,300	3,100	1.2%
	Change	-16.8%	-21.7%	-2.4%	1.7%	-38.5%	-17.9%	16.2%	63.2%	0.6%
All engineering related	2012/13	825,400	160,000	19.38%	39,500	206,800	423,600	146,000	9,500	1.2%
	2013/14	767,600	135,200	17.61%	37,200	159,600	387,300	170,800	12,600	1.6%
	Change	-7.0%	-15.5%	-1.8%	-5.8%	-22.8%	-8.6%	17.0%	32.6%	0.5%
Science and mathematics	2012/13	157,100	77,100	49.08%	-	1,700	137,300	18,000	100	0.1%
	2013/14	90,600	44,700	49.34%	-	1,500	66,300	22,400	300	0.3%
	Change	-42.3%	-42.0%	0.3%	-	-11.8%	-51.7%	24.4%	200.0%	0.3%
All QFC achievements	2012/13	5,011,500	2,343,300	46.76%	361,800	1,151,800	2,508,400	893,100	96,300	1.9%
	2013/14	4,450,100	2,070,600	46.53%	397,100	897,600	2,133,200	915,000	107,100	2.4%
	Change	-11.2%	-11.6%	-0.2%	9.8%	-22.1%	-15.0%	2.5%	11.2%	0.5%

Source: Department of Business, Innovation and Skills

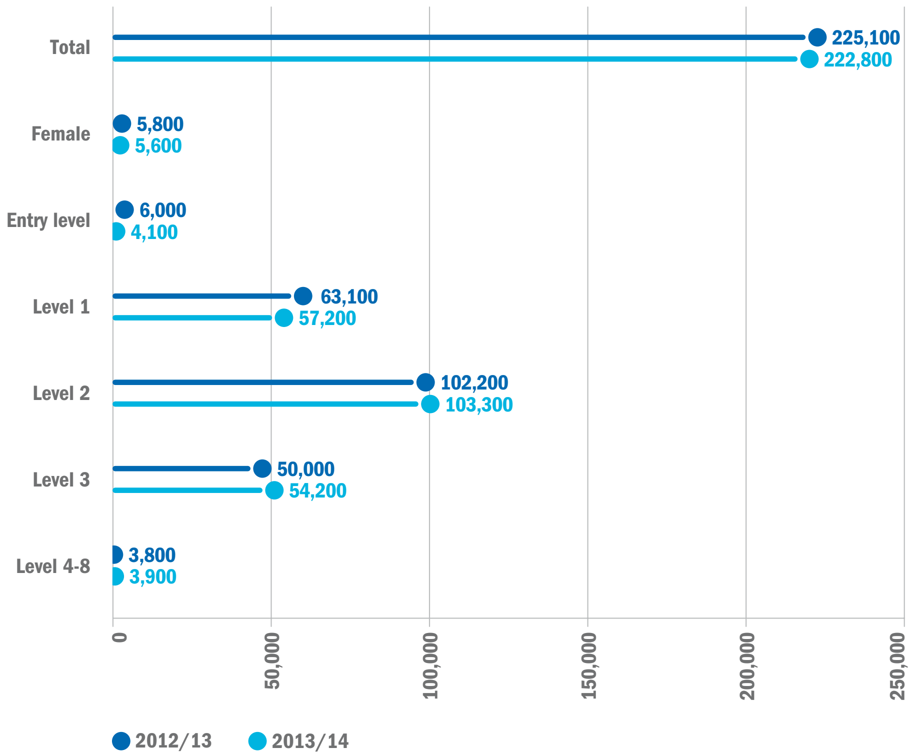
726 Department for Business, Innovation and Skills: A dual mandate for adult vocational education A consultation paper, March 2015, p17 727 Vince Cable, Speech at Cambridge University, 'Where next for further and higher education?', 24th April 2014

Figure 9.3: QCF achievements in engineering and manufacturing technologies (2012/13-2013/14) – UK



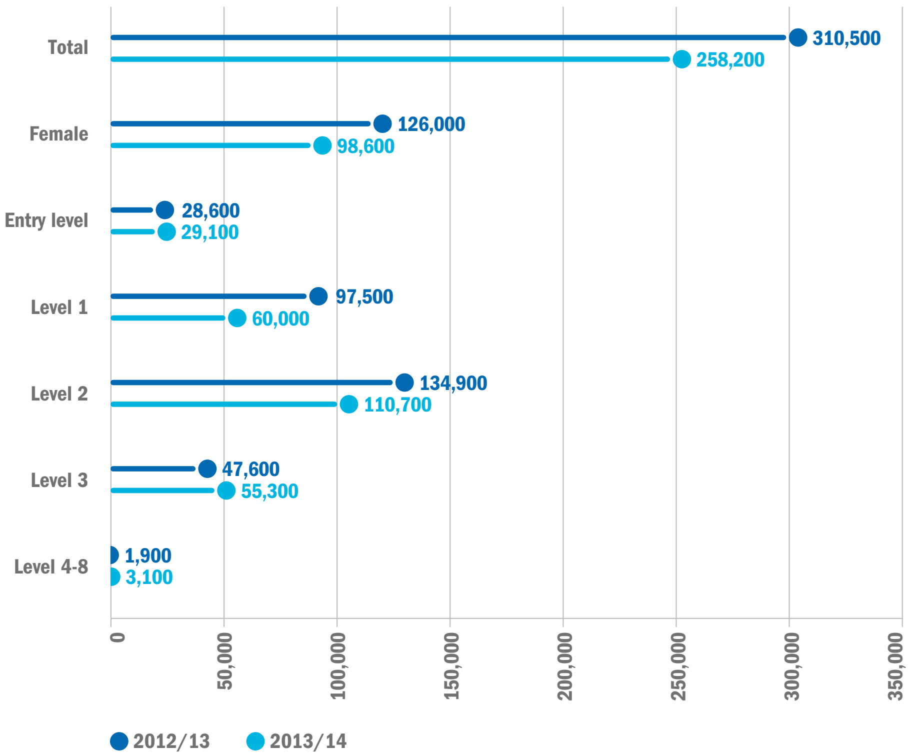
Source: Department for Business, Innovation and Skills

Figure 9.4: QCF achievements in construction, planning and the built environment (2012/13-2013/14) – UK



Source: Department for Business, Innovation and Skills

Figure 9.5: QCF achievements in information and communication technology (2012/13-2013/14) – UK



Source: Department for Business, Innovation and Skills

9.5 Numbers of traineeships

Although initial uptake was modest, the percentage of starts increased substantially, from 10,400 in 2013/14 to 15,100 in 2014/15 – an increase of 45.2% (Table 9.3). The majority of growth was for 19-to 23-year-olds, who took up 70.6% more traineeships. By comparison, the under-19s took up 34.2% more traineeships. As previously discussed, traineeships were introduced in 2013 to provide a pathway to work or an apprenticeship. Therefore, it is encouraging that the majority of those completing a traineeship (67.2%) progressed into paid work, an apprenticeship or, in the case of the under-19s, further learning. Under-19s boasted higher progression rates, at 74.4% compared with 52.0% for 19- to 23-year-olds. OFSTED notes that attendance and retention on traineeships was much better than on previous pre-apprenticeship programmes.[728] However, examining the total number of starts shows that of those who started a traineeships, 29.8% of learners were in work, an apprenticeship or further learning a year later.

Table 9.4: Number of traineeships starts, completions and progression onto an apprenticeship (2013/14-2014/15)

	2013/14	2014/15 (provisional)	Percentage change
Traineeship starts	**10,400**	**15,100**	**45.2%**
Under 19	7,000	9,400	34.3%
19-23	3,400	5,800	70.6%
Traineeship completions		**6,700**	
Under 19		4,300	
19-23		2,500	
Traineeship progression		**4,500**	
Under 19		3,200	
19-23		1,300	
Percentage progression/ starts		**29.8%**	
Under 19		34.0%	
19-23		22.4%	
Percentage progression/ completion		**67.2%**	
Under 19		74.4%	
19-23		52.0%	

Source: Department of Business, Innovation and Skills

Furthermore, OFSTED reported that traineeships provided most learners with a high level of vocational and employability skills that equipped them well for future career development. OFSTED noted increased work-related personal confidence and motivation among participants. However, they warned that the numbers participating in traineeships are still extremely low and that provision would require rapid growth to prepare more young people for an apprenticeship or work.[729] The Department for Education has not defined set targets for uptake of traineeships, although it expects growth to increase dramatically over the next two years.[730]

9.6 Economic benefit of further education

The further education sector provides substantial economic benefit to both individuals and the wider economy. According to analysis conducted by the 157 Group, learners in FE receive an average 11.2% return on their investment in terms of higher future earnings.[731] However, due to the diversity of the FE sector, the substantial wage premium is not widely appreciated. The existence of substantial graduate destinations data makes it relatively easy to determine the return on investment (ROI) of traditional academic routes. However, this task is much harder for the FE sector. As a result, many potential students may be deterred from pursing vocational qualifications in favour of the perceived financial benefit afforded by academic study.

To address such issues, BIS has announced the establishment a Future Employment and Earnings Record (FEER). The aim of the FEER is to publish new and detailed employment and earnings data against all further and higher education courses, so that young people are able to make informed education and career choices.[732]

728 Ofsted Annual Report: Further education and skills 2013/14, 2014, p22 729 *Ibid*, p22 730 Department for Business, Innovation and Skills: 16- to 18-year-old participation in education and training, September 2014, p32. 731 157 group: The economic impact of further education colleges, May 2015, p7 732 Department of Business, Innovation and Skills: Further education learners average earnings post study – 2010/11 to 2012/13, December 2014

Figure 9.6 compares the three- to five-year average earnings premiums of those who achieved full level FE qualifications with those who enrolled but did not achieve. Engineering-related subjects in particular boast larger earning premiums, with those who achieve a level 3 qualification achieving a 16% average increase in earnings compared with those who did not. Furthermore, the addition of a level 1 and/or level 2 maths or English qualification, alongside more substantial FE qualifications, was found to be related to a further 2% increase in an individual's three- to five-year average earnings.[733]

There is a substantial earning premium for those who complete an FE qualification over those who withdraw from study. So it is encouraging to note that the retention rate for FE qualifications has been steadily increasing over the last decade (Figure 9.7). Since 2006/07, FE learning aims not completed by 16- to 18-year-olds fell by 29%, from over 137,000 to just over 97,000 in 2012/13.

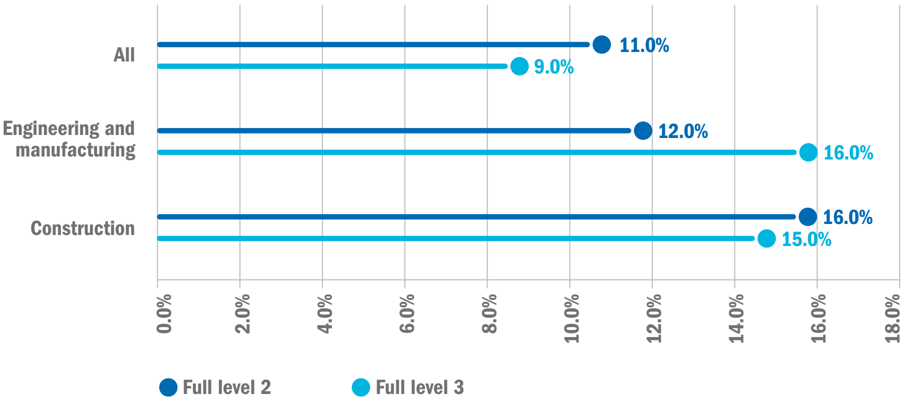
9.6.1 Economic benefit of further education to society

The benefits of further education are not simply limited to the individuals who achieve FE qualifications. Further education also has positive economic benefits to society, both regionally and nationally. For example, a sample of economic impact studies undertaken in 157 Group colleges shows that the average impact of a further education college on the regional economy is £550 million.[737]

In addition to the impact on the regional economy, the studies show that investing in FE colleges benefits not only learners, but also society and taxpayers. The averages from the studies undertaken with 157 Group colleges show that:

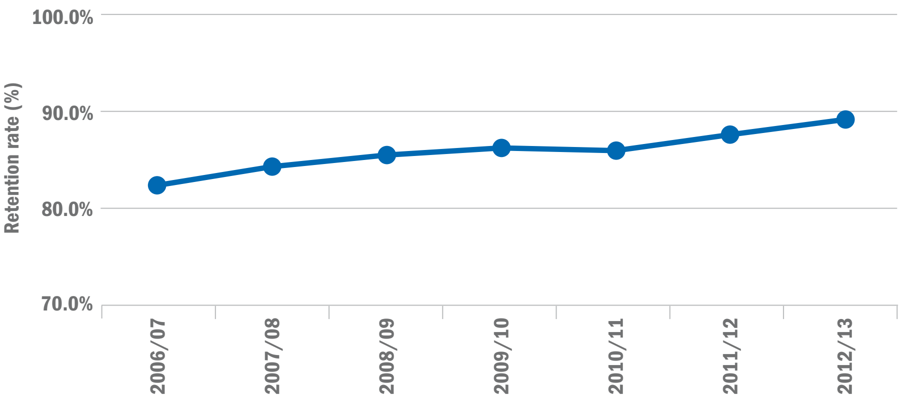
- Society receives an average 12.6 % return on its investment in terms of an expanded tax base and reduced social costs
- The taxpayer receives a 12.3 % return on its investment in terms of returns to the exchequer.

Figure 9.6: Three- to five-year average earnings premium for FE achievements (2004/05-2010/11)[734, 735, 736]



Source: Department for Business, Innovation and Skills

Figure 9.7: Retention rates in the further education sector (percentage of aims completed), 16- to 18-year-olds (2006/07-2012/13) – England



Source: Skills Funding Agency, National Success Rate Tables

9.7 Further education and higher education

In many ways, the distinction between further education and higher education is false. Although the majority of undergraduate qualifications are still provided in higher education institutions, alternative providers and further education colleges have rapidly increased their HE provision. In 2014, FE colleges enrolled around 130,000 HE students: about 10% of the HE undergraduate market. Of these, approximately 60,000 students were studying part-time professional certificates and diplomas, the majority of which were foundation degrees and HNCs/Ds.[738]

For example, in 2012/13, higher education qualifications were taught at 252 FE colleges in England (although half were provided by just 42 colleges).[739] Furthermore, the number of students accessing loans for higher education tuition from further education institutions increased by 35% between 2010/11 and 2012/13.[740]

The profile of learners enrolled on higher education courses in further education colleges is typically different to those enrolled at higher education institutions. A study by the Association of Colleges found that the major factors influencing FE college enrolment in HE qualifications are accessibility, and controlling living costs whilst studying. As a result, FE colleges also attract more students from lower participation neighbourhoods than universities, highlighting the integral role they can play in providing higher level technical and vocational training to the most disadvantaged in society.[741]

733 Department of Business, Innovation and Skills: Estimation of the labour market returns to qualifications gained in English Further Education, December 2014, p16. 734 *Ibid*, p16 735 The figure for 3 to 5 year average earnings return for level 3 achievements may be understated due to individuals progressing to HE. As this group is undertaking non-work based study, they will experience low or negative earnings return. 736 A full level is defined as being equivalent to either 5 GCSEs A*-C at level two or to two A levels at level 3. 737 157 Group: The economic impact of further education colleges, May 2015, p7. 738 Association of Colleges: Breaking the Mould Creating higher education fit for the future, 2014, p.9 739 Department for Business, Innovation and Skills: A dual mandate for adult vocational education A consultation paper, March 2015, p27 740 Universities UK: Trends in undergraduate recruitment, August 2014, P.3 741 Association of Colleges: Breaking the Mould. creating higher education fit for the future, 2014, p.9

9.8 Contribution of the FE sector to the STEM skills landscape

Authored by Dr Rhys Morgan, Director, Engineering and Education, Royal Academy of Engineering

The further education and skills sector is a critical component of the education system in ensuring sufficient numbers of future engineers and technicians. With further significant cuts to public services as the UK government continues to reduce public debt, it is all the more important to understand precisely the contribution of the FE sector to increasing productivity and the growth of the economy.

The Royal Academy of Engineering, working in partnership with the wider STEM community, has over the last five years published a series of reports on the scale of the FE sector and the role of STEM subjects within it. The figures presented here are the initial results of the analysis for the fourth report, which will be published in late 2015 or early 2016.

The latest full-year data available is for 2013/14. In this year, approximately 4.17 million qualifications were achieved across the whole FE sector. Figure 9.8 shows the proportion of those qualifications by major STEM area and non-STEM subjects.

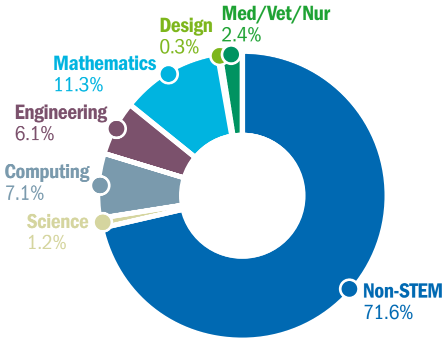
For the latest iteration of the report, the STEM areas have been split to provide more granular data so that we are able to identify subjects associated with medicine, veterinary studies and nursing. In addition, 'technology' subjects have been split into computing and design-based courses.

STEM subjects account for approximately 28% of the total number of qualifications achieved in the FE sector. There were approximately 1.2 million learning aims (qualifications) undertaken in 2013/14 across all STEM subjects.

Figure 9.9 shows the number of qualifications achieved in each subject area across STEM at every level. Mathematics continues to dominate STEM in FE due, in large part, to students taking basic numeracy and entry level qualifications (60%) and level 2 qualifications (25%).

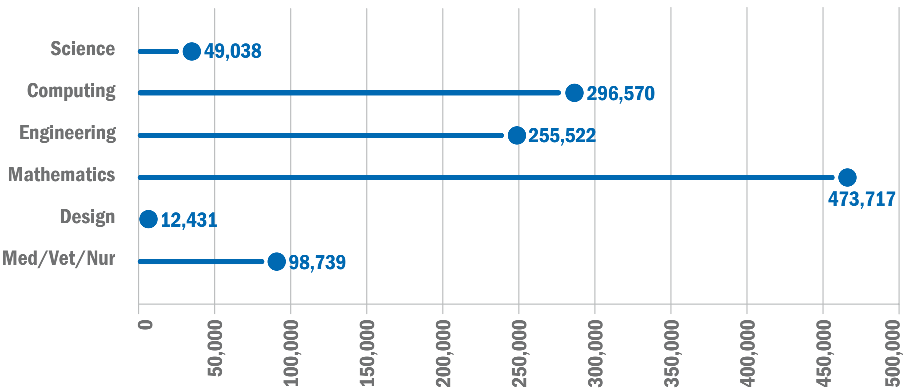
While the number of qualifications being taken looks in general, very healthy, with engineering it should be noted that more than one qualification can be achieved by an individual student. This is particularly the case for small qualifications such as NVQs which might be taken as part of an apprenticeship framework. Therefore, it is not possible as yet from this data to infer the number of students taking STEM subjects in the FE sector.

Figure 9.8: Proportion of qualifications achieved by STEM subject area across the FE and skills sector (2013/14)



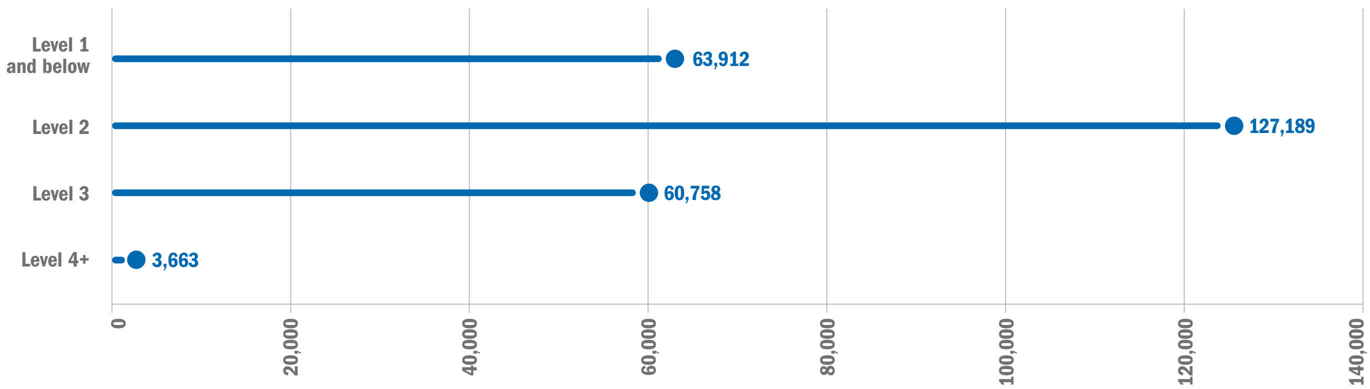
Source: Data from the ILR, BIS Data Service, 2013/14

Figure 9.9: Achievements by STEM subject area for every qualification level (2013/14)



Source: Data from the ILR, BIS Data Service, 2013/14

Figure 9.10: Achievements in engineering subjects by level of qualification (2013/14)



Source: Skills Funding Agency, National Success Rate Tables

From the previous FE STEM data reports, the concern has been that sufficient numbers of students progress beyond lower level qualifications (less than level 2) to the advanced level qualifications required by industry. Figure 9.10 shows the current levels of qualifications being achieved across all engineering subjects for 2013/14. Again, it is clear that the vast majority of qualifications are being taken at level 2 and below. Despite this, however, there are still over 60,000 engineering qualifications being achieved at level 3, which is encouraging. Further analysis to understand the number of learners taking these qualifications, and also more detail of the types of qualifications being taken, will be undertaken in the complete FE STEM data report.

9.9 Vocational qualifications – helping to fill the engineering skills gap?

Authored by Phillip Bryant, Sector Strategist for Technical and Vocational education, AQA

As the UK continues to suffer from a lack of engineering skills, it is timely to reflect on the current state of vocational education. In particular, how a new approach, with input from business and professional bodies, is set to shake up engineering qualifications and provide a much-needed boost to providing in-demand skills.

Vocational education has, in the past, suffered from a poor reputation, with a common perception being that it offered a less challenging route for lower ability learners. Indeed, in her 2011 review of vocational education, Professor Wolf concluded that 350,000 16- to 19-year-olds were taking qualifications each year which were of very limited value, either to them or employers.

Clearly action was needed. So in response to Professor Wolf's recommendations, the government began a programme of vocational reform.

In March 2014, it released *Getting the job done: the government's reform plan for vocational qualifications*, which set out changes to the way 16-19 education is funded to ensure schools and colleges offer study programmes based on genuinely valuable qualifications.

The government also introduced new performance measures to indicate how well schools and colleges are preparing their learners for further or higher education or employment. In addition, they sought to reduce the number of available qualifications in response to criticism that parents and employers often struggled to identify the vocational qualifications that are right for learners.

"In the past, students aged 16-19 have faced a bewildering number of course options, with little clarity about which ones would help them get a job or a place at university," said Matthew Hancock when he was Minister for Enterprise and Skills.

The overall goal of these reforms is to encourage schools and colleges to only offer vocational qualifications that genuinely support progression to higher education and/or skilled employment.

Impact for engineering

This is especially crucial to the engineering industry. Despite being a key sector for the UK economy, a skills shortage has long been depleting productivity and innovation. *"Engineering businesses depend for their viability on their skills and on the abilities and ambitions of each new generation that joins the labour market,"* said Professor John Perkins in his recent government-commissioned Review of Engineering Skills. Yet, while there is no shortage of young people looking for work, there is a shortage of relevant skills when it comes to all fields of engineering.

According to EngineeringUK, Britain currently has a shortfall every year of about 69,000 people with engineering skills at level 3 or above. A recent industry survey revealed that nearly half of engineering firms said that Hard-to-Fill vacancies had meant delays in developing new products or services, while 45% said they experienced increases in operating costs. It's estimated that failing to hire the 182,000 engineers required annually could cost the economy up to £27 billion a year.

But it's not just a matter of attracting more entrants. It's also about providing appropriate training – and as we've seen, ensuring the vocational training on offer to 16- to 18-year-olds especially is fit for purpose.

Einstein once defined insanity as "doing the same thing over and over again and expecting a different result". And this is especially true when it comes to the state of technical engineering education in the UK.

Businesses can only perform as well as the people that work in them. To thrive and grow, they need people with the right skills at the right time in the right place. They need a pipeline of job-ready young people who can quickly start to make a meaningful contribution.

Yet for many years, employers have complained that young people entering the work force are inadequately equipped with the soft skills and technical knowledge needed to move seamlessly from education to the workplace.

It's clear that the UK needs a system that works better for the needs of both employers and young people. We need a system that prepares young people for employment; that provides a meaningful, inspiring and rewarding learning experience; that builds highways to opportunity, not cul de sacs to dead end jobs. And one that delivers a flow of quality work-ready talent when and where it is needed. This is how we can deliver substantive and sustained growth in this country.

Qualification reforms

A key part of government reforms to vocational education involves tasking awarding organisations such as AQA to continue to improve the quality and structure of these

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qualifications, so that they deliver the skills that are needed.

From 2017, Tech levels, Applied General qualifications and Technical Certificates will be the only vocational qualifications for 16- to 19-year-olds recognised in performance tables.

Also, qualifications will only be recognised in one qualification category. This will ensure that all qualifications that are reported in performance tables – whether vocational or academic – are recognised as distinct and respected components of a 16- to 19-year-old study programme.

That said, schools and colleges remain free to offer any qualifications that have section 96 approval under the Learning and Skills Act (2000) to learners aged 16 to 18. But only those I've already identified will be recognised in performance tables.

So in addition to academic qualifications (i.e. A levels), there are now three vocational options for 16- to 19-year-olds:

1. Applied General qualifications – these are rigorous advanced (level 3) qualifications that equip learners with transferable knowledge and skills. They are for post-16 learners wanting to continue their education through applied learning.

Applied General qualifications fulfil entry requirements for a range of higher education courses, either by meeting entry requirements in their own right or being accepted alongside and adding value to other qualifications at the same level.

2. Tech levels – these are rigorous advanced (level 3) technical qualifications, on a par with A levels and recognised by employers. They are for post-16 learners wishing to specialise in a specific industry, occupation or occupational group.

They equip learners with specialist knowledge and skills, enabling entry to a higher apprenticeship or other employment, or progression to a related higher education course. In some cases, these qualifications provide a 'licence to practise' or exemption from professional exams. Tech levels are one of three components of the new Technical Baccalaureate (TechBacc) performance table measure.

3. Technical Certificates – these are rigorous intermediate (level 2) technical qualifications for post-16 learners wishing to specialise in a specific industry, occupation or occupational group. They cover occupations where employers recognise entry at level 2, or where a level 2 qualification is required before learners can progress to a Tech level.

Technical Certificates equip learners with specialist knowledge and skills, enabling entry to an apprenticeship, employment or progression to a Tech level. In some cases, they provide a 'licence to practise' or exemption from professional exams.

Greater employer involvement

In order to fundamentally improve how we develop and deliver technical and vocational education in this country, we need to recognise this is not a challenge that should be left to educators alone. Employers must also get involved – and when they do, we believe the results can be quite powerful.

But it has to be a genuine partnership. Only employers and their professional bodies can define the requirements of the system that

Figure 9.11: Vocational qualifications at a glance

	Applied General	Tech level	Technical Certificates
Intended users	These are level 3 qualifications for post-16 learners wanting to continue their education through applied learning	These are level 3 qualifications for learners aged 16 plus that want to specialise in a specific industry or prepare for a particular job	These are level 2 technical qualifications for post-16 learners wishing to specialise in a specific industry, occupation or occupational group
Declared purpose	Entry to higher education	Specialist learning providing entry to apprenticeship, work, or study at higher level	They equip learners with specialist knowledge and skills, enabling progression to apprenticeships, employment or Tech levels. In some cases, they provide a 'licence to practise' or exemption from professional exams
Minimum duration	150 guided learning hours (GLH)	300 GLH	150 GLH
Appropriate content	60% mandatory content Requires endorsement by minimum of three higher educations institutions	40% mandatory content Requires endorsement by minimum five employers and/or one relevant professional or trade body	40% mandatory content Requires endorsement by minimum five employers and/or one relevant professional or trade body
External assessment minimum	40%	30%	25%
Employer involvement in delivery	Not required	Required	Required
Progression	To higher education	To related employment, apprenticeship, study at higher level	Apprenticeship, employment or progression to a Tech level

Source: AQA

educators must build. Only they can ensure that the solution is fit for purpose.

To achieve this, more must be done to engage employers in the process. We need a new partnership between education and industry. To date, such collaboration has focused on delivery partnerships through work experience placements, career talks, enterprise competitions and the like – and there is considerable evidence to suggest that such collaboration does result in a more meaningful and engaging learning experience.

But we can – and we must – go much further if we are to seriously address the problems in technical and professional skills training. We must learn to collaborate on content and assessment as well as just delivery.

What's more, serious and significant collaboration between employers and educators is not just seen as common sense good practice. It is now mandated, with qualification specifications requiring all learners to "undertake meaningful activity involving employers" *(Vocational Qualifications for 16- to 19-year-olds: Technical Guidance, Department for Education)*.

Educational centres must seek out and involve employers in delivering units as guest lecturers; providing structured work experience relevant to the qualification; or assessing learners' work. This is a real sea change and an opportunity on which we can all build.

Forging new partnerships

By working more closely in partnership with employers and professional bodies, awarding bodies are better equipped to build a technical and vocational education system that is more able to produce work-ready learners, with a clear line of sight to the world of work. It is no longer simply enough to have letters of support and endorsements from employers and professional bodies. At AQA, for example, we have sought out and will continue to seek out collaborative partnerships with employers and professional bodies to build qualifications that will drive up the standard of technical education and training.[742]

We also need to establish an approach that enables employers to be involved in checking the learning outcomes during the initial period of development of new qualifications. This will assure employers, educational centres and learners that the content being taught is right for the jobs local employers are trying to fill.

More critically, this approach responds to the criticism from employers that the current qualification process does not do enough to provide learners with key employability skills, as well as the required technical knowledge and competencies.

The road ahead

There is no doubt that the partnership between employers and education is critical. If we provide qualifications that are built on the principles outlined above, we will be better serving the needs of the engineering sector, and providing learners with the knowledge and skills needed to progress in life.

However, rushing into this without consideration of potential issues is fraught with danger. One obvious issue is that not all employers will have the time to be involved in qualification design, delivery and assessment. Also of concern is that SMEs and micro-businesses may find themselves excluded from this process.

The key to this is for education providers to work smartly to come up with new ways to interact with industry, and develop efficient and effective ways of engaging employers in the delivery and assessment of qualifications. Organisations that represent the engineering community, such as EngineeringUK, could play an increasing role in this.

742 For more information, visit aqa.org.uk

Part 2 – Engineering in Education and Training
10.0 Apprenticeships

Apprenticeships are vital both for improving the life chances of those who are best suited to vocational training at higher level, and for tackling the UK productivity challenge. However, the numbers of higher level apprenticeships are still disappointingly low, with only 451 achievements in 2013/14. The government has ambitious plans to boost the quantity of apprenticeships and, in contrast to recent years, the number of young people starting an apprenticeships is again on the rise. However, with a projected shortfall of over 29,000 level 3 engineering technicians, the recorded number of 27,195 apprenticeship achievements at level 3 needs to more than double to meet demand.

Apprenticeships have the capacity to benefit society by both increasing productivity and promoting greater social mobility.[743]

In 2014, the UK was the fastest growing G7 economy and the OECD forecasts that this will be the case again in 2015. However, despite rising economic growth and falling unemployment, the UK underperforms in productivity compared with other advanced economies. The Centre for Economics and Business Research notes that UK productivity is 28% behind in France, 29% less than in Germany and 30% lower than in the US.[744] In response to what has been popularly dubbed as the 'productivity puzzle', the government has made it a top priority to address this issue and has highlighted apprenticeships as being a key part of the solution.

In the 2015 summer budget, the chancellor George Osborne announced a new levy on large employers, the proceeds of which will be used to fund three million new, high quality apprenticeships over the next five years.[745] Spending on apprenticeships provides a high return on investment. The National Audit Office estimates that for every £1 that the government spends on apprenticeships, the economy sees a return of around £18.[746] Furthermore, between 2013 and 2022, apprenticeships in England are forecast to contribute £3.4 billion of net productivity gains to the UK economy.[747]

They also play an important role in promoting social mobility. The House of Lords' social mobility committee identified a 'missing middle' of young people who do not go on to university but are not included in the statistics for those not in employment, education or training (NEET). For these young people, who are unlikely to pursue higher education, apprenticeships offer a real opportunity to progress in society. Research shows that apprentices earn more over their working life than those who finish their education at A level.[748] Also, the employment rate for those aged 25-64 with no qualifications is 48.5%, compared with 80.7% for those with apprenticeships.[749]

The National Apprenticeship Service (NAS) is responsible for overseeing apprenticeships in England. Established in 2009, NAS encourages both learners and employers to engage in apprenticeships and provides support to employers through the process of recruiting and training their apprentices. NAS also maintains the national online apprenticeship vacancies system, which provides a resource for employers to post apprenticeship vacancies and learners to find them.[750]

An apprenticeships is not a qualification, but a framework that includes:

1. A National Vocational Qualification (which assesses the apprentice's practical vocational skills)
2. A Technical Certificate (which evaluates the apprentice's theoretical knowledge)

743 Institute for Public Policy Research: Learner drivers local authorities and apprenticeships, June 2015, p1 744 Cebr: Productivity and lifetime earnings impacts of engineering education & training – a report for Engineering UK, September 2015, p9 745 HM Treasury: Summer Budget 2015, 8th July 2015, p3 746 DEMOS: The commission on apprenticeships, 2015, p11 747 Cebr: Productivity matters: the impact of apprenticeships on the UK economy, 2013 748 Social Mobility and Child Poverty Commission blog, 13 November 2014 749 Institute for Public Policy Research: Learner drivers local authorities and apprenticeships, June 2015, p9 750 House of Commons library: Apprenticeships policy, March 2015, p3

3. A Key Skills component (which the ensures that apprentices acquire important skills such as numeracy and literacy)

Apprenticeship frameworks can occupy different levels. Intermediate Apprenticeships are level 2 frameworks, roughly equivalent to five GCSE passes. Advanced Apprenticeships are level 3 frameworks and broadly equate to two A level passes. Higher Apprenticeships are level 4 frameworks and constitute a relatively small number total apprenticeship starts. However, in 2013 the government announced £40 million to fund 20,000 Higher Apprenticeships between 2013/14 and 2014/15. Furthermore, in 2014 additional funding of £20 million was announced to fund Higher Apprenticeships until 2016.[751] Finally, in April 2013, statutory changes came into effect that allowed the creation of apprenticeships at levels 6 and 7 – equivalent to bachelor and master's degrees.[752]

10.1 Changes to apprenticeships

During the course of the last parliament, the coalition government oversaw the creation of over 2.3 million apprenticeship starts. However, the quality of such growth is questionable. For example, the Institute for Public Policy Research notes that, rather than newly-employed workers, two-thirds of apprentices at level 2 or level 3 during this period were simply existing company employees who converted onto apprenticeships. Furthermore, over the last five years, over two-fifths of new apprentices have been over the age of 25.[753]

It is worth noting that interest in undertaking an apprenticeship is high among young people. A recent Ipsos MORI poll revealed that a majority of young people (55%) would choose them over university if they were available in a job that they wanted to do.[754]

The quality of apprenticeship provision in the UK falls behind that offered in other advanced economies. For example, only 36% of UK apprenticeships at level 3 and above are 3 years or longer, whereas 90% of apprentices in Germany are participating in three to four year programmes at level 3 or higher.[755]

To shore up the quality of apprenticeships and increase the participation of young people, the government is implementing exacting reforms to how apprenticeships are funded.

At present, the government funds 100% of the external training costs for 16- to 18-year-old apprentices, and 50% for those over 19. However, from 2016, employers will be required to contribute towards the cost of training all apprentices, with the exception of training in maths and English up to level 2, which the government will continue to fully fund.[756]

However, the government has pledged to contribute £2 for every £1 spent by an employer on training, up to a cap. Additionally, further financial incentives will be provided to employers who recruit 16- to 18-year-olds or are SMEs.[757]

The Apprenticeship Grant for Employers of 16- to 24-year-olds (AGE 16-24) provides grants of £1,500 to small businesses who are hiring an apprentice in this age bracket for the first time.[758]

In accordance with recommendations from the 2012 Richard Review of apprenticeships, employers will be granted greater control over spending on training, and funding will be routed directly to employers themselves, rather than to training providers.[759] This aims to ensure the employers are more committed to the quality of training that their apprentices receive. In the 2015 budget, it was announced that employers will receive such funding through a simplified digital apprenticeship voucher model, which is currently being trialled before full implementation in 2017.[760]

In addition to the funding of apprenticeships, the content of apprenticeships are also undergoing reform. By 2017/18 the government expects that all apprenticeships will:

- last for a minimum duration of 12 months
- provide training in English and maths for those who do not have at least a grade C in these subjects at GCSE
- require a full assessment of competence before completion[761]

In formulating new apprenticeship standards, the government has invited employers from relevant industry to collaborate in sector-based groups called Trailblazers. In doing so, it is hoped that the content of new apprenticeships will be oriented towards the needs of industry and provide apprentices with high-quality training that is highly relevant to the world of work.

Engineering employers have been closely involved in the Trailblazer's projects, with engineering sectors as diverse as aerospace, food and drink manufacturing, energy and utilities, rail design and land-based engineering being involved in the formulation of new apprenticeship content and standards.[762]

10.2 Benefits of apprenticeships

Engineering UK commissioned research from Cebr to ascertain the economic benefits of apprenticeships, both for the individual taking them and for wider society.

Its analysis revealed (Table 10.1) that the net lifetime earnings premium associated with an individual gaining a level 3 apprenticeship is substantial, averaging £80,900 across all subject areas.

Table 10.1: Estimated net lifetime earnings premium: level 2 and level 3 apprenticeship, presented in 2014 prices – UK

Apprenticeship subject area	NPV level 2	NPV level 3
Construction, planning and built environment	£88,600	£117,500
Engineering and manufacturing technologies	£64,900	£111,900
Science and mathematics	£30,100	£104,100
Retail and commercial enterprise	£62,100	£95,500
Agriculture, horticulture and animal care	£27,100	£78,400
Health, public services and care	£87,400	£77,700
Business, administration and law	£60,000	£69,500
Arts, media and publishing	£1,700	£51,100
Languages, literature and culture	£3,800	£43,000
Social sciences	£30,000	£41,800
Information and communication technology	£33,900	£27,700
Weighted average	**£66,400**	**£80,900**

Source: Cebr analysis

Furthermore, the premium was higher for those completing a level 3 apprenticeship in engineering and manufacturing technologies, who can expect to earn an additional £111,900 over their working life.[763, 764]

It is important to note that the net lifetime earnings premium associated with a level 3 engineering and manufacturing technologies apprenticeship is between 18% and 25% lower than with an engineering degree. However, students graduating now will incur greater debt due to tuition fee increases, while apprentices will get an income whilst they are training, so the economic decision around whether or not to attend university has become less clear-cut than it was in the past.

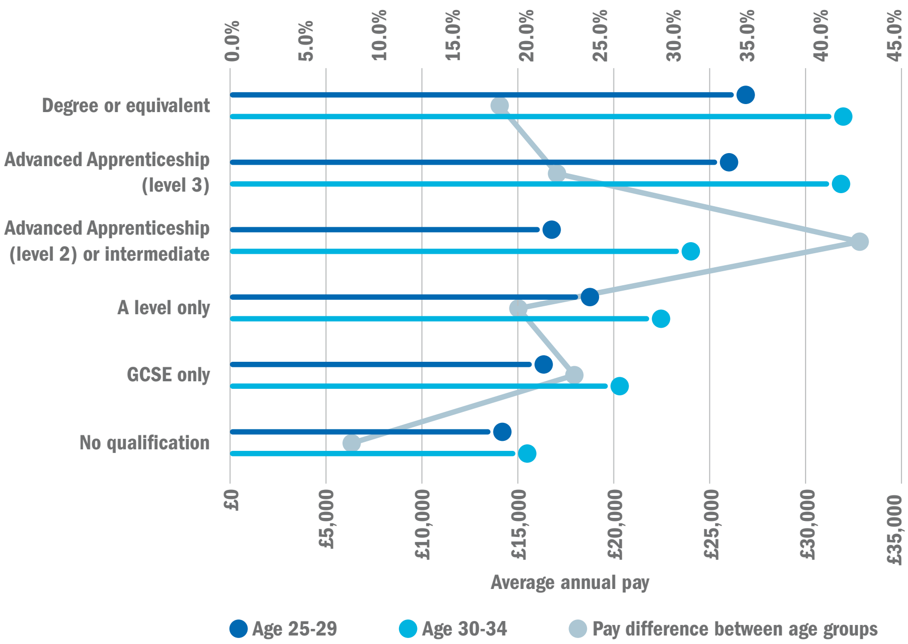
751 Department of Business, Innovation and Skills: A dual mandate for adult vocational education – A consultation paper, March 2015, p10. 752 *Ibid*, p32 753 Institute for Public Policy Research: Learner drivers local authorities and apprenticeships, June 2015, p6 754 Sutton Trust/Ipsos Mori Press release: Available at: http://www.suttontrust.com/news/news/higher-apprenticeships-better-for-jobs-than-university-degrees/ 755 The Sutton Trust: Higher Ambitions Summit Rapporteur Report, July 2014, p7 756 The Department for Education: 16 to 18 year-old participation in education and training, 29 August 2014, p42. 757 *Ibid.* 758 *Ibid*, p5 759 House of Commons library: Apprenticeships policy March 2015, p8 760 *Ibid*, p8 761 The Department for Education: 16- to 18-year-old participation in education and training, 29 August 2014, p40. 762 Department of Business, Innovation and Skills: Engineering Skills: Perkins Review Progress Report, November 2014, p6. 763 Cebr: Productivity and lifetime earnings impacts of engineering education & training – a report for Engineering UK, September 2015, p13. 764 Prices are in 2014 values

As Figure 10.1 shows, there is evidence to suggest that for some individuals it makes more financial sense to obtain an apprenticeship instead of a degree. Across all subject areas, the average salary for 30- to 34-year-olds is approximately £32,500, regardless of whether they possess a degree or a level 3 apprenticeship.

Furthermore, the financial viability of apprenticeships is set to further increase in relation to degree study. From October 2015, the apprenticeship minimum wage will rise by 57 pence to £3.30 per hour. This constitutes the largest ever increase in the National Minimum Wage for apprentices. After the first 12 months of study and once they are aged 19, apprentices are entitled to the national minimum wage, which is set to increase from £6.50 to £6.70 per hour.[765]

However, there is still much work to be done to address the lower regard in which apprenticeships are held by parents and teachers when compared with degrees.

Figure 10.1: Average full-time annual pay by highest qualification obtained, by age group – UK



Source: ONS Labour Force Survey micro dataset Q1 2015, Cebr calculations

The Sutton Trust found that parents are substantially more likely to encourage their children to pursue a university degree (56%) than an apprenticeship (40%).[766] Furthermore, fewer than one in five parents report discussing an apprenticeship with a teacher as a possible option for their child, compared with 45% who did so for university.[767]

However, it is important to challenge the conventional wisdom that undertaking an apprenticeship and enrolling in higher education are mutually exclusive endeavours. Increasingly, an apprenticeship is becoming a legitimate and even financially beneficial way of progressing to higher education study.

Research conducted by BIS estimated that 18.8% of apprentices progressed to higher education within seven years of starting their apprenticeship. Furthermore, 11.7% progressed to higher education within three years of starting of their apprenticeship.[768] It is well worth nothing that for engineering apprentices, this figure rose to 37%.[769]

10.3 Apprenticeship starts

As Table 10.2 reveals, the total number of apprenticeship starts fell by nearly 70,000 (13.7%) between 2012/13 and 2013/14. However, starts in apprenticeships related to engineering subjects rose by 2.8%, largely driven by growth in the construction, planning and the built environment framework, which saw the number of starts increase by 15.7%, from 13,730 in 2012/13 to 15,890 in 2013/14.

Table 10.2: Apprenticeship Programme Starts by Sector Subject Area (2004/05-2013/14) – England[770, 771, 772, 773]

	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 10 years
Construction, planning and the built environment	25,000	21,090	27,300	27,200	23,440	20,550	22,420	13,920	13,730	15,890	15.7%	-36.4%
Engineering and manufacturing technologies	38,280	35,090	37,240	47,220	42,770	42,520	54,640	69,730	66,410	64,830	-2.4%	69.4%
Information and communication technology	6,060	6,490	5,790	6,760	8,820	12,570	19,520	18,520	14,120	13,060	-7.5%	115.5%
Subtotal – all engineering related Sector Subject Areas	69,340	62,670	70,330	81,180	75,030	75,640	96,580	102,170	94,260	93,780	-0.5%	35.2%
All engineering related Sector Subject Areas as a proportion of all Sector Subject Areas	36.7%	35.8%	38.1%	36.1%	31.3%	27.0%	21.1%	19.6%	18.5%	21.3%	2.8%p	-15.4%p
Science and mathematics	-	-	-	-	-	-	10	370	320	360	12.5%	-
All Sector Subject Areas	189,000	175,000	184,400	224,800	239,900	279,700	457,200	520,600	510,200	440,400	-13.7%	133.0%

Source: The Data Service

765 House of Commons library: Apprenticeships policy March 2015, p4 The Department for Business, Innovation and Skills: New National Minimum Wage rates announced, 17 March 2015 766 The Sutton Trust: Higher Ambitions Summit Rapporteur Report, July 2014, p7 767 DEMOS: The commission on apprenticeships, 2015, p24 768 Department of Business, Innovation and Skills: Progression of Apprentices to Higher Education – Cohort Update, May 2014, p6 769 *Ibid*, p9 770 Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred. 771 In this table full-year numbers are a count of the number of starts at any point during the year. Learners starting more than one apprenticeship will appear more than once. 772 Figures for 2011/12 onwards are not directly comparable to earlier years as a Single Individualised Learner Record (ILR) data collection system has been introduced. Small technical changes have been made in the way learners from more than one provision type are counted, leading to a removal of duplicate learners and a reduction in overall learner numbers of approximately 2%. 773 – Indicates a base value of less than 5

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Considering starts by level, Table 10.3 shows that engineering-related apprenticeships saw the largest growth in Higher Apprenticeship starts, with numbers increasing by 42.6%. However, this only amounts to an absolute increase of 300. Discouragingly, Advanced Apprenticeships in engineering-related sector subject areas fell by 14.4%, from 38,950 starts in 2012/13 to 33,340 in 2013/14. As a result, the percentage of apprenticeship starts at level 3 declined by 5.4 percentage points.

Table 10.3: Apprenticeship Programme Starts by Sector Subject Area and level (2004/05-2013/14) – England[774, 775, 776, 777]

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 10 years
Construction, planning and the built environment	Intermediate Apprenticeship	19,810	15,220	20,330	21,020	16,890	14,760	16,020	10,850	10,470	12,600	20.3%	-36.4%
	Advanced Apprenticeship	5,190	5,870	6,970	6,180	6,560	5,790	6,400	3,080	3,210	3,210	0.0%	-38.2%
	Higher Apprenticeship	0	0	-	-	-	-	-	-	60	70	16.7%	-
	All apprenticeships	25,000	21,090	27,300	27,200	23,440	20,550	22,420	13,920	13,730	15,890	15.7%	-36.4%
	Percentage level 3+	20.8%	27.8%	25.5%	22.7%	28.0%	28.2%	28.5%	22.1%	23.8%	20.6%	-3.2%p	-0.1%p
Engineering and manufacturing technologies	Intermediate Apprenticeship	19,630	19,420	19,180	25,020	22,220	22,620	32,220	45,570	38,720	39,110	1.0%	99.2%
	Advanced Apprenticeship	18,650	15,670	18,000	22,200	20,540	19,850	22,340	24,040	27,470	25,450	-7.4%	36.5%
	Higher Apprenticeship	0	0	60	-	10	50	80	120	220	270	22.7%	-
	All apprenticeships	38,280	35,090	37,240	47,220	42,770	42,520	54,640	69,730	66,410	64,830	-2.4%	69.4%
	Percentage level 3+	48.7%	44.7%	48.5%	47.0%	48.0%	46.8%	41.0%	34.6%	41.7%	39.7%	-2.0%p	-
Information and communication technology	Intermediate Apprenticeship	4,500	3,310	3,810	4,130	5,000	5,720	8,640	8,430	5,440	4,590	-15.6%	2.0%
	Advanced Apprenticeship	1,560	3,180	1,950	2,570	3,770	6,710	10,830	9,910	8,270	7,820	-5.4%	401.3%
	Higher Apprenticeship	0	0	20	60	60	140	60	190	420	660	57.1%	-
	All apprenticeships	6,060	6,490	5,790	6,760	8,820	12,570	19,520	18,520	14,120	13,060	-7.5%	115.5%
	Percentage level 3+	25.7%	49.0%	34.0%	38.9%	43.4%	54.5%	55.8%	54.5%	61.5%	64.9%	3.4%p	39.2%p
Sub-total all engineering related Sector Subject Areas	Intermediate Apprenticeship	43,940	37,950	43,320	50,170	44,110	43,100	56,880	64,850	54,630	46,910	-14.1%	6.8%
	Advanced Apprenticeship	25,400	24,720	26,920	30,950	30,870	32,350	39,570	37,030	38,950	33,340	-14.4%	31.3%
	Higher Apprenticeship	0	0	80	60	70	190	140	310	700	1,000	42.9%	-
	All apprenticeships	69,340	62,670	70,330	81,180	75,030	75,640	96,580	102,170	94,260	93,780	-0.5%	35.2%
	Percentage level 3+	36.6%	39.4%	38.4%	38.2%	41.2%	43.0%	41.1%	36.5%	42.1%	36.6%	-5.4%p	0.0%p
All engineering related Sector Subject Areas as a proportion of all Sector subject Areas	Intermediate Apprenticeship	32.5%	30.9%	34.0%	33.1%	27.8%	22.6%	18.9%	19.7%	18.7%	16.4%	-2.3%	-49.7%
	Advanced Apprenticeship	47.1%	47.4%	47.3%	42.5%	38.0%	36.9%	25.7%	19.7%	18.8%	23.0%	4.3%	-51.1%
	Higher Apprenticeship	0.0%	0.0%	80.0%	60.0%	35.0%	12.7%	6.4%	8.4%	7.1%	10.9%	3.7%	-
	All apprenticeships	36.7%	35.8%	38.1%	36.1%	31.3%	27.0%	21.1%	19.6%	18.5%	21.3%	2.8%p	-15.4%p

774 Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred. 775 In this table full-year numbers are a count of the number of starts at any point during the year. Learners starting more than one apprenticeship will appear more than once. 776 Figures for 2011/12 onwards are not directly comparable to earlier years as a Single Individualised Learner Record (ILR) data collection system has been introduced. Small technical changes have been made in the way learners from more than one provision type are counted, leading to a removal of duplicate learners and a reduction in overall learner numbers of approximately 2%. 777 – Indicates a base value of less than 5

Table 10.3: Apprenticeship Programme Starts by Sector Subject Area and level (2004/05-2013/14) – England[774, 775, 776, 777] – continued

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 10 years
Science and mathematics	Intermediate Apprenticeship	-	-	-	-	-	-	-	90	70	80	14.3%	-
	Advanced Apprenticeship	-	-	-	-	-	-	10	280	250	280	12.0%	-
	Higher Apprenticeship	-	-	-	-	-	-	0	-	-	-	-	-
	All apprenticeships	-	-	-	-	-	-	10	370	250	360	44.0%	-
	Percentage level 3+	0	0	0	0	0	0	100.0%	75.7%	100.0%	77.8%	-22.2%p	-
All Sector Subject Areas	Intermediate Apprenticeship	135,100	122,800	127,400	151,800	158,500	190,500	301,100	329,000	292,800	286,500	-2.2%	112.1%
	Advanced Apprenticeship	53,900	52,100	56,900	72,900	81,300	87,700	153,900	187,900	207,700	144,700	-30.3%	168.5%
	Higher Apprenticeship	0	0	100	100	200	1,500	2,200	3,700	9,800	9,200	-6.1%	-
	All apprenticeships	189,000	175,000	184,400	224,800	239,900	279,700	457,200	520,600	510,200	440,400	-13.7%	133.0%
	Percentage level 3+	28.5%	29.8%	30.9%	32.5%	34.0%	31.9%	34.1%	36.8%	42.6%	34.9%	-7.7%p	6.4%p

Source: The Data Service

Considering programme starts by age, Table 10.4 shows that in 2013/14, construction, planning and the built environment had the youngest demographic, with only 7.9% of apprenticeships started by those aged 25 years or older. In contrast, nearly a quarter (24.9%) of those starting engineering and manufacturing technologies apprenticeships were over 25, whilst across all subject areas, the average figure is 36.7%.

Figures 10.2 to 10.4 reveal the ten-year trend in apprenticeship starts by age. The figures show that, over the last 10 years, the numbers of starts by those aged 25 or older have increased substantially for all engineering-related Sector Subject Areas.

This can be mostly attributed to changes in how apprenticeships are funded. In 2005, a pilot programme for adult apprenticeships was established. Subsequently, the number of adult apprentices remained low until in 2007/08, when a £25 million uplift in funding initiated a surge in adult apprenticeship starts.[780]

However, 2013/14 marks a shift in this pattern. The proportion of 25+ apprentices started to decrease across all engineering-related apprenticeship frameworks, and was met by a rise in the number of starts by those ages 19 or younger. Although it is too early to tell if this is a result of recent government reforms, it will be interesting to see if this trend continues over the coming years.

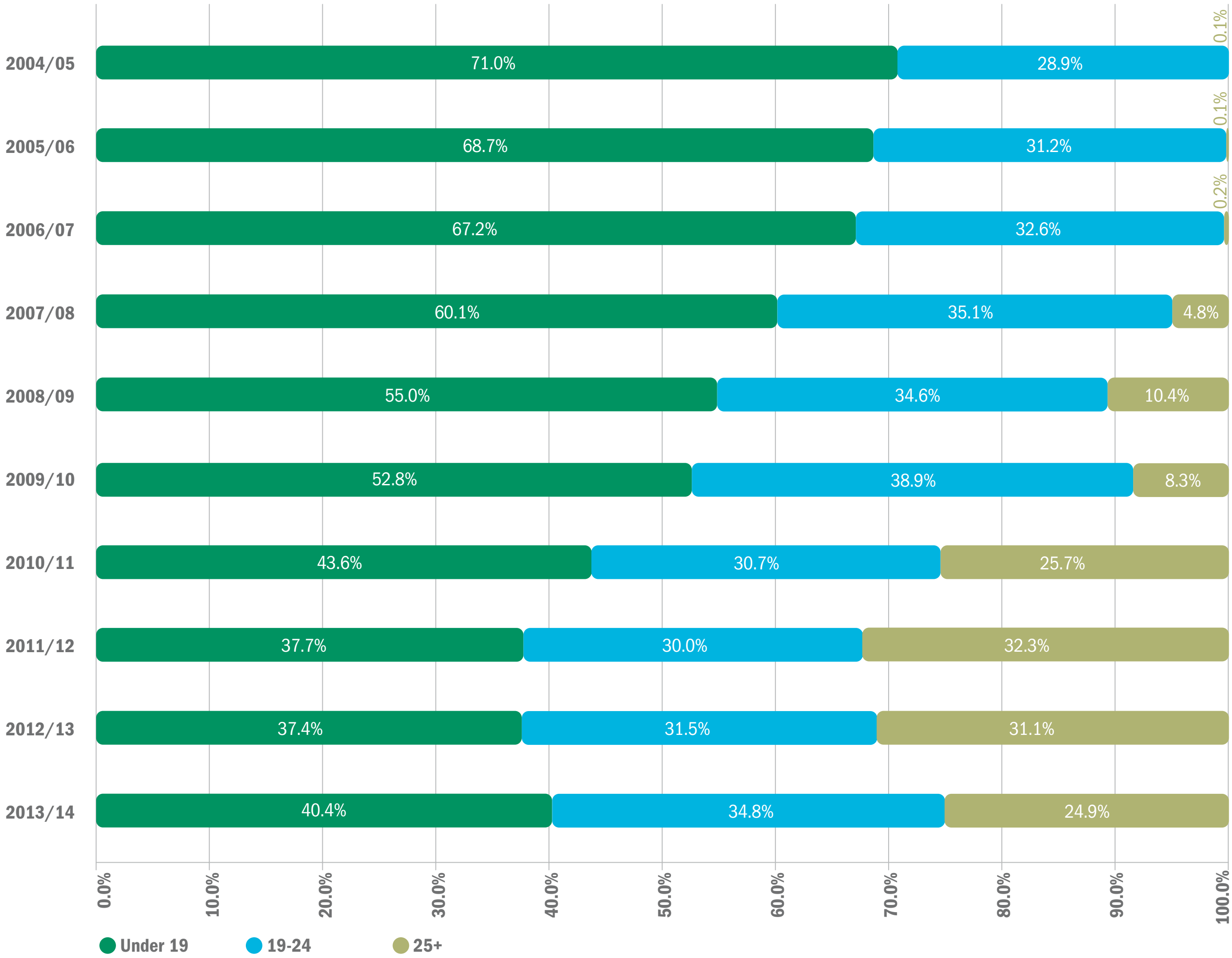
Table 10.4: Apprenticeship Programme Starts by Sector Subject Area, level and age (2013/14) – England[778, 779]

	Age	Intermediate Apprenticeship	Advanced Apprenticeship	Higher Apprenticeship	All apprenticeships
Construction, planning and the built environment	Under 19	7,890	1,320	10	9,220
	19-24	3,680	1,680	50	5,410
	25+	1,030	210	10	1,260
	All ages	12,600	3,210	70	15,890
	Percentage of all apprentices aged 25+	8.2%	6.5%	14.3%	7.9%
Engineering and manufacturing technologies	Under 19	14,480	11,600	100	26,180
	19-24	11,180	11,200	150	22,530
	25+	13,450	2,660	20	16,120
	All ages	39,110	25,450	270	64,830
	Percentage of all apprentices aged 25+	34.4%	10.5%	0.1%	24.9%
Information and communication technology	Under 19	1,050	3,770	210	5,040
	19-24	1,730	3,190	420	5,340
	25+	1,800	850	30	2,680
	All ages	4,590	7,820	660	13,060
	Percentage of all apprentices aged 25+	39.2%	10.9%	4.5%	20.5%
Sub-total all engineering related Sector Subject Areas	Under 19	23,420	16,690	320	40,440
	19-24	16,590	16,070	620	33,280
	25+	16,280	3,720	60	20,060
	All ages	56,300	36,480	1,000	93,780
	Percentage of all apprentices aged 25+	28.9%	10.2%	0.2%	21.4%
Science and mathematics	Under 19	10	120	-	130
	19-24	30	90	-	120
	25+	30	40	-	70
	All ages	70	250	-	320
	Percentage of all apprentices aged 25+	42.9%	16.0%	-	21.9%
All Sector Subject Areas	Under 19	83,400	35,600	700	119,800
	19-24	97,000	59,300	2,900	159,100
	25+	106,100	49,800	5,600	161,600
	All ages	286,500	144,700	9,200	440,400
	Percentage of all apprentices aged 25+	37.0%	34.4%	60.9%	36.7%

Source: The Data Service

778 Figures for 2011/12 onwards are not directly comparable to earlier years as a Single Individualised Learner Record (ILR) data collection system has been introduced. Small technical changes have been made in the way learners from more than one provision type are counted, leading to a removal of duplicate learners and a reduction in overall learner numbers of approximately 2%. 779 Age is calculated based on age at start of the programme rather than based on 31 August. 780 London Economics: An international comparison of apprentice pay: Final Report for the Low Pay Commission, October 2013, p4

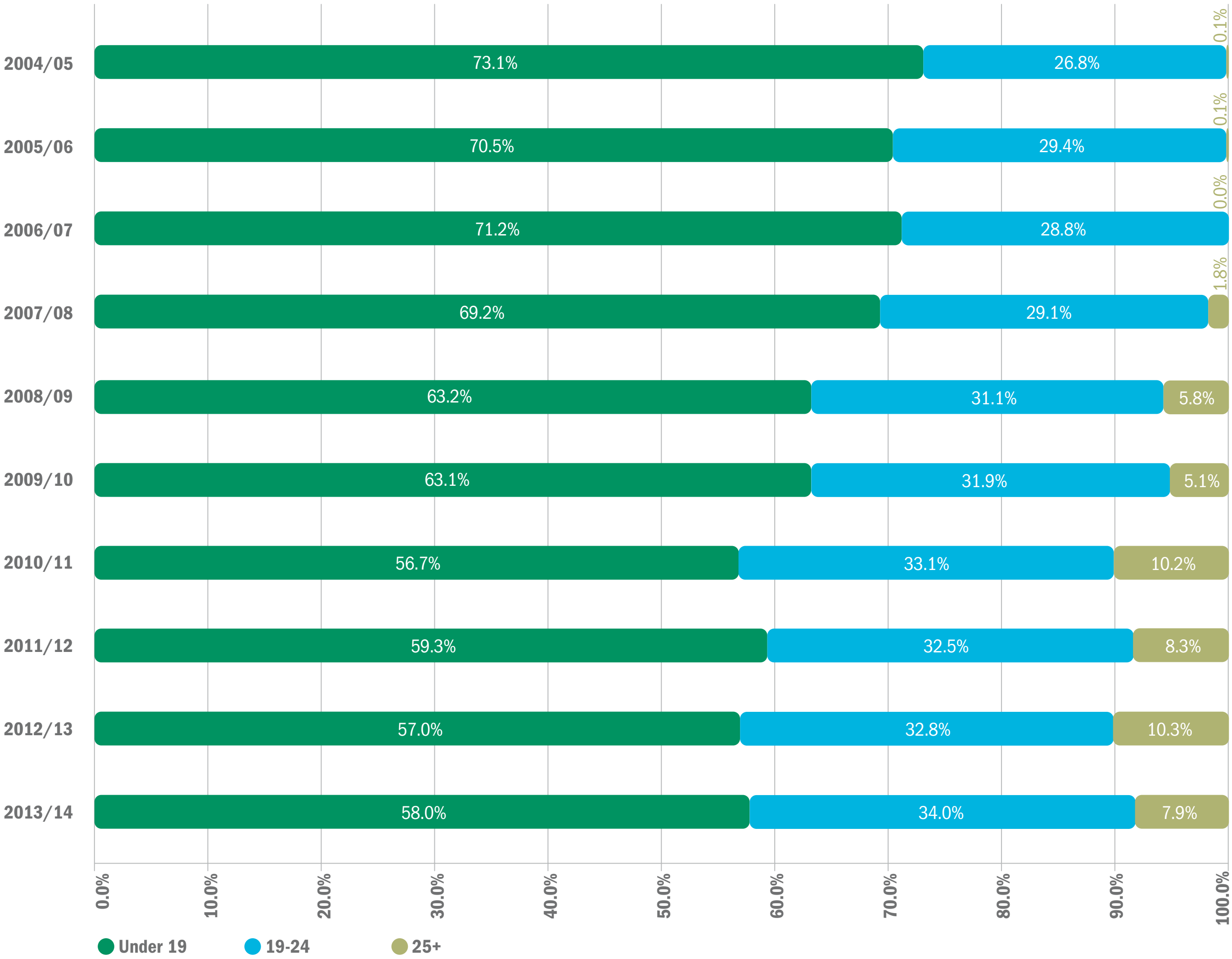
Figure 10.2: Apprenticeship Programme Starts in engineering and manufacturing technologies by age (2004/05-2013/14) – England[781, 782, 783]



Source: The Data Service

781 24+ Advanced Learning Loans were introduced in August 2013. Data show that the number of apprenticeship starts for those aged 24 and above studying at level 3 and above has been directly affected. There is also some anecdotal evidence that the numbers of starts for other ages may have been indirectly affected. The Skills Funding Statement in February 2014 announced that regulations have been laid to remove apprenticeships from loan funding and make them eligible for funding via the Adult Skills Budget. 782 Figures for 2011/12 onwards are not directly comparable to earlier years as a Single Individualised Learner Record (ILR) data collection system has been introduced. Small technical changes have been made in the way learners from more than one provision type are counted, leading to a removal of duplicate learners and a reduction in overall learner numbers of approximately 2%. 783 Age is calculated based on age at start of the programme rather than based on 31 August.

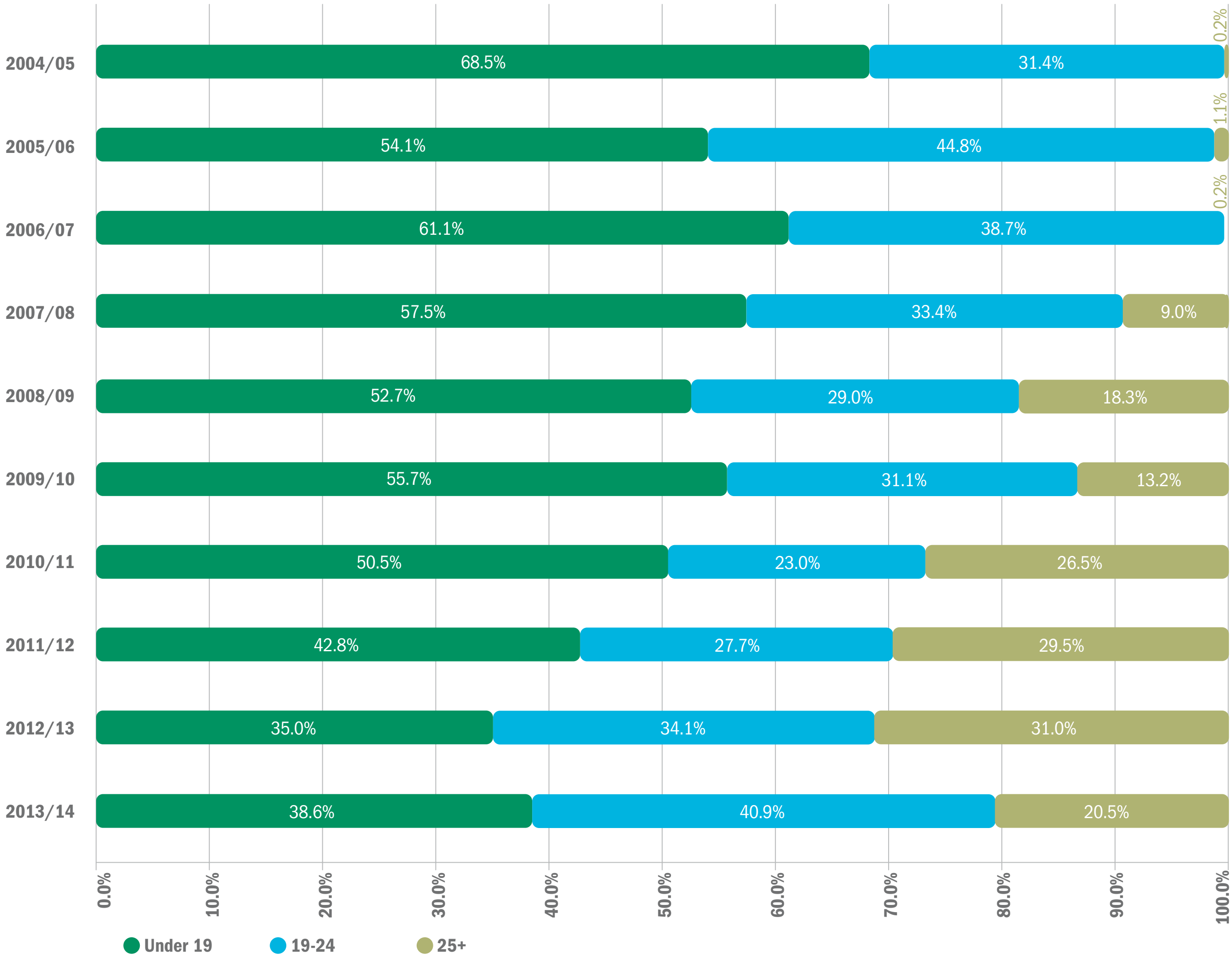
Figure 10.3: Apprenticeship Programme Starts in construction, planning and the built environment by age (2004/05-2013/14) – England[784, 785, 786]



Source: The Data Service

784 24+ Advanced Learning Loans were introduced in August 2013. Data show that the number of apprenticeship starts for those aged 24 and above studying at level 3 and above has been directly affected. There is also some anecdotal evidence that the numbers of starts for other ages may have been indirectly affected. The Skills Funding Statement in February 2014 announced that regulations have been laid to remove apprenticeships from loan funding and make them eligible for funding via the Adult Skills Budget. 785 Figures for 2011/12 onwards are not directly comparable to earlier years as a Single Individualised Learner Record (ILR) data collection system has been introduced. Small technical changes have been made in the way learners from more than one provision type are counted, leading to a removal of duplicate learners and a reduction in overall learner numbers of approximately 2%. 786 Age is calculated based on age at start of the programme rather than based on 31 August.

Figure 10.4: Apprenticeship Programme Starts in information and communication technology by age (2004/05-2013/14) – England[787, 788, 789]



Source: The Data Service

787 24+ Advanced Learning Loans were introduced in August 2013. Data show that the number of apprenticeship starts for those aged 24 and above studying at level 3 and above has been directly affected. There is also some anecdotal evidence that the numbers of starts for other ages may have been indirectly affected. The Skills Funding Statement in February 2014 announced that regulations have been laid to remove apprenticeships from loan funding and make them eligible for funding via the Adult Skills Budget. 788 Figures for 2011/12 onwards are not directly comparable to earlier years as a Single Individualised Learner Record (ILR) data collection system has been introduced. Small technical changes have been made in the way learners from more than one provision type are counted, leading to a removal of duplicate learners and a reduction in overall learner numbers of approximately 2%. 789 Age is calculated based on age at start of the programme rather than based on 31 August.

Table 10.5 shows that, for those aged 19 or under, the average length of an apprenticeship has increased, with the number of those starting programmes lasting 12 months or more increasing by 5.9%. As a result, in 2013/14, 98.0% of apprenticeships started by those aged 19 or younger had a planned duration of 12 months or more. However, across all apprenticeship starts, the proportion that had a planned length of 12 months or more declined between 2012/13 and 2013/14, from 93.3% to 91.9%.

Table 10.5: All age apprenticeship starts by age and planned length of stay (2008/09-2013/14)

Age	Planned length of stay	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 6 years
Under 19	Fewer than 12 months	21,600	39,000	57,600	45,800	3,700	2,400	-35.1%	-88.9%
	12 months or more	77,800	77,800	74,100	84,100	110,900	117,400	5.9%	50.9%
	Total	**99,400**	**116,800**	**131,700**	**129,900**	**114,500**	**119,800**	**4.6%**	**20.5%**
	% 12 months or more	78.3%	66.6%	56.3%	64.7%	96.9%	98.0%	1.1%p	19.7%p
19-24	Fewer than 12 months	26,600	46,700	67,500	67,300	14,800	16,100	8.8%	-39.5%
	12 months or more	58,100	67,100	75,900	94,100	150,600	143,100	-5.0%	146.3%
	Total	**84,700**	**113,800**	**143,400**	**161,400**	**165,400**	**159,100**	**-3.8%**	**87.8%**
	% 12 months or more	68.6%	59.0%	52.9%	58.3%	91.1%	89.9%	-1.1%p	21.3%p
25+	Fewer than 12 months	18,200	22,300	81,400	91,300	15,900	17,100	7.5%	-6.0%
	12 months or more	37,700	26,800	100,600	137,900	214,400	144,400	-32.6%	283.0%
	Total	**55,900**	**49,100**	**182,100**	**229,300**	**230,300**	**161,600**	**-29.8%**	**189.1%**
	% 12 months or more	67.4%	54.6%	55.2%	60.1%	93.1%	89.4%	-3.7%p	21.9%p
All apprenticeships	Fewer than 12 months	66,300	108,000	206,600	204,400	34,300	35,600	3.8%	-46.3%
	12 months or more	173,600	171,700	250,600	316,200	475,900	404,900	-14.9%	133.2%
	Total	**239,900**	**279,700**	**457,200**	**520,600**	**510,200**	**440,400**	**-13.7%**	**83.6%**
	% 12 months or more	72.4%	61.4%	54.8%	60.7%	93.3%	91.9%	-1.3%p	19.6%p

Source: The Data Service

10.4 Apprenticeship starts and participation by region

Table 10.6 shows programme starts by English region and Sector Subject Area. At 16.5%, the North West had the largest proportion of apprenticeship starts of any English region, followed by the South East (13.9%). However, the South East came top for engineering-related apprenticeships, with 16.4% of the total. London had the lowest number of engineering-related apprenticeship starts, which is not surprising, as the region's economy is heavily weighted towards the services sector. Proportionately, manufacturing and construction businesses are under-represented in London compared to other parts of England.[790]

In addition to starts, the proportion of employers offering apprenticeships varies by English region. Research conducted by UKCES reveals that, in contrast to the number of starts, the proportion of employers in the south of England offering apprenticeships is generally lower than across the rest of England. Furthermore, employers in Leeds and Manchester are substantially more likely than those in London to have offered apprenticeships and to do so in the future.[791] The take home message from this finding is that, the area where an individual lives can bear a strong influence on their opportunity to undertake an apprenticeship.

Table 10.7 looks at participation in apprenticeships. In 2013/14, a total of 841,820 apprenticeships were being participated in across all English regions. As with starts, London had the lowest rate of engineering-related apprenticeship participation, at only 7.0% of the total. However, the South East region had the highest participation, at 30,820.

Table 10.6: Apprenticeship Programme Starts by region and Sector Subject Area (2013/14) – England[792, 793, 794, 795]

		English region									
		North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East of England	London	South East	South West	England total
Construction, planning and the built environment	Number	1,330	2,740	2,000	1,370	1,800	1,290	1,110	1,930	2,050	**15,640**
	Percentage of total	8.5%	17.5%	12.8%	8.8%	11.5%	8.2%	7.1%	12.3%	13.1%	
Engineering and manufacturing technologies	Number	4,670	9,450	7,430	5,750	9,080	5,550	4,000	10,730	7,180	**63,850**
	Percentage of total	7.3%	14.8%	11.6%	9.0%	14.2%	8.7%	6.3%	16.8%	11.2%	
Information and communication technology	Number	720	1,690	1,060	780	1,350	920	1,560	2,530	2,280	**12,890**
	Percentage of total	5.6%	13.1%	8.2%	6.1%	10.5%	7.1%	12.1%	19.6%	17.7%	
Sub-total all engineering related Sector Subject Areas	Number	6,720	13,880	10,490	7,900	12,230	7,760	6,670	15,190	11,510	**92,380**
	Percentage of total	7.3%	15.0%	11.4%	8.6%	13.2%	8.4%	7.2%	16.4%	12.5%	
Science and mathematics	Number	40	90	70	30	30	30	10	40	20	**350**
	Percentage of total	11.4%	25.7%	20.0%	8.6%	8.6%	8.6%	2.9%	11.4%	5.7%	
All Sector Subject Areas	Number	30,480	71,670	53,120	40,290	52,410	40,430	40,050	60,220	45,960	**434,600**
	Percentage of total	7.0%	16.5%	12.2%	9.3%	12.1%	9.3%	9.2%	13.9%	10.6%	

Source: The Data Service

Table 10.7: Apprenticeship participation by region and Sector Subject Area (2013/14) – England[796]

		English region									
		North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East of England	London	South East	South West	England total
Construction, planning and the built environment	Number	2,340	4,960	3,210	2,580	3,150	2,390	2,100	3,650	3,850	**28,230**
	Percent of total	8.3%	17.6%	11.4%	9.1%	11.2%	8.5%	7.4%	12.9%	13.6%	
Engineering and manufacturing technologies	Number	10,190	20,520	16,610	13,400	19,770	12,420	8,870	22,660	15,580	**140,030**
	Percent of total	7.3%	14.7%	11.9%	9.6%	14.1%	8.9%	6.3%	16.2%	11.1%	
Information and communication technology	Number	1,500	3,280	2,330	1,560	2,890	1,920	2,570	4,510	4,240	**24,810**
	Percent of total	6.0%	13.2%	9.4%	6.3%	11.6%	7.7%	10.4%	18.2%	17.1%	
Sub-total all engineering related Sector Subject Areas	Number	14,030	28,760	22,150	17,540	25,810	16,730	13,540	30,820	23,670	**193,070**
	Percent of total	7.3%	14.9%	11.5%	9.1%	13.4%	8.7%	7.0%	16.0%	12.3%	
Science and mathematics	Number	70	180	140	50	50	90	20	100	50	**750**
	Percent of total	9.3%	24.0%	18.7%	6.7%	6.7%	12.0%	2.7%	13.3%	6.7%	
All Sector Subject Areas	Number	58,520	138,460	101,160	79,400	102,680	78,590	77,130	116,890	88,990	**841,820**
	Percent of total	7.0%	16.4%	12.0%	9.4%	12.2%	9.3%	9.2%	13.9%	10.6%	

Source: The Data Service

790 UK Commission for Employment and Skills: Geographical variation in the offering of Apprenticeships now and in the future: data from the Employer Perspectives Survey, 2014 791 *Ibid.* 792 Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred. 793 In this table full-year numbers are a count of the number of starts at any point during the year. Learners starting more than one apprenticeship will appear more than once. 794 Region is based upon the home postcode of the learner. Where the learner has a home postcode outside of England, they have been excluded from this table 795 These figures are based on the geographic boundaries of regions as of May 2010 796 Totals do not sum as an apprentice can participate in more than one Sector Subject Area in one academic year.

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Table 10.8 shows the estimated number of workplaces employing apprentices by English region. In total, 240,000 workplaces were offering apprenticeships across the whole of England, an increase of 6.4% on the previous year. This increase corresponds with research conducted by UKCES, which estimates that the proportion of employers offering formal apprenticeships has increased since 2012, from 13% to 15%.[797]

According to the analysis, employers in England, large establishments and those in the non-market services, manufacturing and construction sectors were more likely to offer formal apprenticeships. Overall, UKCES found that a third of employers in the UK stated that they plan to offer apprenticeships in the future.[798] However, this figure is still below other advanced economies. For example, 51% of companies in Germany offer apprenticeships, and Switzerland offers seven times as many high quality apprenticeships for its population size.[799]

Table 10.8: Workplaces employing apprentices by region (2009/10-2014/15 in-year estimates) – England[800, 801, 802]

Region	2009/10 full year	2010/11 full year	2011/12 full year	2012/13 full year	2013/14 full year	Change 1 year	Change 5 year
North East	8,060	10,730	12,250	14,000	14,550	3.9%	80.5%
North West	21,390	28,840	32,230	37,990	40,080	5.5%	87.4%
Yorkshire and The Humber	14,760	20,090	23,270	26,510	27,560	4.0%	86.7%
East Midlands	12,820	16,960	18,940	22,220	23,280	4.8%	81.6%
West Midlands	13,950	19,080	22,420	25,730	26,890	4.5%	92.8%
East of England	12,210	16,910	19,830	23,010	24,470	6.3%	100.4%
London	8,770	13,490	16,550	20,200	21,780	7.8%	148.3%
South East	17,000	23,420	27,330	32,680	34,380	5.2%	102.2%
South West	15,970	20,960	23,440	26,190	27,170	3.7%	70.1%
England Total	**124,900**	**168,600**	**193,800**	**225,600**	**240,000**	**6.4%**	**92.2%**

Source: The Data Service

10.5 Apprenticeship achievements

Table 10.9 displays the number of apprentice achievements by Sector Subject Area over a 10-year period. Overall, achievements increased by 1.1% between 2012/13 and 2013/14, with the percentage of achievements at level 3 or above growing by 2.8 percentage points. There was a decline in total achievements for engineering-related subject areas, with the numbers falling by 710 (1.3%) in the same period. However, the proportion of level 3+ achievements rose by 2.7% percentage points. In contrast to starts, achievements for construction, planning and the built environment declined, with the numbers falling by 11.4%.

797 UK Commission for Employment and Skills: Geographical variation in the offering of Apprenticeships now and in the future: data from the Employer Perspectives Survey, 2014, pxviii 798 *Ibid.* 799 The Sutton Trust: Higher Ambitions Summit Rapporteur Report, July 2014, p15 800 The figures are a count of the number of individual workplaces (site level). 801 From 2010/11 onwards, geographic information is based on the delivery location of the apprenticeship. Note that some workplaces deliver apprenticeships in more than one location. 802 Figures for 2009/10 are not directly comparable with later years as there have been improvements in the way workplace information is recorded and processed.

Table 10.9: Apprenticeship achievements by Sector Subject Area and level (2004/05-2013/14) – England[803, 804]

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 10 years
Construction, planning and the built environment	Intermediate Apprenticeship	5,570	9,660	12,330	12,370	13,650	11,340	9,110	8,270	6,510	5,980	-8.1%	7.4%
	Advanced Apprenticeship	1,330	2,410	3,830	4,710	5,340	5,550	5,130	4,340	2,560	2,030	-20.7%	52.6%
	Higher Apprenticeship	0	0	0	-	-	-	-	-	-	10	-	
	All apprenticeships	6,900	12,070	16,160	17,080	18,980	16,890	14,240	12,600	9,060	8,030	-11.4%	16.4%
	Percentage level 3+	19.3%	20.0%	23.7%	27.6%	28.1%	32.9%	36.0%	34.4%	28.3%	25.4%	-2.9%p	-28.3%p
Engineering and manufacturing technologies	Intermediate Apprenticeship	6,900	10,410	11,600	11,180	13,870	15,300	15,830	20,130	23,790	22,740	-4.4%	229.6%
	Advanced Apprenticeship	8,430	11,910	12,040	11,320	12,350	14,720	15,360	14,400	13,370	14,470	8.2%	71.6%
	Higher Apprenticeship	0	0	0	-	10	20	-	20	20	30	50.0%	
	All apprenticeships	15,330	22,310	23,640	22,500	26,230	30,030	31,190	34,550	37,180	37,240	0.2%	142.9%
	Percentage level 3+	55.0%	53.4%	50.9%	50.3%	47.1%	49.1%	49.2%	41.7%	36.0%	38.9%	2.9%p	-36.0%p
Information and communication technology	Intermediate Apprenticeship	1,790	2,800	3,020	2,540	3,290	3,930	4,130	4,680	3,400	3,100	-8.8%	73.2%
	Advanced Apprenticeship	1,090	1,140	1,120	2,290	2,380	3,830	6,320	4,680	4,130	4,640	12.3%	325.7%
	Higher Apprenticeship	0	0	0	-	-	20	60	40	50	100	100.0%	
	All apprenticeships	2,870	3,930	4,140	4,820	5,670	7,770	10,510	9,400	7,580	7,840	3.4%	173.2%
	Percentage level 3+	38.0%	29.0%	27.1%	47.5%	42.0%	49.5%	60.7%	50.2%	55.1%	60.5%	5.3%p	-55.1%p
Sub-total all engineering related Sector Subject Areas	Intermediate Apprenticeship	14,260	22,870	26,950	26,090	30,810	30,570	29,070	33,080	33,700	31,820	-5.6%	123.1%
	Advanced Apprenticeship	10,850	15,460	16,990	18,320	20,070	24,100	26,810	23,420	20,060	21,140	5.4%	94.8%
	Higher Apprenticeship	0	0	0	-	10	40	60	60	70	140	16.7%	
	All apprenticeships	25,100	38,310	43,940	44,400	50,880	54,690	55,940	56,550	53,820	53,110	-1.3%	111.6%
	Percentage level 3+	43.2%	40.4%	38.7%	41.3%	39.5%	44.1%	48.0%	41.5%	37.4%	40.1%	2.7%p	-37.4%p
Science and mathematics	Intermediate Apprenticeship	-	-	-	-	-	-	-	-	50	30	-40.0%	
	Advanced Apprenticeship	-	-	-	-	-	-	-	10	60	110	83.3%	
	Higher Apprenticeship	0	0	0	0	0	0	0	0	-	-	-	
	All apprenticeships	-	-	-	-	-	-	-	10	120	140	16.7%	
	Percentage level 3+								100.0%	50.0%	78.6%	28.6%p	
All Sector Subject Areas	Intermediate Apprenticeship	48,400	70,300	78,400	76,300	98,100	111,900	131,700	172,400	156,300	150,900	-3.5%	211.8%
	Advanced Apprenticeship	18,900	28,400	33,400	36,200	45,200	59,400	67,500	84,700	95,000	102,200	7.6%	440.7%
	Higher Apprenticeship	0	0	0	-	-	200	1,000	1,200	1,600	2,700	68.8%	
	All apprenticeships	67,200	98,700	111,800	112,600	143,400	171,500	200,300	258,400	252,900	255,800	1.1%	280.7%
	Percentage level 3+	28.1%	28.8%	29.9%	32.1%	31.5%	34.6%	34.2%	33.2%	38.2%	41.0%	2.8%p	-38.2%p

Source: The Data Service

803 Figures for 2011/12 onwards are not directly comparable to earlier years as a Single Individualised Learner Record (ILR) data collection system has been introduced. Small technical changes have been made in the way learners from more than one provision type are counted, leading to a removal of duplicate learners and a reduction in overall learner numbers of approximately 2% 804 Figures for Sector Subject Area in 2012/13 are recorded on a different basis to earlier years due to a change in the way apprenticeship frameworks are allocated to Sector Subject Areas. Comparisons should not be made with previous years. The back series will be changed to be on a consistent basis when full year data are available.

Data on gender for Sector Subject Areas is not available. However, considering engineering-related sector framework areas (Table 10.10) shows that, whilst the number of male achievements grew slightly by 0.2%, female achievement for engineering-related frameworks fell by -1.4% between 2012/13 and 2013/14. This pattern was much larger for the dedicated engineering framework, with male achievements increasing by 2.5% whilst female achievements fell by 4.2%.

Table 10.11 displays the number of apprenticeship achievements by level and age. It is interesting to note that for EMT and ICT apprenticeships, as the level increases the age of those achieving them becomes younger. For example, for EMT, those aged 25 years or older

Table 10.10: Apprenticeship Framework Achievements by sector framework code, level and gender (2012/13-2013/14) – England

	2012/13				2013/14				Change over 1 year		
Sector Framework Code	**Male**	**Female**	**All**	**% Female**	**Male**	**Female**	**All**	**% Female**	**Male**	**Female**	**All**
Aviation operations on the ground	340	160	500	32.0%	470	150	610	24.6%	38.2%	-6.3%	22.0%
Building services engineering technicians	30	-	30		40	-	40		33.3%		33.3%
Ceramics manufacturing	30	30	60	50.0%	20	40	60	66.7%	-33.3%	33.3%	0.0%
Electrical and electronic servicing	10	-	10		30	-	30		200.0%		200.0%
Electrotechnical	2,850	30	2,880	1.0%	2,190	20	2,210	0.9%	-23.2%	-33.3%	-23.3%
Engineering	7,230	240	7,470	3.2%	7,410	230	7,630	3.0%	2.5%	-4.2%	2.1%
Engineering construction	280	10	290	3.4%	260	20	270	7.4%	-7.1%	100.0%	-6.9%
Engineering technology	20	-	20		30	-	30		50.0%		50.0%
Extractive and mineral processing occupations	10	-	10		-	-	-				
Food manufacture	1,030	480	1,500	32.0%	1,400	520	1,910	27.2%	35.9%	8.3%	27.3%
Gas industry	530	20	550	3.6%	240	10	250	4.0%	-54.7%	-50.0%	-54.5%
Glass industry occupations	1,920	20	1,940	1.0%	1,220	10	1,230	0.8%	-36.5%	-50.0%	-36.6%
Heating, ventilation, air conditioning and refrigeration	520	10	530	1.9%	550	-	550		5.8%		3.8%
Industrial applications	8,920	1,150	10,070	11.4%	8,370	950	9,320	10.2%	-6.2%	-17.4%	-7.4%
It and telecoms professionals	4,280	410	4,700	8.7%	4,440	490	4,930	9.9%	3.7%	19.5%	4.9%
Land-based service engineering	190	-	190		170	-	170				
MES plumbing	2,190	40	2,230	1.8%	2,580	60	2,640	2.3%	17.8%	50.0%	18.4%
Metals processing	10	-	10		-	-	-				
Paper manufacture	-	-	-		10	-	10				
Polymer processing and signmaking	10	-	20		30	10	40	25.0%	200.0%		100.0%
Power industry	110	-	110		120	-	130		9.1%		18.2%
Print and printed packaging	150	30	170	17.6%	180	30	210	14.3%	20.0%	0.0%	23.5%
Process technology	110	20	130	15.4%	100	10	110	9.1%	-9.1%	-50.0%	-15.4%
Rail infrastructure engineering	10	-	10		200	-	200		1900.0%		1900.0%
Rail services	120	20	140	14.3%	180	50	230	21.7%	50.0%	150.0%	64.3%
Rail traction and rolling stock engineering	-	-	-		20	-	20				
Rail transport engineering	1,010	10	1,020	1.0%	1,150	10	1,160	0.9%	13.9%	0.0%	13.7%
Roadside assistance and recovery	30	-	30		-	-	-				
Smart meter installations (dual fuel)	-	-	-		40	-	50				
Transport engineering and maintenance	110	-	110		180	10	190	5.3%	63.6%		72.7%
Vehicle body and paint operations	540	10	550	1.8%	530	-	530		-1.9%		-3.6%
Vehicle fitting	220	-	220		390	10	400	2.5%	77.3%		81.8%
Vehicle maintenance and repair	5,000	60	5,060	1.2%	5,360	80	5,440	1.5%	7.2%	33.3%	7.5%
Vehicle parts operations	370	20	390	5.1%	360	20	380	5.3%	-2.7%	0.0%	-2.6%
Water industry	110	-	120		90	-	90		-18.2%		-25.0%
Sub-total engineering related frameworks	**38,290**	**2,770**	**41,070**	**6.7%**	**38,360**	**2,730**	**41,070**	**6.6%**	**0.2%**	**-1.4%**	**0.0%**
Grand total	**116,400**	**136,400**	**252,900**	**53.9%**	**117,600**	**138,100**	**255,800**	**54.0%**	**1.0%**	**1.2%**	**1.1%**
Percentage engineering related framework	**32.9%**	**2.0%**	**16.2%**	**12.5%**	**32.6%**	**2.0%**	**16.1%**	**12.3%**	**-0.3%**	**-0.1%**	**-0.2%**

Source: The Data Service

accounted for 34.7% of intermediate achievements, however, this figure falls to 16.4% for Advanced Apprenticeships and 0.0% for Higher Apprenticeships. The trend is similar for ICT achievements. However, this trend does not hold for achievements in construction, planning and the built environment, where only 1% fewer over-25s achieved an Advanced Apprenticeship than an intermediate one.

Table 10.11: Apprenticeship achievements by Sector Subject Area, level and age (2013/14) – England[805]

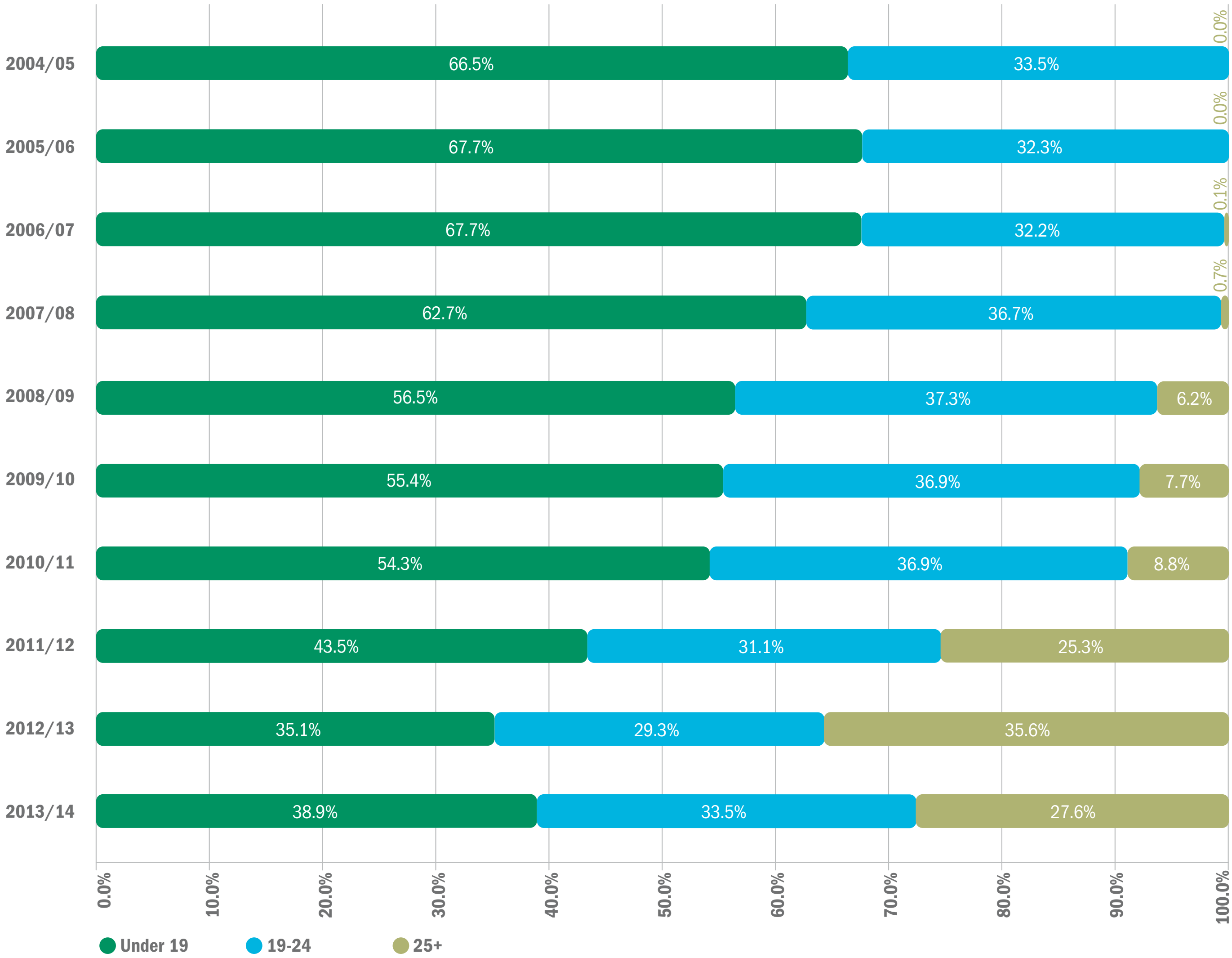
	Age	Intermediate Apprenticeship	Advanced Apprenticeship	Higher Apprenticeship	All apprenticeships
Construction, planning and the built environment	Under 19	3,730	800	-	4,530
	19-24	1,720	1,080	10	2,800
	25+	530	160	10	690
	All ages	5,980	2,030	10	8,030
	Percentage of all apprentices aged 25+	8.9%	7.9%	50.0%	8.6%
Engineering and manufacturing technologies	Under 19	8,500	5,980	20	14,500
	19-24	6,350	6,120	10	12,480
	25+	7,890	2,370	-	10,260
	All ages	22,740	14,470	30	37,240
	Percentage of all apprentices aged 25+	34.7%	16.4%	0.0%	27.6%
Information and communication technology	Under 19	1,090	1,790	30	2,910
	19-24	920	1,760	60	2,740
	25+	1,090	1,090	10	2,190
	All ages	3,100	4,640	100	7,840
	Percentage of all apprentices aged 25+	35.2%	23.5%	10.0%	27.9%
Sub-total all engineering related Sector Subject Areas	Under 19	13,320	8,570	50	21,940
	19-24	8,990	8,960	80	18,020
	25+	9,510	3,620	20	13,140
	All ages	31,820	21,140	140	53,110
	Percentage of all apprentices aged 25+	29.9%	17.1%	14.3%	24.7%
Science and mathematics	Under 19	10	60	-	70
	19-24	20	30	-	50
	25+	-	20	-	20
	All ages	30	110	-	140
	Percentage of all apprentices aged 25+	0.0%	18.2%	0.0%	14.3%
All Sector Subject Areas	Under 19	45,200	20,000	200	65,400
	19-24	50,800	35,000	1,100	86,900
	25+	54,900	47,200	1,400	103,500
	All ages	150,900	102,200	2,700	255,800
	Percentage of all apprentices aged 25+	36.4%	46.2%	51.9%	40.5%

Source: The Data Service

805 Percentages and total may not reflect individual values due to rounding and suppression practices.

Figures 10.5 to 10.7 show the 10-year trend of apprenticeship achievements in engineering-related Sector Subject Areas by age. In accordance with the pattern for starts, the numbers of achievements by those aged 25 years or older rapidly increased from 2008/09 to 2012/13. However, in 2013/14 the trend began to reverse: the proportions of those under 19 achieving apprenticeships grew for all engineering-related Sector Subject Areas except for construction, planning and the built environment, which saw the proportion of over 19s grow by 1.1 percentage points.

Figure 10.5: Apprenticeship achievements in engineering and manufacturing technologies by age (2004/05-2013/14) – England



Source: The Data Service

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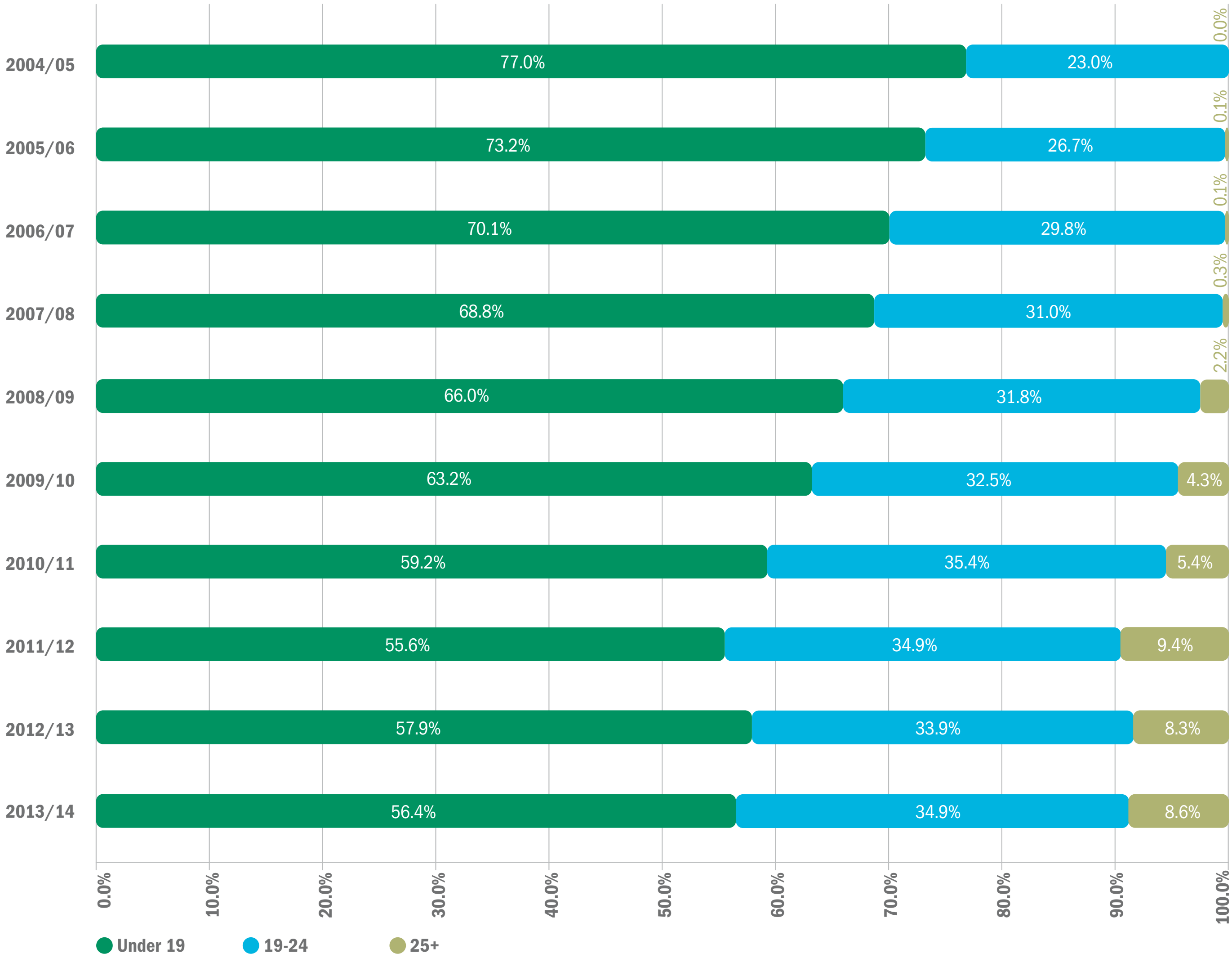
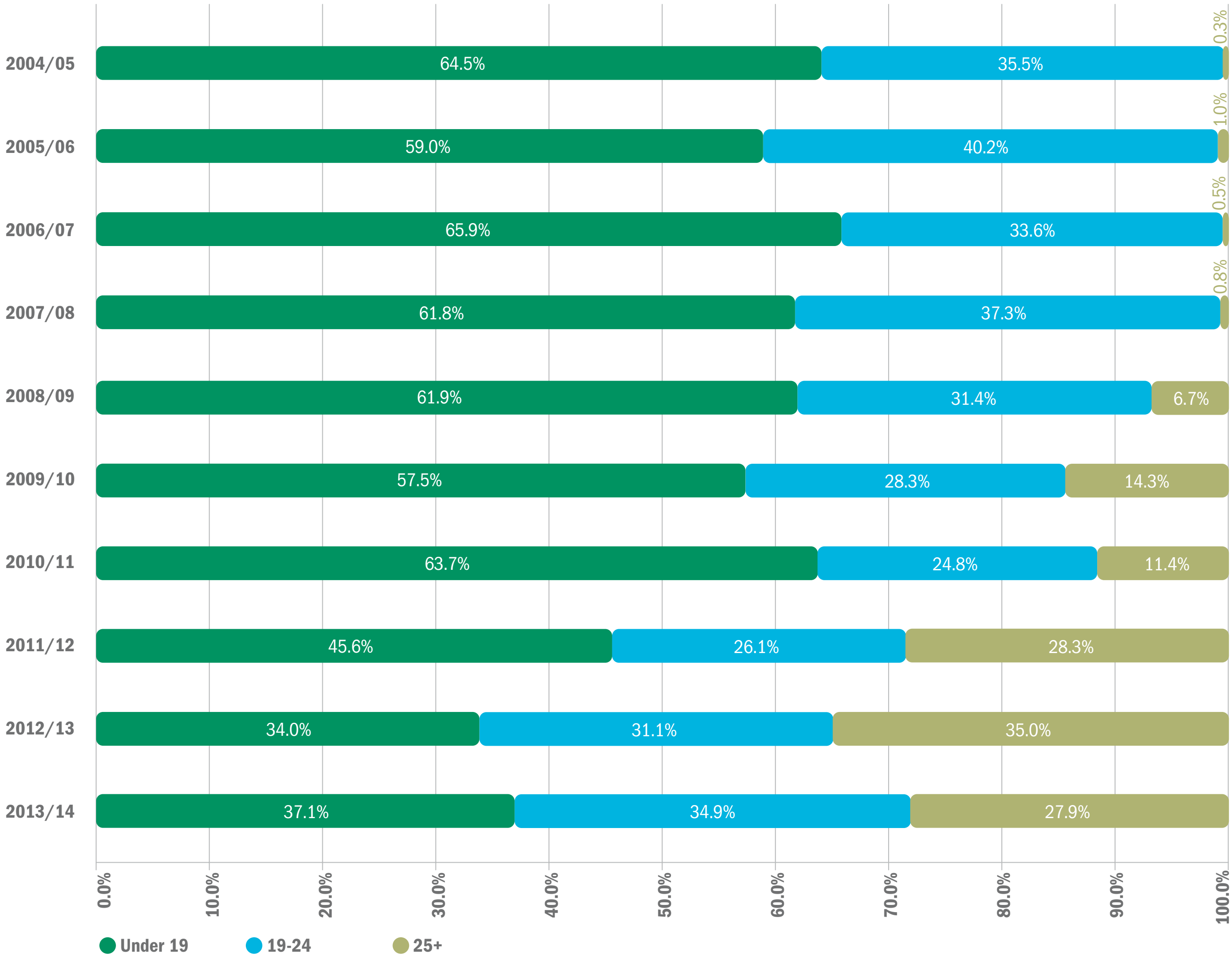
Figure 10.6: Apprenticeship achievements in construction, planning and the built environment by age (2004/05-2013/14) – England



Source: The Data Service

Figure 10.7: Apprenticeship achievements in information and communication technology by age (2004/05-2013/14) – England



Source: The Data Service

Apprenticeships: recognising professional competence

The engineering profession has always supported and driven high quality apprenticeship provision as a pathway to professional registration. Apprenticeships provide a work-based training programme for those who want to work in engineering and construction, and provide benefits to all stakeholders: apprentices who prefer a different approach to learning; employers who are keen to attract and develop the right people; and the industry, which needs to harness technical talent.

The engineering profession has been closely involved in the development of a wide range of Trailblazer Apprenticeships.[806] These align the standards set by employers with the established and respected Engineering Council standards for underpinning knowledge and competence: the Information and Communications Technology (ICT) Technician Standard[807] and the UK Standard for Professional Engineering Competence (UK-SPEC).[808]

The development of Trailblazer Apprenticeships has demonstrated a clear step change in approach. Although the underpinning qualifications to develop technical knowledge and competence have generally remained in place or been enhanced, the change comes through inclusion of professional behaviours within the new standards.

This approach to creating and underpinning apprenticeship standards will assure the government, apprentices and their employers that these training pathways meet the standards set by the profession. This also provides the opportunity for those who complete their apprenticeship to become professionally registered technicians and engineers.

The engineering profession already offers apprenticeship providers an opportunity to demonstrate the link to professional registration. By working with one or more professional engineering institutions and gaining 'approved for the purposes of professional registration' status, apprentices and their employers can be assured of the independent verification and quality assurance of the apprenticeship standard. Apprenticeships with approved status can be recognised through use of the Engineering Council Approved Apprenticeship logo. All approved qualifications and apprenticeships are listed on the Engineering Council's website.[809]

Engineering Council approved apprenticeship

Engineering Council prentishiaesh gymeradwy

The ability for individuals to identify approved pathways that lead to professional registration provides the opportunity to attract and develop a pipeline of professionally-registered technicians and engineers.

Achieving registered status through demonstrating the profession's standards of underpinning knowledge, competence and commitment provides individuals with a globally recognised title. For employers, a professionally-registered workforce demonstrates commitment to engineering competence on a global level, and the ability to develop and attract a high-quality workforce, ultimately increasing their global competitiveness.

Increasingly, the advantages of professional approval are being recognised by individuals, education providers and employers globally. The UK engineering profession participates in several major international accords, within and outside Europe, which establish the 'tradability' of engineering and technology apprenticeships. In each case, the system of approval applied in the UK is fundamental to the acceptance of UK competence. With increasing globalisation, such accords and frameworks are assuming growing importance with employers as a means by which they can be confident in the skills and professionalism of the technicians and engineers involved.

806 www.gov.uk/government/publications/future-of-apprenticeships-in-england-guidance-for-trailblazers 807 www.engc.org.uk/icttech 808 www.engc.org.uk/ukspec 809 www.engc.org.uk/techdb

10.6 Apprentice age and productivity

The age of an apprentice bears a considerable impact on the productivity benefit of the apprenticeship. Research conducted by Cebr on behalf of Engineering UK revealed that net productivity benefit of an apprentice over a 10-year period decreased with their age.

As Table 10.12 reveals, each apprentice aged 16-18 on average provides a net productivity benefit of £50,600 over a 10-year period. However, for those aged 25 and older, the benefit falls to £14,500. This is likely because older apprentices have usually been in work longer than younger ones, and thus command a higher wage whilst training.[810]

Table 10.12: EMT net productivity benefit summary: by age group, including drop-out costs, apprentices completing in 2013/14

	Total cost of apprentice incl. salaries and training over 10 year period	Apprentice productive contribution over 10 year period	Net productivity benefit over 10 year period
16-18	£257,300	£307,900	£50,600
19-24	£278,100	£307,900	£29,800
25+	£293,400	£307,900	£14,500
Weighted average	**£275,700**	**£307,900**	**£32,200**

Source: Cebr analysis

Furthermore, the age of an apprentice has a significant impact on how long it takes before the employer recoups the cost of funding the apprenticeship. As Table 10.13 shows, an employer can expect to break even on their investment in an apprenticeship after 5 years and 4 months for an apprentice aged under 19. However, for apprentices aged between 19 and 24, this figure rises to 7 years and 2 months, and for those aged 25 or older, it will take an employer 8 years and 9 months to regain the money they spent on the apprenticeship – a difference of 3 years and 5 months. Furthermore, when factoring the costs associated with apprentices dropping out of their programme, the difference between 16- to 19-year-old apprentices and those aged 25 and older becomes 3 years and 10 months.

Table 10.13: Employer break-even point per apprentice

	Break-even point: completed apprentice	Break-even point: including drop-out costs
16-18	5 Years 4 months	6 Years 1 months
19-24	7 Years 2 months	8 Years 1 months
25+	8 Years 9 months	9 Years 11 months
Weighted average	**7 years 0 months**	**8 years 0 months**

Source: Cebr analysis

10.7 Success rates[811, 812, 813, 814]

Offering an apprenticeship can be an expensive endeavour for an employer. London Economics calculated that the average net cost to employers in training an apprentice lies between £3,000 and £7,250 per apprentice at level 2 (Intermediate Apprenticeships) and for some apprenticeships over £11,000 at level 3 (Advanced Apprenticeship). However, these costs are significantly greater for the engineering and construction sectors, where the net cost to employers of offering an apprenticeship at level 2/3 can total £39,600 and £26,000 respectively. This is largely a result of the higher cost of equipment required in engineering and construction, as well as the longer duration of these apprenticeships on average.[815]

Therefore, the success rates of apprenticeships are an important metric to consider, as the cost of training those apprentices who do not complete their programme represents an investment that is unlikely to be recouped by employers. This poses a large threat to the engineering sector because, as discussed in Section 2.0, Figure 2.2, some 98% of engineering employers are SMEs with fewer than 50 employees. As noted in Section 10.6, the break-even point for employers, including the costs of those apprentices not completing their programme, is on average one year longer than when such costs are not considered. Further analysis from Cebr reveals that the average internal rate of return (IRR) of offering an apprenticeship in EMT for an employer, excluding the cost of drop outs, is 17.1%. However, when the training costs of drop-outs are considered, this rate falls to 11.8%.[816]

Table 10.14 displays the success rates for different levels of apprenticeships in England between 2011/12 and 2013/14.

Table 10.14: Apprenticeship success rates by level (2011/12-2013/14) – England

		2011/12	2012/13	2013/14	Change over 1 year	Change over 3 years
Construction, planning and the built environment	Intermediate	66.6%	68.4%	67.2%	-1.1%p	0.6%p
	Advanced	82.8%	81.2%	75.0%	-6.3%p	-7.8%p
	Higher	-	-	92.1%	-	-
	All levels	70.9%	72.4%	69.6%	-2.8%p	-1.3%p
Engineering and manufacturing technologies	Intermediate	79.5%	74.7%	70.3%	-4.3%p	-9.1%p
	Advanced	78.3%	77.9%	72.9%	-5.1%p	-5.4%p
	Higher	94.4%	84.5%	83.5%	-0.9%p	-10.9%p
	All levels	78.8%	76.0%	71.5%	-4.5%p	-7.2%p
Information and communication technology	Intermediate	80.5%	70.6%	75.1%	4.5%p	-5.4%p
	Advanced	76.7%	78.5%	77.6%	-0.9%p	0.9%p
	Higher	43.5%	91.3%	69.8%	-21.5%p	26.3%p
	All levels	79.3%	72.7%	74.7%	2.0%p	-4.6%p
Science and mathematics	Intermediate	-	78.7%	78.4%	-0.3%p	-
	Advanced	-	83.8%	66.7%	-17.1%p	-
	All levels	-	80.2%	68.5%	-11.6%p	-
All subject areas	Intermediate	75.2%	73.5%	71.7%	-1.9%p	-3.5%p
	Advanced	74.9%	74.1%	71.2%	-2.9%p	-3.6%p
	Higher	64.3%	77.4%	73.3%	-4.1%p	9.1%p
	All levels	74.7%	72.8%	71.3%	-1.4%p	-3.4%p

Source: Skills funding agency

810 Cebr: Productivity and lifetime earnings impacts of engineering education & training – A report for EngineeringUK, September 2015, p8. 811 Figures for 2011/12 onwards are not directly comparable to earlier years as a Single Individualised Learner Record (ILR) data collection system has been introduced. Small technical changes have been made in the way learners from more than one provision type are counted, leading to a removal of duplicate learners and a reduction in overall learner numbers of approximately 2%. 812 Percentages are calculated based on pre-rounded data. 813 Apprenticeship success rates are based on the number of learners who meet all of the requirements of their apprenticeship framework, divided by the number of learners who have left training or successfully completed their training in the academic year. 814 Success rates are based on the individual apprenticeship frameworks that were completed in the relevant year (the Hybrid End Year). 815 London Economics: An international comparison of apprentice pay: Final Report for the Low Pay Commission, October 2013, p16 816 CEBR: Analysis, p8

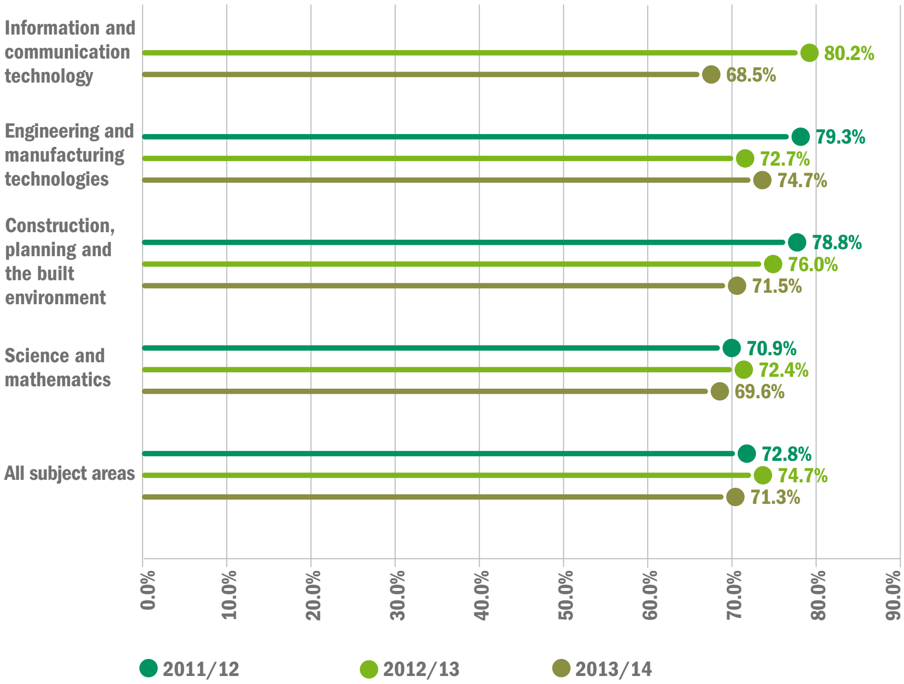
At 71.5%, the overall success rate for EMT apprenticeships is slightly above the all-subject average of 71.3%. Furthermore, it is worth noting that Higher Apprenticeships have a significantly greater success rate than lower levels, at 83.5%, compared with 72.9% for Advanced Apprenticeships and 70.3% for Intermediate Apprenticeships. However, this was not the case for ICT apprenticeships, where Advanced Apprenticeships boasted the highest success rates, with 77.6% of apprenticeships started being completed.

As Figure 10.8 illustrates, across all subject areas and for all engineering-related Sector Subject Areas (where data is available), success rates were lower in 2013/14 than in 2011/12. For example, in 2011/12, the success rate for EMT apprenticeships was 79.3% – 4.9 percentage points lower than the rate in 2013/14.

Considering success rates by provider type (Table 10.15) shows little difference between apprenticeship training provided by colleges or funded by the private sector/public. For example, the EMT success rate was 75.3% for general FE and tertiary colleges and 75.7 for private sector and public funded apprenticeships.

It is interesting to note that specialist colleges generally have lower success rates than average, at around two thirds, compared with over three quarters for other provider types.

Figure 10.8: Apprenticeship success rates (2011/12-2013/14) – England



Source: skills funding agency

Table 10.15: Apprenticeship success rate by provider type (2013/14) – England

	Apprenticeship type	General FE and tertiary college	Other public funded	Private sector public funded	Schools	Sixth form college	Specialist college	All institution type
Construction, planning and the built environment	Intermediate	67.3%	71.8%	64.1%	48.6%	-	68.9%	67.9%
	Advanced	79.0%	84.1%	76.5%	-	-	79.2%	79.7%
	Higher	92.1%	-	-	-	-	-	92.1%
	All levels	70.7%	75.6%	68.2%	48.6%	-	72.7%	71.5%
Engineering and manufacturing technologies	Intermediate	74.9%	83.8%	73.7%	-	-	65.0%	74.9%
	Advanced	75.1%	81.8%	78.5%	-	-	66.2%	77.9%
	Higher	84.4%	-	92.7%	-	-	-	84.8%
	All levels	75.3%	83.6%	75.7%	33.3%	-	66.4%	76.2%
Information and communication technology	Intermediate	73.1%	81.4%	71.1%	-	87.5%	80.0%	75.0%
	Advanced	77.0%	79.7%	77.5%	-	64.5%	-	78.8%
	Higher	56.8%	-	74.1%	-	-	-	67.7%
	All levels	74.9%	80.4%	74.6%	-	68.0%	64.6%	76.0%
Science and mathematics	Intermediate	78.1%	-	-	-	-	-	79.0%
	Advanced	82.6%	-	59.7%	-	-	-	76.5%
	Higher	-	-	-	-	-	-	-
	All levels	79.8%	-	61.1%	-	-	-	76.5%

Source: The Data Service

10.8 Engineering-related apprenticeships in devolved nations

Skills and training policy is devolved to the separate nations in the UK. As a result, England, Scotland, Wales and Northern Ireland all have their own apprenticeships policies and programmes that differ in terms of their levels, funding, aims and challenges. This section considers the unique characteristics of apprenticeships in Scotland, Wales and Northern Ireland.

10.8.1 Engineering-related apprenticeships in Scotland

In Scotland, the term 'Modern Apprenticeships' refers to all apprenticeships approved by the Modern Apprenticeship Group (MAG) and which therefore qualify for public sector funding.

Established in the 1990s, people aged 16 and over are eligible to participate in a Modern Apprenticeship, which provides them with the opportunity to develop their workplace skills and experience and acquire a qualifications whilst earning a wage.

Individuals are able to study around 70 different types of Modern Apprenticeships, which occupy levels 2 to 5 of a Scottish Vocational Qualification (SVQ).[817]

The Scottish government has established a target of creating 25,000 new Modern Apprenticeship places each year from 2011/12 to 2015/16. Allowing for inflation, funding for modern apprenticeships has grown by 24% over the least six years, and now equates to approximately £75 million a year.[818]

In 2012, a survey of former apprentices conducted by Skills Development Scotland found that six months after completing their apprenticeships, 92% of respondents were in employment with 70% working for the same employer.[819]

Table 10.16 shows Modern Apprenticeship starts by gender and age in engineering-related frameworks between 2012/13 and 2013/14.

Over all, the number of all engineering-related framework starts fell slightly between these two years, from 8,214 in 2012/13 to 7,887 in 2013/14. As a proportion of all starts, starts for engineering frameworks also declined from 32.0% to 31.2%. Furthermore, the number of females starting engineering-related frameworks fell considerably, from 783 in 2012/13 to only 282 in 2013/14.

817 Audit Scotland: Modern apprenticeships, March 2014, p5. 818 *Ibid.* 819 *Ibid*, p28

Table 10.16: Engineering-related Modern Apprenticeship starts by gender and age (2012/13-2013/14) – Scotland

	16-19				20-24				25+				All ages			
	Total		Female		Total		Female		Total		Female		Total		Female	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
Automotive	761	852	12	11	97	118	4	5	45	77	1	0	903	1,047	17	16
Biotechnology	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bus and coach engineering and maintenance	13	11	0	0	4	1	0	0	0	0	0	0	17	12	0	0
Chemicals manufacturing and petroleum industries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	33	9	0	1	34	19	0	0	46	0	0	0	113	28	0	1
Construction: building	3	911	0	16	1	203	0	9	5	58	0	1	9	1,172	0	26
Construction: civil engineering	7	250	0	3	13	57	0	0	39	210	0	1	59	517	0	4
Construction (civil engineering & specialist sector)	260	8	2	0	99	0	0	0	230	1	2	0	589	9	4	0
Construction (craft operations)	812	6	9	0	142	19	4	1	52	2	3	0	1,006	27	16	1
Construction: professional apprenticeship	-	0	-	0	-	0	-	0	-	68	-	1	0	68	0	1
Construction: specialist	17	62	0	0	19	52	1	0	16	49	1	0	52	163	2	0
Construction (technical operations)	33	33	3	4	32	32	2	0	600	462	35	14	665	527	40	18
Construction: technical	-	5	-	0	-	12	-	1	-	209	-	6	0	226	0	7
Construction: technical apprenticeship	-	0	-	0	-	19	-	1	-	227	-	9	0	246	0	10
Electrical installation	362	439	6	7	79	111	2	3	127	143	1	1	568	693	9	11

	16-19				20-24				25+				All ages			
	Total		Female		Total		Female		Total		Female		Total		Female	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
Electricity industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic security systems	-	22	-	0	-	6	-	0	-	0	-	0	0	28	0	0
Electrotechnical services	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Engineering	1,112	1,164	36	55	215	193	6	8	102	112	5	5	1,429	1,469	47	68
Engineering construction	23	44	3	2	37	28	8	2	3	1	0	0	63	73	11	4
Extractive and mineral processing	6	5	2	1	10	4	1	1	162	100	0	4	178	109	3	6
Food manufacture	158	4	41	1	240	4	90	1	814	15	400	6	1,212	23	531	8
Gas industry	26	31	1	0	10	3	0	0	2	1	0	0	38	35	1	0
Glass industry operations	23	13	0	0	27	33	0	0	85	185	2	0	135	231	2	0
Heating, ventilation, air conditioning and refrigeration	57	75	0	0	12	7	0	0	14	14	0	0	83	96	0	0
Information & communication technologies profession	263	38	37	3	79	24	15	2	126	33	25	7	468	95	77	12
IT and telecommunications	-	222	-	25	-	105	-	23	-	98	-	13	0	425	0	61
Land-based engineering	59	41	0	0	6	7	1	0	0	0	0	0	65	48	1	0
Oil and gas extraction	89	83	8	11	40	30	1	4	4	7	0	2	133	120	9	17
Plumbing	240	233	2	2	40	37	1	1	15	19	0	2	295	289	3	5
Polymer processing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power distribution	13	38	0	0	11	14	0	0	4	2	0	0	28	54	0	0
Printing	7	0	1	0	2	0	0	0	0	0	0	0	9	0	1	0
Process manufacturing	36	37	4	4	0	2	0	0	1	0	0	0	37	39	4	4
Rail transport engineering	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vehicle body and paint operations	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0
Vehicle maintenance and repair	2	2	0	0	4	1	1	0	0	1	0	0	6	4	1	0
Water industry	8	5	1	0	4	1	0	0	22	0	1	0	34	6	2	0
Wind turbine operations and maintenance	12	4	2	0	3	3	0	1	2	1	0	0	17	8	2	1
Subtotal all engineering frameworks	4,436	4,647	170	146	1,262	1,145	137	63	2,516	2,095	476	72	8,214	7,887	783	281
All frameworks	12,719	13,107	5,704	5,616	6,962	6,766	3,645	3,337	6,010	5,411	1,691	1,492	25,691	25,284	11,040	10,445
Percentage engineering frameworks	34.9%	35.5%	3.0%	2.6%	18.1%	16.9%	3.8%	1.9%	41.9%	38.7%	28.1%	4.8%	32.0%	31.2%	7.1%	2.7%

Source: Skills Development Scotland

Considering starts by level shows a slightly different trend. The percentage of engineering-related framework starts actually increase for level 3 and 4 apprenticeships. Engineering-related starts at level 3 grew from 5,631 in 2012/13 to 6,278 in 2013/14, accounting for 42.4% of all starts of this level. Furthermore, level 4 starts increased from 267 to 412. Significant decline was seen in engineering-related starts at level 2, from 2,255 to 1,105 between 2012/13 and 2013/14.

Table 10.17: Engineering-related Modern Apprenticeship starts by level (2012/13-2013/14) – Scotland

	Level 2		Level 3		Level 4		Level 5		All levels	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
Automotive	111	78	792	969	-	-	-	-	903	1,047
Biotechnology	-	-	-	-	-	-	-	-	-	-
Bus and coach engineering and maintenance	-	-	17	12	-	-	-	-	17	12
Chemicals manufacturing and petroleum industries	-	-	-	-	-	-	-	-	-	-
Construction	50	2	61	26	2	-	-	-	113	28
Construction: building	9	1	-	1,171	-	-	-	-	9	1,172
Construction: civil engineering	59	470	-	47	-	-	-	-	59	517
Construction (civil engineering & specialist sector)	589	9	-	-	-	-	-	-	589	9
Construction (craft operations)	-	-	1,006	27	-	-	-	-	1,006	27
Construction: professional apprenticeship	-	-	-	-	-	-	-	68	-	68
Construction: specialist	52	159	-	4	-	-	-	-	52	163
Construction (technical operations)	-	-	339	337	265	166	61	24	665	527
Construction: technical	-	-	-	226	-	-	-	-	-	226
Construction: technical apprenticeship	-	-	-	-	-	246	-	-	-	246
Electrical installation	-	-	568	693	-	-	-	-	568	693
Electricity industry	-	-	-	-	-	-	-	-	-	-
Electronic security systems	-	-	-	28	-	-	-	-	-	28
Electrotechnical services	-	-	1	-	-	-	-	-	1	-
Engineering	-	-	1,429	1,469	-	-	-	-	1,429	1,469
Engineering construction	-	-	63	73	-	-	-	-	63	73
Extractive and mineral processing	120	96	58	13	-	-	-	-	178	109
Food manufacture	1,077	21	135	2	-	-	-	-	1,212	23
Gas industry	-	-	38	35	-	-	-	-	38	35
Glass industry operations	95	177	40	54	-	-	-	-	135	231
Heating, ventilation, air conditioning and refrigeration	-	-	83	96	-	-	-	-	83	96
Information & communication technologies profession	-	-	468	95	-	-	-	-	468	95
IT and telecommunications	-	1	-	424	-	-	-	-	-	425
Land-based engineering	55	37	10	11	-	-	-	-	65	48
Oil and gas extraction	-	-	133	120	-	-	-	-	133	120
Plumbing	-	-	295	289	-	-	-	-	295	289
Polymer processing	-	-	-	-	-	-	-	-	-	-
Power distribution	28	54	-	-	-	-	-	-	28	54
Printing	8	-	1	-	-	-	-	-	9	-
Process manufacturing	-	-	37	39	-	-	-	-	37	39
Rail transport engineering	-	-	-	-	-	-	-	-	-	-
Vehicle body and paint operations	-	-	2	-	-	-	-	-	2	-
Vehicle maintenance and repair	-	-	6	4	-	-	-	-	6	4
Water industry	2	-	32	6	-	-	-	-	34	6
Wind turbine operations and maintenance	-	-	17	8	-	-	-	-	17	8
Subtotal all engineering frameworks	**2,255**	**1,105**	**5,631**	**6,278**	**267**	**412**	**61**	**92**	**8,214**	**7,887**
All frameworks	**10,781**	**9,629**	**14,339**	**14,805**	**496**	**726**	**75**	**124**	**25,691**	**25,284**
Percentage engineering frameworks	20.9%	11.5%	39.3%	42.4%	53.8%	56.7%	81.3%	74.2%	32.0%	31.2%

Source: Skills Development Scotland

Table 10.18 shows achievements for Modern Apprenticeships in engineering-related frameworks by age and gender between 2012/13 and 2013/14.

Overall, the number of engineering-related achievements fell from 6,534 to 5,729 over this period. Furthermore, the number of female achievements also fell from 581 to 434. This decline was consistent across all age groups, with achievement by those between the ages of 16 and 19 falling the most steeply, from 3,638 in 2012/13 to 3,174 in 2013/14.

The framework with the most female achievements was food manufacture, although the numbers for this fell substantially from 446 in 2012/13 to 265 in 2013/14.

Table 10.18: Engineering-related Modern Apprenticeship achievements by gender and age (2012/13-2013/14) – Scotland

	16-19				20-24				25+				All ages			
	Total		Female		Total		Female		Total		Female		Total		Female	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
Automotive	3	39	0	0	3	21	0	1	3	12	0	0	9	72	0	1
Biotechnology	4	3	1	3	2	0	0	0	2	3	1	3	8	6	2	6
Bus and coach engineering and maintenance	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Chemicals manufacturing and petroleum industries	2	0	0	0	3	0	0	0	1	5	0	3	6	5	0	3
Construction	1,158	791	16	9	257	160	5	4	505	90	10	1	1,920	1,041	31	14
Construction: building	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction: civil engineering	0	13	0	0	0	24	0	0	0	69	0	1	0	106	0	1
Construction (civil engineering & specialist sector)	7	99	0	0	12	41	0	0	81	103	0	1	100	243	0	1
Construction (craft operations)	0	6	0	0	6	26	0	0	1	5	0	0	7	37	0	0
Construction: professional apprenticeship	-	0	-	0	-	0	-	0	-	4	-	0	0	4	0	0
Construction: specialist	0	3	0	0	0	5	0	0	0	7	0	1	0	15	0	1
Construction (technical operations)	0	1	0	0	14	18	0	2	367	539	15	21	381	558	15	23
Construction: technical	-	0	-	0	-	0	-	0	-	2	-	0	0	2	0	0
Construction: technical apprenticeship	-	0	-	0	-	0	-	0	-	20	-	1	0	20	0	1
Electrical installation	3	11	0	0	5	22	0	0	15	33	0	0	23	66	0	0
Electricity industry	19	0	0	0	3	0	0	0	4	0	0	0	26	0	0	0
Electronic security systems	-	0	-	0	-	0	-	0	-	0	-	0	0	0	0	0
Electrotechnical services	477	340	5	3	73	67	3	0	80	63	0	2	630	470	8	5
Engineering	751	538	12	16	122	117	9	1	51	49	2	2	924	704	23	19
Engineering construction	43	71	1	4	18	14	2	2	5	5	1	3	66	90	4	9
Extractive and mineral processing	0	2	0	0	3	8	0	2	56	94	2	0	59	104	2	2
Food manufacture	148	112	39	26	168	127	74	41	660	397	333	198	976	636	446	265
Gas industry	66	25	1	0	6	13	1	2	8	7	0	0	80	45	2	2
Glass industry operations	14	26	1	0	8	16	0	0	48	65	0	1	70	107	1	1
Heating, ventilation, air conditioning and refrigeration	65	29	0	1	29	18	0	0	18	9	0	0	112	56	0	1
Information & communication technologies profession	87	172	10	28	22	49	3	9	85	81	16	18	194	302	29	55

	16-19				20-24				25+				All ages			
	Total		Female		Total		Female		Total		Female		Total		Female	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
IT and telecommunications	-	7	-	2	-	8	-	2	-	0	-	0	0	15	0	4
Land-based engineering	54	60	0	0	5	5	0	0	2	0	0	0	61	65	0	0
Oil and gas extraction	57	81	3	3	19	11	0	1	3	0	0	0	79	92	3	4
Plumbing	212	230	5	2	30	29	0	1	21	18	1	0	263	277	6	3
Polymer processing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power distribution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Printing	6	7	1	1	2	1	0	0	1	0	0	0	9	8	1	1
Process manufacturing	3	11	0	1	0	0	0	0	0	0	0	0	3	11	0	1
Rail transport engineering	3	4	0	0	0	0	0	0	0	0	0	0	3	4	0	0
Vehicle body and paint operations	53	57	0	1	0	3	0	1	1	2	0	0	54	62	0	2
Vehicle maintenance and repair	403	427	6	5	43	34	1	3	24	24	1	0	470	485	8	8
Water industry	0	8	0	0	1	4	0	0	0	8	0	1	1	20	0	1
Wind turbine operations and maintenance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-total all engineering frameworks	**3,638**	**3,174**	**101**	**105**	**854**	**841**	**98**	**72**	**2,042**	**1,714**	**382**	**257**	**6,534**	**5,729**	**581**	**434**
All frameworks	**10,181**	**9,902**	**4,551**	**4,705**	**3,069**	**4,896**	**1,447**	**2,563**	**6,671**	**5,778**	**2,540**	**1,724**	**19,921**	**20,576**	**8,538**	**8,992**
Percentage engineering frameworks	**35.7%**	**32.1%**	**2.2%**	**2.2%**	**27.8%**	**17.2%**	**6.8%**	**2.8%**	**30.6%**	**29.7%**	**15.0%**	**14.9%**	**32.8%**	**27.8%**	**6.8%**	**4.8%**

Source: Skills Development Scotland

Looking at engineering-related achievements by level, Table 10.19 shows that, despite general decline, there was growth at level 4, with the numbers increasing from 139 in 2012/13 to 264 in 2013/14. However, this number represents a fraction of the total number of apprenticeships. Furthermore, the growth was driven predominantly by achievements for construction (technical operations) apprenticeships, whilst the vast majority of other engineering frameworks had no achievements at this level.

Achievements for engineering apprenticeships declined from 924 in 2012/13 to 704 in the following year. However, there was growth in some frameworks. For example, the number of achievements more than doubled for construction (civil engineering & specialist sector), increasing from 100 to 243.

Table 10.19: Engineering-related Modern Apprenticeship achievements by level (2012/13-2013/14) – Scotland

	Level 2		Level 3		Level 4		Level 5		Total	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
Automotive	1	28	8	44	0	0	0	0	9	72
Biotechnology	0	0	8	6	0	0	0	0	8	6
Bus and coach engineering and maintenance	0	0	0	1	0	0	0	0	0	1
Chemicals manufacturing and petroleum industries	0	0	6	5	0	0	0	0	6	5
Construction	390	136	1,327	896	0	8	37	1	1,754	1,041
Construction: building	0	0	0	0	0	0	0	0	0	0
Construction: civil engineering	0	106	0	0	0	0	0	0	0	106
Construction (civil engineering & specialist sector)	100	243	0	0	0	0	0	0	100	243
Construction (craft operations)	0	0	7	37	0	0	0	0	7	37
Construction: professional apprenticeship	-	0	-	0	0	0	0	4	0	4
Construction: specialist	0	15	0	0	0	0	0	0	0	15
Construction (technical operations)	0	0	197	282	135	235	49	41	381	558
Construction: technical	-	0	-	2	-	0	-	0	0	2
Construction: technical apprenticeship	-	0	-	0	-	20	-	0	0	20
Electrical installation	0	0	23	66	0	0	0	0	23	66
Electricity industry	0	0	26	0	0	0	0	0	26	0
Electronic security systems	0	0	-	0	0	0	0	0	0	0
Electrotechnical services	0	0	630	470	0	0	0	0	630	470
Engineering	0	0	924	704	0	0	0	0	924	704
Engineering construction	0	0	66	90	0	0	0	0	66	90
Extractive and mineral processing	35	75	20	27	4	1	0	1	59	104
Food manufacture	884	549	92	87	0	0	0	0	976	636
Gas industry	0	0	80	45	0	0	0	0	80	45
Glass industry operations	48	80	22	27	0	0	0	0	70	107
Heating, ventilation, air conditioning and refrigeration	0	0	112	56	0	0	0	0	112	56
Information & communication technologies profession	0	0	194	302	0	0	0	0	194	302
IT and telecommunications	-	1	-	15	0	0	0	0	0	16
Land-based engineering	19	81	42	46	0	0	0	0	61	127
Oil and gas extraction	0	0	79	92	0	0	0	0	79	92
Plumbing	0	0	263	277	0	0	0	0	263	277
Polymer processing	0	0	0	0	0	0	0	0	0	0
Power distribution	0	0	0	0	0	0	0	0	0	0
Printing	1	0	8	8	0	0	0	0	9	8
Process manufacturing	0	0	3	11	0	0	0	0	3	11
Rail transport engineering	0	0	3	4	0	0	0	0	3	4
Vehicle body and paint operations	0	0	54	62	0	0	0	0	54	62
Vehicle maintenance and repair	24	11	446	474	0	0	0	0	470	485
Water industry	0	3	1	21	0	0	0	0	1	24
Wind turbine operations and maintenance	0	0	0	0	0	0	0	0	0	0
Subtotal all engineering frameworks	**1,502**	**1,328**	**4,641**	**4,157**	**139**	**264**	**86**	**47**	**6,368**	**5,796**
All frameworks	**7,994**	**8,079**	**11,184**	**11,927**	**614**	**509**	**129**	**61**	**19,921**	**20,576**
Percentage engineering frameworks	18.8%	16.4%	41.5%	34.9%	22.6%	51.9%	66.7%	77.0%	32.0%	28.2%

Source: Skills Development Scotland

10.8.2 Engineering related apprenticeships in Wales

In 2009 the Welsh government (WG) introduced the Pathways to Apprenticeships (PtA) programme in collaboration with Sector Skills Councils and further education colleges. The programme was an intensive one-year course which aimed to enable learners between the ages of 16 and 24 to develop the necessary skills and experience to progress onto an apprenticeship. The programme concluded in 2013/14, by which time it had served over 8,000 learners.[820]

Table 10.20 displays the number of learners who completed the Pathways to Apprenticeships programmes between 2011/12 and 2012/13 and their subsequent progression. In 2012/13, 1,075 learners completed the programme, slightly up from the previous year's figure of 1,010. The percentage of those progressing onto an apprenticeships was also up from the previous year, with 16% doing so in 2012/13 compared with 14% in the preceding year. Science, engineering and manufacturing technologies had the highest rate of progression onto an apprenticeships at 38%, however, this was a slight decrease from the 40% progression rate reported in 2011/12.

Table 10.20: Number of learners completing Pathways to Apprenticeships programmes by pathway and subsequent learning programme (2011/12 – 2012/13) – Wales[821, 822, 823]

		Apprenticeships		Foundation Apprenticeship		Further education (level 3)		Other learning programme		No subsequent programme identified		Total
		Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number
Agriculture, horticulture and land-based engineering	2011/12	5	22%	*	**	10	44%	*	**	5	22%	25
	2012/13	15	24%	*	**	20	35%	*	**	15	27%	65
Automotive skills	2011/12	5	7%	30	30%	20	18%	*	**	35	35%	100
	2012/13	5	5%	50	34%	20	15%	5	4%	45	32%	145
Construction	2011/12	*	**	125	39%	10	3%	*	**	35	10%	320
	2012/13	15	6%	100	41%	*	*	10	3%	25	10%	240
Construction (insulation and energy efficiency)	2011/12	-	-	-	-	-	-	-	-	-	-	-
	2012/13	0	0%	0	0%	0	0%	*	**	*	**	30
Hospitality, leisure, travel and tourism	2011/12	5	6%	0	0%	40	40%	10	9%	40	40%	105
	2012/13	15	14%	*	*	55	43%	*	**	45	36%	125
IT and telecommunications	2011/12	0	0%	0	0%	55	62%	5	8%	20	23%	85
	2012/13	5	6%	*	*	40	53%	5	8%	20	24%	80
Plumbing	2011/12	20	25%	10	17%	*	**	*	**	25	33%	70
	2012/13	25	26%	15	14%	20	19%	*	**	35	36%	100
Science, engineering and manufacturing technologies	2011/12	95	40%	15	7%	40	17%	5	3%	70	29%	240
	2012/13	80	38%	15	8%	55	27%	10	4%	40	18%	210
Sport and active leisure	2011/12	*	**	*	**	15	48%	*	**	10	26%	30
	2012/13	5	7%	*	**	20	31%	*	**	25	40%	70
Total	2011/12	140	14%	195	19%	205	20%	45	4%	250	25%	1,010
	2012/13	170	16%	205	19%	250	23%	40	4%	260	24%	1,075

Source: Welsh government

820 The Welsh Government, Progressions from Pathways to Apprenticeships Programmes 2012/13, 25th November 2014 821 Data is rounded to the nearest five students 822 *Data suppressed due to potentially disclosive, nature 823 ** Percentage suppressed as the base is less than 50 students

Table 10.21 shows the number of learners attaining a full framework by apprenticeship type and Sector Subject Area between 2012/13 and 2013/14. Overall, 1,570 apprentices attained an engineering-related apprenticeship at level 3, up from the corresponding figure of 1,495 in the previous year. Furthermore, the number of learners acquiring a level 2 Foundation Apprenticeship also rose during the same period, from 2,085 in 2012/13 to 2,265 the following year.

10.8.3 Engineering-related apprenticeships in Northern Ireland

Apprenticeships Northern Ireland was established in September 2007 to replace the previous Modern Apprenticeships scheme in a bid to increase participation. To be eligible to start an apprenticeship, candidates must be either in, or about to commence, work of at least 21 hours per week.

In June 2014, the Northern Ireland Department for employment and learning (DELNI) published its Strategy on Apprenticeships.[825] As part of its strategy, the department announced a new system of apprenticeships which consist of five core components:

1. Apprenticeships will be for new employees or, in the case of existing employees, a role that requires a substantial amount of learning and skills development.
2. Apprenticeships will be available in professional and technical occupations from level 3 up to level 8.
3. Apprenticeships will last a minimum of two years.
4. Through the provision of training beyond the specific needs of a job, apprenticeships will enable the learner to develop skills and experience that are transferable across the wider economy.
5. Apprenticeships will support the progression of participants to higher professional or technical training or on to a higher academic pathway.[826]

Furthermore, these new apprenticeships will be available to individuals of all ages, with a primary focus on young people aged 16-24.[827]

As Table 10.22 shows, the total number of apprenticeship starts fell considerably between 2012/13 and 2013/14, from 6,331 to 5,409. However, this decline was driven by a sharp decline in starts from those aged 25 years or older: down from 2,358 in 2012/13 to just 387 in 2013/14. This decline was likely due to funding changes which mean that for those aged 25 or over, only 50% of training costs would come from the government. In comparison, there is 100% funding for those under 25.[828]

Table 10.21: Leavers attaining full framework by apprenticeship type and Sector Subject Area (2012/13-2013/14) – Wales[824]

		Foundation Apprenticeships		Apprenticeships		All apprenticeships	
	Year	Leavers attaining full framework	Percentage	Leavers attaining full framework	Percentage	Leavers attaining full framework	Percentage
Engineering and manufacturing technologies	2012/13	1,145	88%	810	92%	1,955	89%
	2013/14	1,180	85%	800	91%	2,000	88%
Construction, planning and the built environment	2012/13	665	80%	565	81%	1,230	81%
	2013/14	765	80%	525	81%	1,285	81%
Information and communication technology	2012/13	275	86%	120	90%	395	87%
	2013/14	320	83%	245	84%	560	83%
Sub-total all engineering related Sector Subject Areas	2012/13	2,085		1,495		3,580	
	2013/14	2,265		1,570		3,845	
All Sector Subject Areas	2012/13	7,620	85%	5,750	87%	13,370	86%
	2013/14	9,890	84%	7,070	85%	17,715	84%

Source: Welsh government

Table 10.22: Apprenticeships starts by age and gender (2007/08-2013/14) – Northern Ireland[829]

Academic year	Total	Aged 16 to 19			Aged 20 to 24			Aged 25+		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
2007/08	4,280	2,141	649	2,790	621	851	1,472	5	13	18
2008/09	8,080	1,807	670	2,477	697	978	1,675	1,150	2,778	3,928
2009/10	7,835	1,483	618	2,101	770	1,002	1,772	1,412	2,550	3,962
2010/11	8,948	1,158	496	1,654	962	1,216	2,178	1,995	3,121	5,116
2011/12	7,880	1,141	388	1,529	931	1,088	2,019	1,630	2,702	4,332
2012/13	6,331	1,233	396	1,629	1,086	1,258	2,344	915	1,443	2,358
2013/14	5,409	1,520	576	2,096	1,385	1,541	2,926	245	142	387

Source: Northern Ireland government

824 Data is rounded to the nearest five students 825 DELNI: Securing our success: The Northern Ireland Strategy on Apprenticeships, June 2014 826 *Ibid*, p8 827 *Ibid*, p8. 828 http://www.nibusinessinfo.co.uk/node/14880; Finance and funding for apprenticeships. Website accessed 20 August 2014 829 From September 2007, apprenticeships in Northern Ireland were aimed at individuals aged 16-24, however, in September 2008 they became all-age apprenticeships. From August 2012 adult apprenticeships have been restricted to the priority economic sectors needed to rebalance the economy.

Table 10.23 shows the total number of participants on different Apprenticeships NI frameworks in 2014. In total, there were 2,521 apprentices on a level 3 framework, of whom 1,170 were on an engineering-related framework. This is an increase on the 2013 figures, where only 916 individuals were participating in an engineering-related apprenticeship.[830]

Although the Northern Ireland government does not publish statistics on the number of apprenticeship achievements by framework area, an estimate of the number of engineering-related achievements at level 3 can be calculated by multiplying those participating in such apprenticeships by the overall success rate for all framework areas at this level, which was 28% in 2014.[831]

This gives an estimated achievement number for level 3 engineering apprenticeships of 328.

Table 10.23: All participants on apprenticeships by framework (2014) – Northern Ireland[832, 833]

Framework	Total	Level 2			Level 3					
					Level 2/3			Level 3 progression		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Construction	107	107	0	107	0	0	0	0	0	0
Construction crafts	204	0	0	0	0	0	0	202	2	204
Electrical and electronic servicing	13	1	0	1	0	0	0	12	0	12
Electrical distribution and trans. engineering	40	0	0	0	32	1	33	7	0	7
Electrotechnical	359	0	0	0	285	1	286	73	0	73
Engineering	863	301	9	310	212	11	223	327	3	330
Engineering construction	1	0	0	0	0	0	0	1	0	1
Food and drink manufacturing	1	0	0	0	1	0	1	0	0	0
Food and drink manufacturing operations	10	9	1	10	0	0	0	0	0	0
Food manufacture	229	132	51	183	2	0	2	25	19	44
Furniture production	1	0	0	0	0	0	0	1	0	1
Gas utilisation, installation and maintenance	13	0	0	0	13	0	13	0	0	0
Glass industry	4	4	0	4	0	0	0	0	0	0
Heating, ventilation, air conditioning and refrigeration	34	16	0	16	0	0	0	18	0	18
IT services and development	27	21	2	23	0	0	0	3	1	4
Land based service engineering	54	7	0	7	0	0	0	47	0	47
Light vehicle body and paint operations	26	0	0	0	0	0	0	26	0	26
Mechanical engineering services (plumbing)	188	38	0	38	38	0	38	112	0	112
Motor vehicle industry	43	42	1	43	0	0	0	0	0	0
Polymer processing and signmaking	1	1	0	1	0	0	0	0	0	0
Polymer processing	2	0	0	0	0	0	0	0	2	2
Print production	10	0	0	0	0	0	0	10	0	10
Printing industry	10	10	0	10	0	0	0	0	0	0
Vehicle body and paint	30	30	0	30	0	0	0	0	0	0
Vehicle fitting	1	1	0	1	0	0	0	0	0	0
Vehicle maintenance and repair	360	77	2	79	2	0	2	279	0	279
Vehicle parts	3	3	0	3	0	0	0	0	0	0
Sub-total all engineering related frameworks.	2,634	800	66	866	585	13	598	1,143	27	1,170
Total	6,296	1,738	1,279	3,017	640	101	741	1,563	958	2,521
Percentage engineering related frameworks	41.8%	46.0%	5.2%	28.7%	91.4%	12.9%	80.7%	73.1%	2.8%	46.4%

Source: Northern Ireland government

830 Engineering UK: The State of Engineering, January 2015, p149. 831 Department for Employment and Learning: ApprenticeshipsNI Quarterly Statistics from September 2007 to April 2015, 26th August 2015, p31 832 From September 2007, apprenticeships in Northern Ireland were aimed at individuals aged 16-24, however, in September 2008 they became all-age apprenticeships. 833 From August 2012 adult apprenticeships have been restricted to the priority economic sectors needed to rebalance the economy.

10.9 Addressing skills needs: recognising and rewarding engineering technicians

The demand for STEM technicians is now well recognised by employers, the engineering profession and by government.[834] Evidence shows that the need to attract, recognise and increase the number of registered technicians throughout the UK is crucial in delivering economic growth.

With immediate and future technician shortages identified, many employers recognise the need to engage with schools, offer more STEM-based apprenticeships[835] and ensure that the appropriate level of skills and quality are developed.

However, research undertaken by the engineering profession has identified that the value provided by technicians and technical careers is not sufficiently recognised and technician careers do not receive the credit they deserve.[836]

On an individual level, professional recognition of their achievement is a key driver for seeking to achieve registration. This is also true of apprentices in the sector. A survey undertaken by the Industry Apprentice Council found that 96.5% of apprentices felt their apprenticeship should lead to professional registration as standard.

Recent major changes in government policy, whereby vocational qualifications and apprenticeships are required to meet professional standards, enable the profession to promote professional registration as a means of improving the recognition and status of technicians and encouraging more people into technician careers.

Developing pathways to technician registration

Engineering employers, with support from the professional engineering institutions, are working to address skills needs through the development of attractive vocational pathways to professional registration, particularly through the apprenticeship route.

The engineering profession has always supported and driven high quality vocational pathways to professional registration, and welcomed the requirement for Tech level qualifications in published performance tables to be recognised by a relevant professional engineering institution.[837] This will ensure that they align with the Engineering Council's standards for underpinning knowledge[838] and with UK Standard for Professional Engineering Competence (UK-SPEC)[839] and the Information and Communications Technology (ICT) Technician Standard,[840] enabling the approval of more pathways leading to Engineering Technician (EngTech), ICT Technician (ICTTech) and Incorporated Engineer (IEng) registration.

The Engineering Council's standards for underpinning knowledge – UK-SPEC and the ICTTech Standard – provide the framework to develop a globally-recognised apprenticeship programme, offering a benchmark of competence and commitment to continuing professional development. Tech levels and apprenticeships with approved status can be readily recognised through the Engineering Council Approved Qualification and Apprenticeship logos, and are listed on the Engineering Council's website.[841]

The ability for individuals to identify approved pathways that lead to professional registration provides the opportunity to attract and develop a talent pipeline of professionally-registered technicians and engineers.

Recognising and rewarding technicians in the workplace

The Engineering Council estimates that, across all industries and occupations, more than 1.2 million people are eligible to join the national register as an Engineering Technician (EngTech).[842] The small number of these individuals on the register may suggest that there is a low level of awareness of EngTech registration and the value it can bring to employers and technical staff.

Those employers who actively support professional registration amongst their staff find clear benefits to their employees and to their organisation. Registration:

- demonstrates a competent, qualified technician workforce to regulators, clients and customers
- supports the creation of a loyal, keen to learn, enthusiastic and motivated team
- supports recruitment and retention of high calibre staff
- shows breadth of experience within technicians
- develops right behaviours and attitudes and creates an achievement-focused professional environment
- improves morale, raises self-esteem and builds relationships between engineers and technicians
- encourages staff to keep up to date and helps identify any gaps that need addressing
- promotes a structured development pathway for those employees who wish to use EngTech or ICTTech registration as an interim step towards progression to IEng and CEng registration

For employers, a professionally-registered workforce demonstrates commitment to engineering competence on a global level and can enhance their competitive advantage. In addition, supporting engineering employees to achieve professional registration demonstrates commitment to their staff and can help with recruitment and retention of their workforce.

Registered technicians with these employers also state that their employers have shown an increased recognition of their skills and competence, and that they have benefited from an enhanced status within their company and/or industry. It has also allowed individuals to develop their own learning, skills and competence, enabling them to stay up to date with the latest industry trends and issues, and ultimately improving their own career prospects.

Developing a professional community

The engineering profession is investing in the development of a professional technician community through the development of a number of collaborative activities aimed at raising the profile of technicians and promoting routes to registration.

The Technician Apprentice Consortium is one such example:[843] it brings together employers, professional engineering institutions and colleges, to ensure that business needs are met through the recruitment and training of technician apprentices. By collaborating, the consortium will:

- ensure that there is a valued work-based route to professional status for aspiring engineers, including those who are currently under-represented within the sector such as females, ethnic minorities and those from disadvantaged backgrounds
- increase the numbers of young people taking up this route and the number of companies appreciating the benefits it brings and so committing to providing technician apprenticeship places
- broaden the availability across a range of engineering disciplines through using the common base of the Engineering Council UK Standard for Professional Engineering

834 UKCES Working Futures 2010-2020 835 CBI/Pearson Education and Skills Survey 2014, Gateway to Growth 836 Project TRaM, 2013 837 www.gov.uk/government/publications/vocational-qualifications-for-14-to-19-year-olds 838 www.engc.org.uk/education-skills/approval-of-qualifications-and-apprenticeship-programmes 839 www.engc.org.uk/ukspec 840 www.engc.org.uk/icttech 841 www.engc.org.uk/techdb 842 See section 15.7 843 www.tacnet.org.uk/home/511

Competence (UK-SPEC) to compile a suite of linked qualifications working with Sector Skills Councils, professional institutions and awarding bodies

A collaboration between the Institution of Civil Engineers (ICE), Institution of Mechanical Engineers (IMechE) and the Institution of Engineering and Technology (IET) was formed in 2014 to significantly increase the EngTech population across the engineering sector. The EngTechNow campaign[844] promotes professional registration and membership to those working in engineering at technician level, as well as to new entrants into the sector. The key aims are to achieve 100,000 registered EngTechs by 2020, provide a valued membership proposition and establish professional registration for those working in the sector as the expectation by employers and clients.

844 www.engtechnow.com

Part 2 - Engineering in Education and Training
11.0 Higher education

Demand for higher education (HE) engineering courses is increasing faster than for other STEM subjects and for all subjects in general. However, the pool of level 4+ individuals with qualifications that allow them to go into engineering occupations (66,391) is still well below the numbers needed to fulfil projected annual engineering skill shortages (107,000). Despite this year's cohort of graduates being the first to have paid the new higher tuition fees, fears of a decline in HE participation have not been realised. However, first time enrolments in HE are undergoing longer term decline, bolstered by a sharp fall in those studying part-time. Furthermore, a declining young population, increased debt incurred by graduates, and a new policy affecting international students all pose significant challenges to higher education recruitment. Therefore, it is important to highlight the benefits that engineering-related degrees can offer students, both in terms of earnings premium and employment prospects.

11.1 The higher education sector

Figure 11.1 provides an overview of higher education institutions in the UK, broken down by English region and home nation. In 2013/14, there were 163 HEIs in the UK serving 2,299,355 students. Of these, 159,010 students were studying engineering and technology courses, amounting to 6.9% of all higher education students. London has the largest number of higher education institutions (HEIs) at 39, which is more than Wales, Scotland and Northern Ireland combined.

Over a five-year period from 2009/10 to 2013/14, the total number of students in HE has declined by 7.8% (Table 11.1). However, numbers of engineering and technology students have bucked the general trend, increasing by 1.3% over the same period.

Data from the Higher Education Statistic Agency (HESA) presented in Table 11.2 shows that from 2012/13 to 2013/14, the total numbers of new enrolments onto HE courses increased by 2.5%, from 971,410 to 995,740. New enrolments of engineering and technology students increased even more so during this period: by 4.1%, from 61,930 to 64,450.

However, over a five-year period, first time enrolments to HE showed a downward trend. Numbers enrolling in all subjects decreased by 16.0% between 2009/10 and 2013/14: down from 1,068,830 to 995,740. This decline was slightly lower for engineering and technology subjects, with numbers reducing by 6.7% from 69,085 to 64,450.

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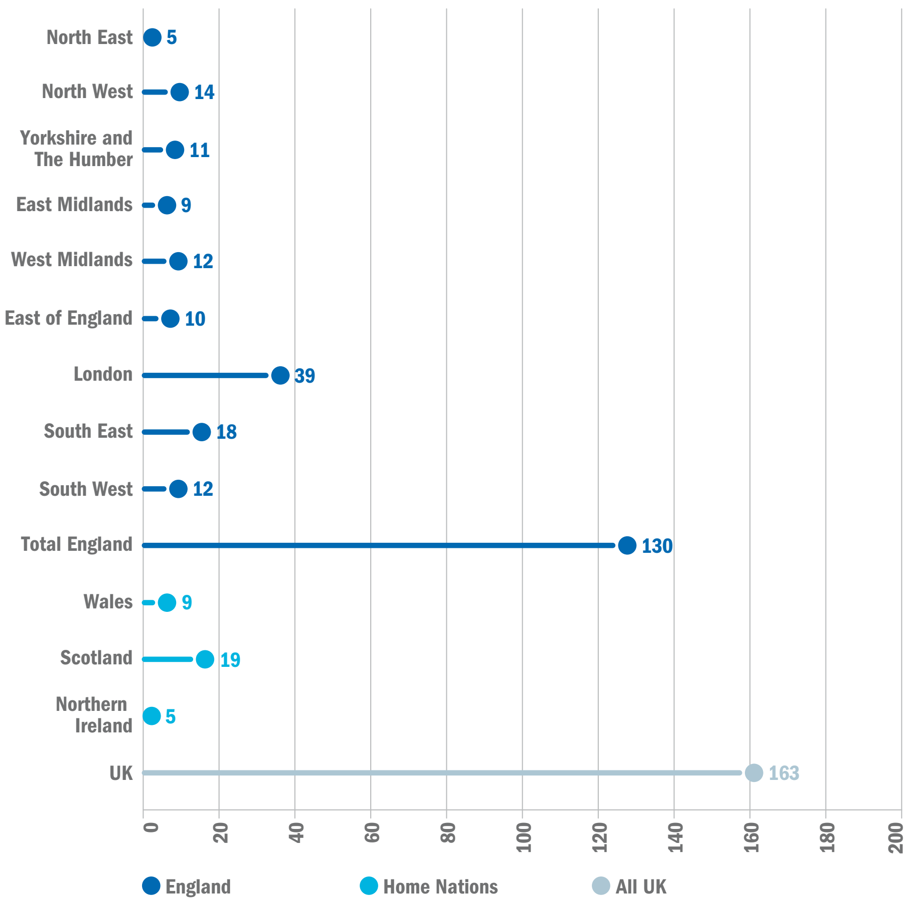
Figure 11.1: Overview of UK HEIs by region and home nation (2013/14)



Source: HESA bespoke data request

This trend is slightly at odds with the numbers of students accepted into higher education via the UCAS admissions process, which has reported record numbers of entries into HE. Between 2010/11 and 2014/15, UCAS accepted applicants onto all HE courses grew by 5.1%, from 487,320 to 512,355. For engineering and technology courses the increase was greater, with those accepted growing by 8.2% from 29,295 to 31,695 in the same period. It is interesting to note that the percentage decline in entrants to HE recorded between 2011 and 2012, and attributed to tuition fees increases, was significantly higher for the HESA data cohort (13.1%), than for those who entered through UCAS (9.0%).

The discrepancy in new HE students between the UCAS and HESA data warrants consideration. Data from HESA on student enrolments includes students who entered HE courses via routes other than the UCAS application process. Such students are more likely to be studying non-traditional academic courses, such as vocational and technical degrees. As a result, it can be argued that the HESA data provides a more valid pool from which to benchmark the potential supply future engineers, especially those from more disadvantaged demographics.

Table 11.1: Number of students enrolled in higher education (2009/10-2013/14) – UK

	2009/10	2010/11	2011/12	2012/13	2013/14	Change 1 Year	Change 5 years
Total students in HE	2,493,420	2,501,295	2,496,645	2,340,275	2,299,355	-1.7%	-7.8%
Engineering and technology students	156,985	160,885	162,020	158,115	159,010	0.6%	1.3%

Source: HESA students in higher education

Table 11.2: Comparison between UCAS accepts and HESA first year enrolment data to engineering and technology degrees (2007/08-2014/15) – UK

	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change 1 year	Change 5 years
Ucas accepts	413,440	456,630	481,860	487,320	492,015	464,930	495,590	512,355	3.4%	5.1%
Hesa first year enrolments	1,068,830	1,144,020	1,185,190	1,145,970	1,117,335	971,410	995,740	-	2.5%	-16.0%
Ucas engineering and technology accepts	23,695	25,660	28,520	29,295	28,810	27,645	29,715	31,695	6.7%	8.2%
Hesa engineering and technology enrolments	-	-	69,085	68,210	68,020	61,930	64,450	-	4.1%	-6.7%

Source: UCAS and HESA

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Engineering Gateways: a work-based learning pathway to professional registration

Many engineers already in the workplace aspire to achieve an undergraduate or postgraduate degree and then professional registration without moving from employment to full time study. Work-based learning pathways, through higher education and ultimately to professional registration, are valuable both to individuals and to employers who want to ensure their businesses have the skills they need for the future.

Engineering Gateways[845] is a flexible, work-based pathway to professional registration, aimed specifically at working engineers without the necessary full exemplifying academic qualifications. It is open to a broad range of engineers, with benefits identified by learners including:

- development of skills to succeed in work
- guidance from both an academic and industry supervisor
- study related to real work projects and problems
- learning tailored to meet the needs of the individual and their job role
- completion of a higher qualification whilst remaining in full time employment
- achievement of Incorporated Engineer (IEng) or Chartered Engineer (CEng) status

The programme is delivered through a learning contract approach between the employer, employee, university and professional engineering institution. Successful completion leads to the award of an appropriate academic qualification (master's or bachelor's degree) and demonstration (completed fully or partially alongside the degree) of the required competence for professional registration, as outlined in the UK Standard for Professional Engineering Competence (UK-SPEC). The candidate is thus eligible to apply for a professional review interview for Incorporated Engineer or Chartered Engineer status with a participating professional engineering institution.

Benefits identified by employers include:

- improved quality of work
- staff bringing new ideas, methods and systems to the business informed by their learning
- employees able to take on additional responsibilities
- mechanism to draw out and recognise the latent talent
- degree level study helps recent graduates cope with the responsibilities that they face increasingly early in their careers

First developed in December 2006, the programme is now available in 10 universities and is supported by a number of professional engineering institutions. Over 250 individuals have achieved or are working towards professional registration as Incorporated or Chartered Engineers via the Engineering Gateways pathway.

With heightened interest in apprenticeships, this model could be used to enable those who have achieved EngTech or ICT Tech registration or completed an Advanced Apprenticeship to progress further in a work-based setting. This aligns with an original aspiration of the programme as a pathway professional registration for those following an Advanced Apprenticeship.

11.2 Economic benefits of higher education

The UK is seeing growth in the number of higher wage jobs that require a greater level of skills and analytical capability. At the opposite end of the spectrum, there is also forecast to be an expansion in the number of manual low-wage roles. In contrast to this bipolar growth, it has been predicted that there will be a contraction of middle-wage jobs.[846] As such, those with an intermediate level of education will no longer be able to rest on their laurels, as higher education will increasingly become a sine qua non for secure employment.

In 2011/12 alone, universities across the UK generated a total output of £73 billion. This resulted in a contribution of over £36.4 billion to UK GDP. In addition, the off-campus expenditure of international students and visitors contributed a further £3.5 billion. This means that, in total, universities boosted UK GDP by nearly £40 billion (2.8%). Universities UK notes that for every £1 million of university Gross Value Added (GVA), a further £1.03 million GVA is generated in other UK industries.[847] In 2011, universities directly employed 378,250 people. In addition, there are 373,794 full-time equivalent (FTE) jobs in other sectors of the economy dependant on universities' expenditure, totalling 2.7% of UK FTE employment.[848]

As discussed in Section 2.0, the economic recovery in GDP and employment has not been met with an equal increase in productivity.[849] The HE sector has a vital contribution to make in this regard, as analysis by the National Institute of Economic and Social Research estimates that a 1% increase in the share of the workforce with a university degree raises the level of long-run **productivity** by 0.2-0.5%.[850]

11.3 Student numbers

The number of unique applicants to engineering subjects via UCAS increased by 11.6% this year, from 60,030 to 67,105. This compares with an average increase in applicants for all subjects of 3.9%. The percentage increase in applicant numbers for engineering was greater than it was for all other STEM subjects. Furthermore, accepted applicants also increased this year by 7.2%, from 27,155 to 29,110. This was again higher than the all-subject average of 3.4%. The proportion of young people who entered higher education by the time they are aged 19 has also reached record levels for England (40.5%), Northern Ireland (43.9 %) and Wales (35.1%).[851]

It is worth noting that routes by which students are entering HE are becoming increasingly diverse. For example, 18-year-olds in England are 20% more likely to enter HE holding a BTEC this year than last, and around 120% more likely than they were in 2006.[852]

The number of students enrolling onto a HE degree course with a level 3 attainment from one sole type of level 3 BTEC almost doubled, from 25,515 in summer 2006 to 48,425 in summer 2013. Having accounted for 10% of the overall 2005/06 level 3 cohort, they made up 17% of the equivalent 2012/13 cohort. Furthermore, the numbers of pupils holding a combination of A level and BTEC qualifications has increased tenfold, from 2,100 in summer 2006 to around 21,000 in summer 2013. Similarly, the number of pupils successfully enrolling in higher education who hold only BTEC qualifications at level 3 have also increased, from 1,125 in summer 2006 to 18,140 in summer 2013.[853]

Table 11.3 shows the top ten higher education degree subjects chosen by students with BTEC

845 www.engc.org.uk/engineeringgateways 846 UKCES, Working Futures 2012-2022, 2014, Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/298510/working-futures-2012-2022-main-report. Pdf; 847 Universities UK: The impact of universities on the UK economy, report by Viewforth Consulting, 2014, Available at: http://www.universitiesuk.ac.uk/highereducation/Pages/ImpactOfUniversities.aspx#.VTTGVU1ATK 848 Universities UK: The economic role of UK universities, June 2015, p2 849 Office for national statistics: Labour Productivity, Q1 2015, 01 July 2015, p2. 850 Department for Business, Innovation and Skills: The relationship between graduates and economic growth across countries, August 2013, p8 851 *Ibid.* 852 UCAS: End of Cycle Report, December 2014, p1 853 HEFCE: Young participation in higher education A levels and similar qualifications, 2014, p4

qualifications at level 3. Such data challenges the conventional wisdom that A levels constitute the only legitimate pathway towards university study. For example, in 2013/14, 165 students with a BTEC in construction progressed to study architecture at university whilst, surprisingly, 20 students were able to pursue study in computer science. Furthermore, 1,495 students with a level 3 BTEC in engineering successfully enrolled in an engineering sub-discipline at university.

Table 11.3: Top 10 HE degree subjects of study chosen by BTEC level students – (university year of enrolment 2012/13)

BTEC level 3 construction	Female	%	Male	%	Total	% Female
Building	19	27.9%	414	43.0%	433	4.4%
Architecture	17	25.0%	148	15.4%	165	10.3%
Civil engineering	14	20.6%	149	15.4%	163	8.6%
Planning (urban, rural & regional)	1	1.5%	23	2.3%	24	4.3%
Computer science	1	1.5%	19	1.9%	20	5.1%
Business studies	2	2.9%	16	1.6%	18	11.2%
Management studies	0	0.0%	14	1.5%	14	0.0%
Sport & exercise science	0	0.0%	12	1.3%	12	0.0%
General engineering	1	1.5%	11	1.2%	12	8.1%
Mechanical engineering	1	1.5%	11	1.1%	12	8.3%
Other	12	17.6%	146	15.2%	158	7.6%
Total	**68**	**100.0%**	**962**	**100.0%**	1,030	6.6%
BTEC level 3 engineering	**Female**	**%**	**Male**	**%**	**Total**	**% Female**
Mechanical engineering	19	16.8%	463	23.4%	482	3.9%
Electronic & electrical engineering	10	9.3%	369	18.7%	379	2.7%
Aerospace engineering	15	13.5%	239	12.1%	254	5.9%
Civil engineering	15	13.5%	188	9.5%	203	7.4%
General engineering	10	9.2%	124	6.3%	135	7.6%
Building	3	2.7%	59	3.0%	62	4.9%
Computer science	2	1.8%	48	2.4%	50	4.0%
Production & manufacturing engineering	1	0.9%	41	2.1%	42	2.4%
Design studies	4	3.5%	36	1.8%	40	9.6%
Sport & exercise science	2	1.4%	26	1.3%	28	5.4%
Other	31	27.5%	384	19.4%	415	7.4%
Total	**111**	**100.0%**	**1978**	**100.0%**	2,089	5.3%
BTEC level 3 all subjects	**Female**	**%**	**Male**	**%**	**Total**	**% Female**
Sport & exercise science	1,761	5.0%	5,005	13%	6,766	26.0%
Design studies	4,425	12.6%	2,287	6%	6,711	65.9%
Computer science	463	1.3%	3,673	10%	4,136	11.2%
Business studies	1,525	4.3%	2,549	7%	4,075	37.4%
Nursing	3,531	10.1%	249	1%	3,780	93.4%
Drama	1,618	4.6%	916	2%	2,535	63.8%
Cinematics & photography	1,068	3.0%	1,145	3%	2,212	48.3%
Hospitality, leisure, sport, tourism & transport	1,288	3.7%	914	2%	2,202	58.5%
Media studies	803	2.3%	1,246	3%	2,049	39.2%
Music	521	1.5%	1,443	4%	1,964	26.5%
Other	18,078	51.5%	17,818	48%	35,896	50.4%
Total	**35,081**	**100.0%**	**37,245**	**100%**	72,326	48.5%

Source: Pearson

Furthermore, there is little evidence to suggest that students who entered university with BTECs perform significantly worse than those progressing to higher education via traditional academic routes. For example, as Figure 11.2 shows, the vast majority of students who have BTECs obtained either a first class or second class degree, with those possessing BTECs in engineering or construction performing particularly well. For example, 60.1% of students with construction BTECs obtained a first or upper second class honours, a figure generally in line with the average achievement rate of 65.9% for first degrees (Table 11.18).

Furthermore, female students with engineering and construction BTECs outperformed their male counterparts, with 16.1% and 18% achieving a first class degree respectively, compared with only around 11% of males.

However, despite the encouraging data on BTEC holders' progression to and achievement in higher education, there is much work to be done to change the attitudes held by young people about these qualifications. For example, a recent YouGov poll on people's perceptions of qualifications found that 70% of young people disagreed that BTECs (level 3) are equivalent in challenge to A levels, and one third (33%) disagreed that BTEC level 3 qualifications were good preparation for further study.[854]

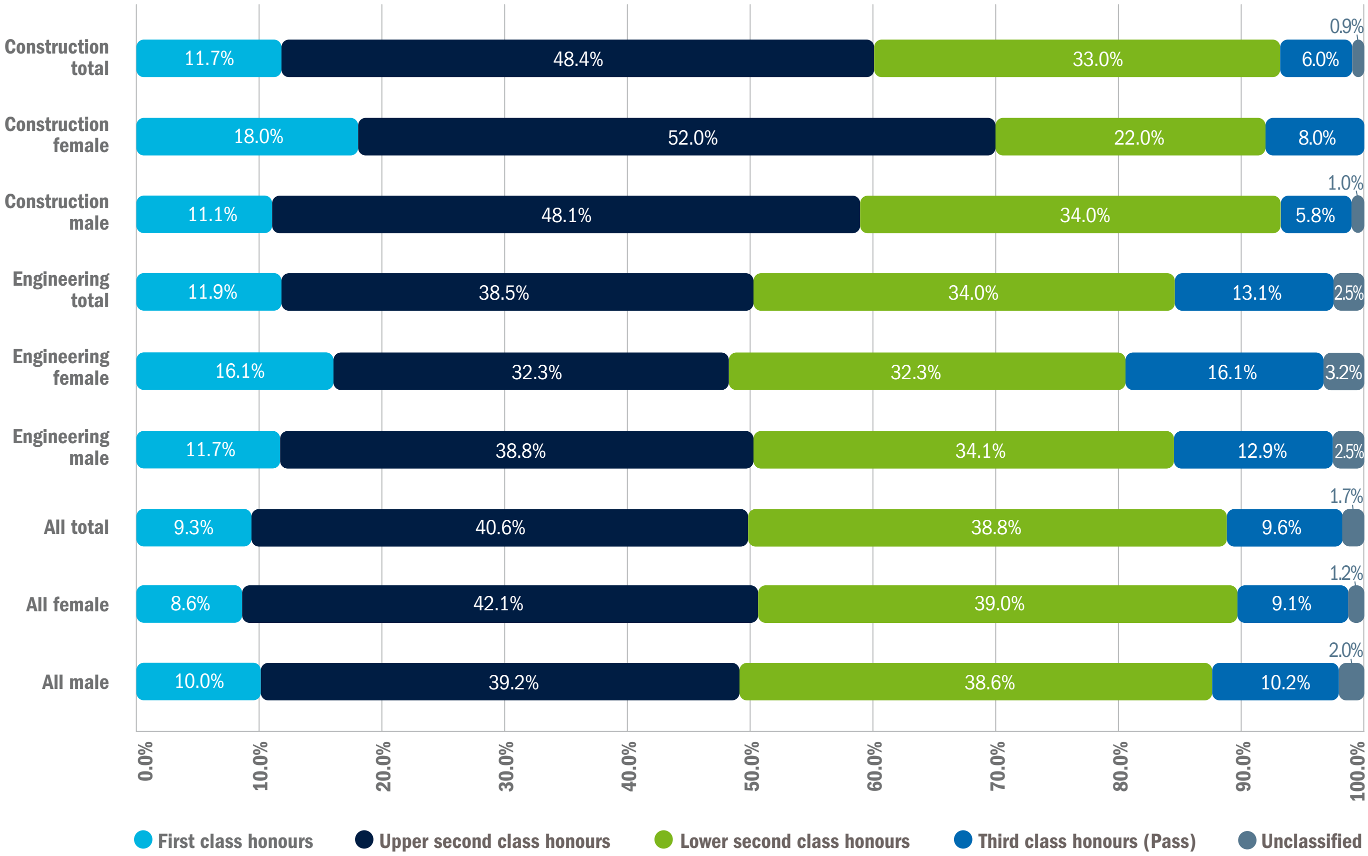
11.4 Applicants to higher education[855]

As Table 11.4 shows, demand to study engineering is steadily increasing. In total, there were 699,685 applicants to HE degrees in 2014/15, of which applicants to engineering degrees constituted 47,140 or 6.7%.

Engineering also experienced the greatest percentage increase in female applicants of any subject. Numbers increased by over a quarter (29.0%) on 2013/14, from 6,665 to 8,600 (Figure 11.3).

However, as Figure 11.4 shows, engineering still attracts the lowest proportion of female applicants (18.2%) of all STEM subjects, except computer sciences.

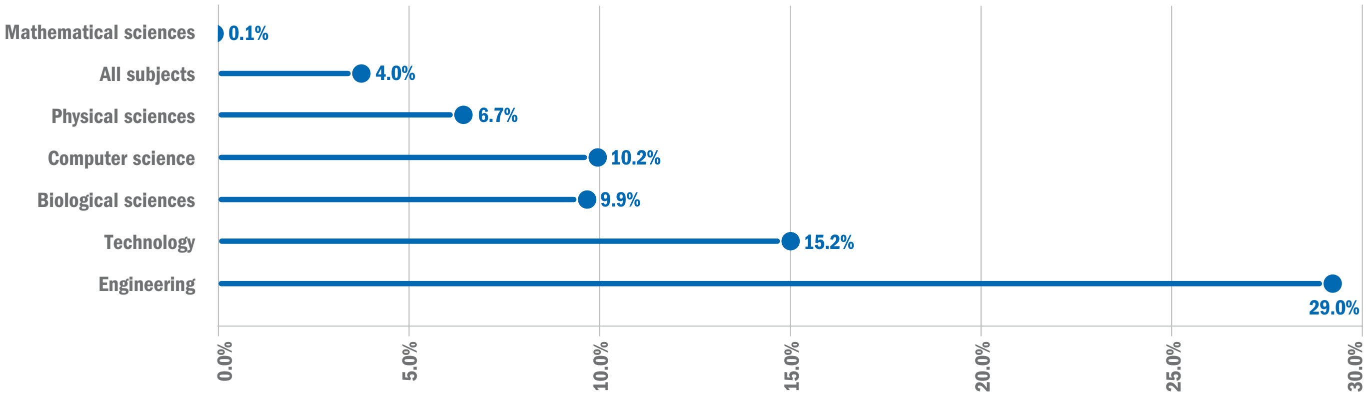
Figure 11.2: BTEC holder degree outcome at university by gender (2013/14) – year of enrolment 2009/10



Source: Pearson

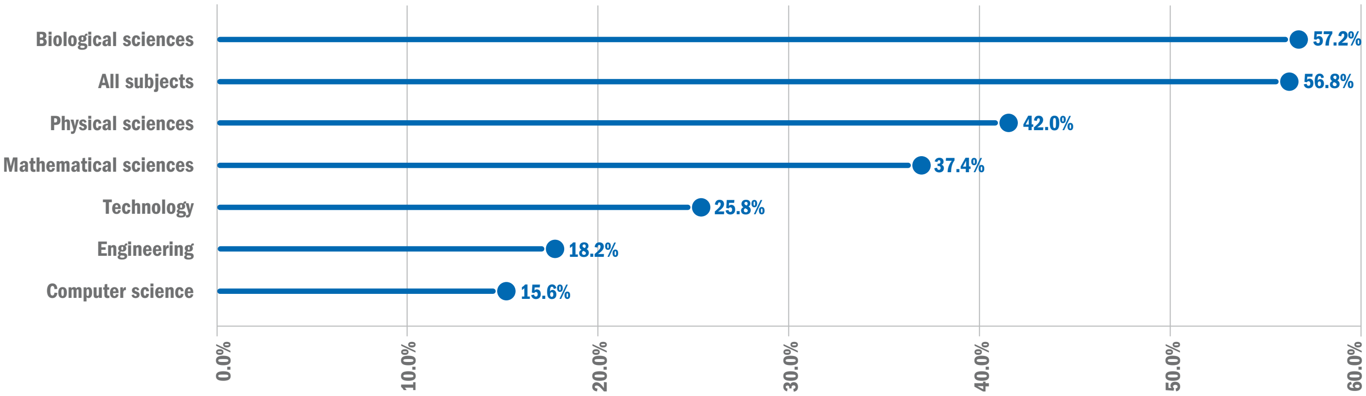
854 YouGov: Perceptions of A levels, GCSEs and Other Qualifications in England – Wave 13, June 2-15, p13 855 Data on applicants is sourced from UCAS who recorded applicants differently from previous years. Previously, applicants were recorded by dominant subject area. In the event that applicants applied to multiple subjects, they were categorised as 'no dominant subject choice', which resulted in an understating of the actual number of applicants to specific subjects. This new form of reporting counts applicant in each subject group/detailed subject group once, which will result in higher numbers of applicants in each subject area compared to the previous method of reporting.

Figure 11.3: Percentage change in female applicants to HE subjects (2013/14-2014/15) – all domiciles



Source: UCAS

Figure 11.4: Percentage of female applicants to STEM subjects (2014/15) – all domiciles



Source: UCAS

Table 11.4: Unique applicants to STEM subjects by domicile and gender (2007/08-2014/15)

Subject		2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change 1 year	Change 7 years
Biological sciences	UK	54,760	55,485	60,855	68,495	70,665	65,780	69,360	74,830	7.9%	36.7%
	EU (excluding UK)	3,025	2,810	3,475	4,315	4,635	4,555	5,065	5,480	8.2%	81.2%
	Not EU	2,940	2,800	3,275	3,570	3,910	4,440	4,970	5,700	14.7%	93.9%
	Total	**60,725**	**61,095**	**67,605**	**76,380**	**79,210**	**74,775**	**79,395**	**86,010**	**8.3%**	**41.6%**
	Female	36,120	35,695	38,450	42,135	43,845	41,890	44,745	49,190	9.9%	36.2%
	Percentage female	59.5%	58.4%	56.9%	55.2%	55.4%	56.0%	56.4%	57.2%	0.8%p	-2.3%p
	Percentage UK	90.2%	90.8%	90.0%	89.7%	89.2%	88.0%	87.4%	87.0%	-0.4%p	-3.2%p
	Percentage not-UK	9.8%	9.2%	10.0%	10.3%	10.8%	12.0%	12.6%	13.0%	0.4%p	3.2%p
Physical sciences	UK	24,245	23,790	25,045	27,635	29,320	28,230	29,685	30,260	1.9%	24.8%
	EU (excluding UK)	1,305	1,200	1,500	1,875	2,010	1,865	1,995	2,015	1.0%	54.4%
	Not EU	1,635	1,735	1,865	2,135	2,140	2,420	2,510	2,980	18.7%	82.3%
	Total	**27,185**	**26,725**	**28,410**	**31,645**	**33,470**	**32,515**	**34,190**	**35,255**	**3.1%**	**29.7%**
	Female	11,510	11,300	11,920	13,125	13,705	13,245	13,890	14,820	6.7%	28.8%
	Percentage female	42%	42%	42%	41%	41%	41%	41%	42%	1.4%p	-0.3%p
	Percentage UK	89%	89%	88%	87%	88%	87%	87%	86%	-1.0%p	-3.4%p
	Percentage not-UK	11%	11%	12%	13%	12%	13%	13%	14%	1.0%p	3.4%p
Mathematical sciences	UK	8,210	8,615	10,540	10,925	10,920	10,340	10,840	10,745	-0.9%	30.9%
	EU (excluding UK)	655	625	765	820	960	865	830	935	12.7%	42.7%
	Not EU	1,775	2,025	2,570	2,595	2,590	2,925	2,780	2,730	-1.8%	53.8%
	Total	**10,640**	**11,265**	**13,875**	**14,340**	**14,470**	**14,130**	**14,450**	**14,410**	**-0.3%**	**35.4%**
	Female	4,315	4,550	5,700	5,680	5,760	5,460	5,390	5,395	0.1%	25.0%
	Percentage female	40.6%	40.4%	41.1%	39.6%	39.8%	38.6%	37.3%	37.4%	0.1%p	-3.1%p
	Percentage UK	77.2%	76.5%	76.0%	76.2%	75.5%	73.2%	75.0%	74.6%	-0.5%p	-2.6%p
	Percentage not-UK	22.8%	23.5%	24.0%	23.8%	24.5%	26.8%	25.0%	25.4%	0.5%p	2.6%p
Engineering	UK	23,095	23,675	26,765	28,570	29,635	28,070	29,680	33,100	11.5%	43.3%
	EU (excluding UK)	3,000	2,770	3,410	3,820	3,980	3,380	3,500	3,720	6.3%	24.0%
	Not EU	6,970	7,340	7,940	8,420	8,145	8,715	9,200	10,320	12.2%	48.1%
	Total	**33,065**	**33,785**	**38,115**	**40,810**	**41,760**	**40,165**	**42,380**	**47,140**	**11.2%**	**42.6%**
	Female	4,675	4,695	5,315	5,600	5,780	6,115	6,665	8,600	29.0%	84.0%
	Percentage female	14.1%	13.9%	13.9%	13.7%	13.8%	15.2%	15.7%	18.2%	2.5%p	4.1%p
	Percentage UK	69.8%	70.1%	70.2%	70.0%	71.0%	69.9%	70.0%	70.2%	0.2%p	0.4%p
	Percentage not-UK	30.2%	29.9%	29.8%	30.0%	29.0%	30.1%	30.0%	29.8%	-0.2%p	-0.4%p
Computer science	UK	22,475	22,650	25,605	27,680	28,250	25,795	27,485	30,045	9.3%	33.7%
	EU (excluding UK)	1,385	1,320	1,615	1,930	2,330	2,045	2,305	2,650	15.0%	91.3%
	Not EU	2,630	2,290	2,175	2,215	2,015	2,160	2,305	2,700	17.1%	2.7%
	Total	**26,490**	**26,260**	**29,395**	**31,825**	**32,595**	**30,000**	**32,095**	**35,395**	**10.3%**	**33.6%**
	Female	4,670	4,635	5,075	5,260	5,355	4,905	5,000	5,510	10.2%	18.0%
	Percentage female	17.6%	17.7%	17.3%	16.5%	16.4%	16.4%	15.6%	15.6%	0.0%p	-2.1%p
	Percentage UK	84.8%	86.3%	87.1%	87.0%	86.7%	86.0%	85.6%	84.9%	-0.8%p	0.0%p
	Percentage not-UK	15.2%	13.7%	12.9%	13.0%	13.3%	14.0%	14.4%	15.1%	0.8%p	0.0%p

Table 11.4: Unique applicants to STEM subjects by domicile and gender (2007/08-2014/15) – continued

Subject		2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change 1 year	Change 7 years
Technology	UK	6,005	5,905	6,535	7,105	6,530	5,400	5,550	5,685	2.4%	-5.3%
	EU (excluding UK)	450	410	450	560	620	620	625	720	15.2%	60.0%
	Not EU	625	570	700	750	735	710	740	950	28.4%	52.0%
	Total	**7,080**	**6,885**	**7,685**	**8,415**	**7,885**	**6,730**	**6,915**	**7,355**	**6.4%**	**3.9%**
	Female	1,950	1,860	1,995	1,920	1,585	1,490	1,645	1,895	15.2%	-2.8%
	Percentage female	27.5%	27.0%	26.0%	22.8%	20.1%	22.1%	23.8%	25.8%	2.0%p	-1.8%p
	Percentage UK	84.8%	85.8%	85.0%	84.4%	82.8%	80.2%	80.3%	77.3%	-3.0%p	-7.5%p
	Percentage not-UK	15.2%	14.2%	15.0%	15.6%	17.2%	19.8%	19.7%	22.7%	3.0%p	7.5%p
All subjects	UK	452,745	501,070	542,915	585,300	587,865	543,340	561,985	578,290	2.9%	27.7%
	EU (excluding UK)	33,620	34,530	39,505	47,320	49,275	43,150	44,835	46,830	4.4%	39.3%
	Not EU	48,130	53,090	57,445	64,730	63,020	67,150	70,555	74,560	5.7%	54.9%
	Total	**534,495**	**588,690**	**639,860**	**697,350**	**700,160**	**653,635**	**677,375**	**699,685**	**3.3%**	**30.9%**
	Female	293,590	328,810	355,105	390,445	393,095	368,570	381,920	397,085	4.0%	35.3%
	Percentage female	54.9%	55.9%	55.5%	56.0%	56.1%	56.4%	56.4%	56.8%	0.4%p	1.8%p
	Percentage UK	84.7%	85.1%	84.8%	83.9%	84.0%	83.1%	83.0%	82.7%	-0.3%p	-2.1%p
	Percentage not-UK	15.3%	14.9%	15.2%	16.1%	16.0%	16.9%	17.0%	17.3%	0.3%p	2.1%p

Source: UCAS

11.4.1 Applications to higher education by engineering sub-discipline

Looking at specific engineering sub-disciplines, Table 11.5 reveals that general engineering saw the greatest increase in applicants over last year, growing from 8,590 to 11,060 (28.8%). Applicants to chemical, process and energy engineering also grew by a substantial amount in this period, from 5,309 to 6,235 (17.5%). This discipline experienced the greatest percentage increase in applicants over the last seven years, almost doubling from 2,795 to 6,235 (123%). Chemical process and energy engineering also had the highest proportion of female applicants (26%). Therefore, the strong growth in this sub-discipline is a promising avenue to explore in addressing the gender balance in the engineering sector in general. Production and manufacturing engineering was the only sub-discipline to experience a decline in applicants, with the percentage declining by 1.0% since 2013/14 and 4.8% since 2007/08.

Table 11.5: Unique applicants to engineering disciplines by domicile and gender (2007/08-2014/15)

Subject		2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change 1 year	Change 7 years
General engineering	UK	6,245	6,030	6,790	7,485	7,335	7,395	8,590	11,060	28.8%	77.1%
	EU (excluding UK)	640	570	805	905	940	875	1,070	1,245	16.4%	94.5%
	Not EU	1,395	1,350	1,590	1,870	1,695	2,095	2,330	2,860	22.7%	105.0%
	Total	**8,280**	**7,950**	**9,185**	**10,260**	**9,970**	**10,365**	**11,990**	**15,165**	**26.5%**	**83.2%**
	Female	1,120	1,155	1,300	1,480	1,515	1,925	2,280	3,635	59.4%	224.6%
	Percentage female	13.5%	14.5%	14.2%	14.4%	15.2%	18.6%	19.0%	24.0%	5.0%p	10.4%p
	Percentage UK	75.4%	75.8%	73.9%	73.0%	73.6%	71.3%	71.6%	72.9%	1.3%p	-2.5%p
	Percentage not-UK	24.6%	24.2%	26.1%	27.0%	26.4%	28.7%	28.4%	27.1%	-1.3%p	2.5%p
Civil engineering	UK	4,840	5,310	5,990	5,945	5,840	5,060	4,825	4,830	0.1%	-0.2%
	EU (excluding UK)	1,065	1,070	1,205	1,195	1,140	740	615	595	-3.3%	-44.1%
	Not EU	1,130	1,225	1,350	1,625	1,610	1,700	1,655	1,870	13.0%	65.5%
	Total	**7,035**	**7,605**	**8,545**	**8,765**	**8,590**	**7,500**	**7,095**	**7,295**	**2.8%**	**3.7%**
	Female	1,045	1,240	1,325	1,390	1,370	1,290	1,230	1,395	13.4%	33.5%
	Percentage female	14.9%	16.3%	15.5%	15.9%	15.9%	17.2%	17.3%	19.1%	1.8%p	4.3%p
	Percentage UK	68.8%	69.8%	70.1%	67.8%	68.0%	67.5%	68.0%	66.2%	-1.8%p	-2.6%p
	Percentage not-UK	31.2%	30.2%	29.9%	32.2%	32.0%	32.5%	32.0%	33.8%	1.8%p	2.6%p
Mechanical engineering	UK	6,080	6,725	8,245	9,370	9,895	9,800	10,475	11,330	8.2%	86.3%
	EU (excluding UK)	705	635	840	1,050	1,120	1,170	1,230	1,295	5.3%	83.7%
	Not EU	1,915	2,045	2,270	2,420	2,490	2,730	2,985	3,375	13.1%	76.2%
	Total	**8,700**	**9,405**	**11,355**	**12,840**	**13,505**	**13,700**	**14,690**	**16,000**	**8.9%**	**83.9%**
	Female	735	735	920	1,010	1,130	1,230	1,410	1,690	19.9%	129.9%
	Percentage female	8.4%	7.8%	8.1%	7.9%	8.4%	9.0%	9.6%	10.6%	1.0%p	2.1%p
	Percentage UK	69.9%	71.5%	72.6%	73.0%	73.3%	71.5%	71.3%	70.8%	-0.5%p	0.9%p
	Percentage not-UK	30.1%	28.5%	27.4%	27.0%	26.7%	28.5%	28.7%	29.2%	0.5%p	-0.9%p
Aerospace engineering	UK	2,945	2,880	3,330	3,820	3,845	3,715	3,925	4,255	8.4%	44.5%
	EU (excluding UK)	250	230	325	435	420	415	435	485	11.5%	94.0%
	Not EU	750	755	905	1,050	950	855	875	995	13.7%	32.7%
	Total	**3,945**	**3,865**	**4,560**	**5,305**	**5,215**	**4,985**	**5,235**	**5,735**	**9.6%**	**45.4%**
	Female	410	420	470	590	605	560	615	725	17.9%	76.8%
	Percentage female	10.4%	10.9%	10.3%	11.1%	11.6%	11.2%	11.7%	12.6%	0.9%p	2.2%p
	Percentage UK	74.7%	74.5%	73.0%	72.0%	73.7%	74.5%	75.0%	74.2%	-0.8%p	-0.5%p
	Percentage not-UK	25.3%	25.5%	27.0%	28.0%	26.3%	25.5%	25.0%	25.8%	0.8%p	0.5%p

Table 11.5: Unique applicants to engineering disciplines by domicile and gender (2007/08-2014/15) – continued

Subject		2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change 1 year	Change 7 years
Electronic and electrical engineering	UK	6,470	5,915	6,525	6,795	7,200	6,405	6,630	6,935	4.6%	7.2%
	EU (excluding UK)	725	580	750	855	920	795	800	865	8.1%	19.3%
	Not EU	2,590	2,540	2,490	2,500	2,200	2,280	2,285	2,410	5.5%	-6.9%
	Total	**9,785**	**9,035**	**9,765**	**10,150**	**10,320**	**9,480**	**9,715**	**10,210**	**5.1%**	**4.3%**
	Female	1,185	985	1,165	1,090	1,015	1,030	1,050	1,105	5.2%	-6.8%
	Percentage female	12.1%	10.9%	11.9%	10.7%	9.8%	10.9%	10.8%	10.8%	0.0%p	-1.3%p
	Percentage UK	66.1%	65.5%	66.8%	66.9%	69.8%	67.6%	68.2%	67.9%	-0.3%p	1.8%p
	Percentage not-UK	33.9%	34.5%	33.2%	33.1%	30.2%	32.4%	31.8%	32.1%	0.3%p	-1.8%p
Production and manufacturing engineering	UK	2,105	1,790	1,835	2,110	2,195	1,990	2,030	2,000	-1.5%	-5.0%
	EU (excluding UK)	130	110	130	130	175	135	170	145	-14.7%	11.5%
	Not EU	350	315	335	195	225	240	285	315	10.5%	-10.0%
	Total	**2,585**	**2,215**	**2,300**	**2,435**	**2,595**	**2,365**	**2,485**	**2,460**	**-1.0%**	**-4.8%**
	Female	560	505	470	495	550	510	535	510	-4.7%	-8.9%
	Percentage female	21.7%	22.8%	20.4%	20.3%	21.2%	21.6%	21.5%	20.7%	-0.8%p	-0.9%p
	Percentage UK	81.4%	80.8%	79.8%	86.7%	84.6%	84.1%	81.7%	81.3%	-0.4%p	-0.1%p
	Percentage not-UK	18.6%	19.2%	20.2%	13.3%	15.4%	15.9%	18.3%	18.7%	0.4%p	0.1%p
Chemical, process and energy engineering	UK	1,725	1,780	2,120	2,125	2,525	2,810	3,455	4,020	16.4%	133.0%
	EU (excluding UK)	170	155	185	235	255	260	315	385	22.2%	126.5%
	Not EU	900	960	1,125	1,205	1,245	1,380	1,535	1,830	19.2%	103.3%
	Total	**2,795**	**2,895**	**3,430**	**3,565**	**4,025**	**4,450**	**5,305**	**6,235**	**17.5%**	**123.1%**
	Female	710	750	910	950	1,050	1,160	1,350	1,620	20.0%	128.2%
	Percentage female	25.4%	25.9%	26.5%	26.6%	26.1%	26.1%	25.4%	26.0%	0.5%p	0.6%p
	Percentage UK	61.7%	61.5%	61.8%	59.6%	62.7%	63.1%	65.1%	64.5%	-0.7%p	2.8%p
	Percentage not-UK	38.3%	38.5%	38.2%	40.4%	37.3%	36.9%	34.9%	35.5%	0.7%p	-2.8%p

Source: UCAS

Figure 11.5 reveals a gradual shift in the profile of applicants to engineering sub-disciplines, to have less of a focus on electronic and electrical engineering, production and manufacturing engineering, and civil engineering, in favour of chemical, process and energy engineering and general engineering.

Chemical process and energy engineering have the highest proportion of female applicants (26%). The strong growth in this sub-discipline is a promising avenue for exploration in addressing the gender balance in the engineering sector in general.

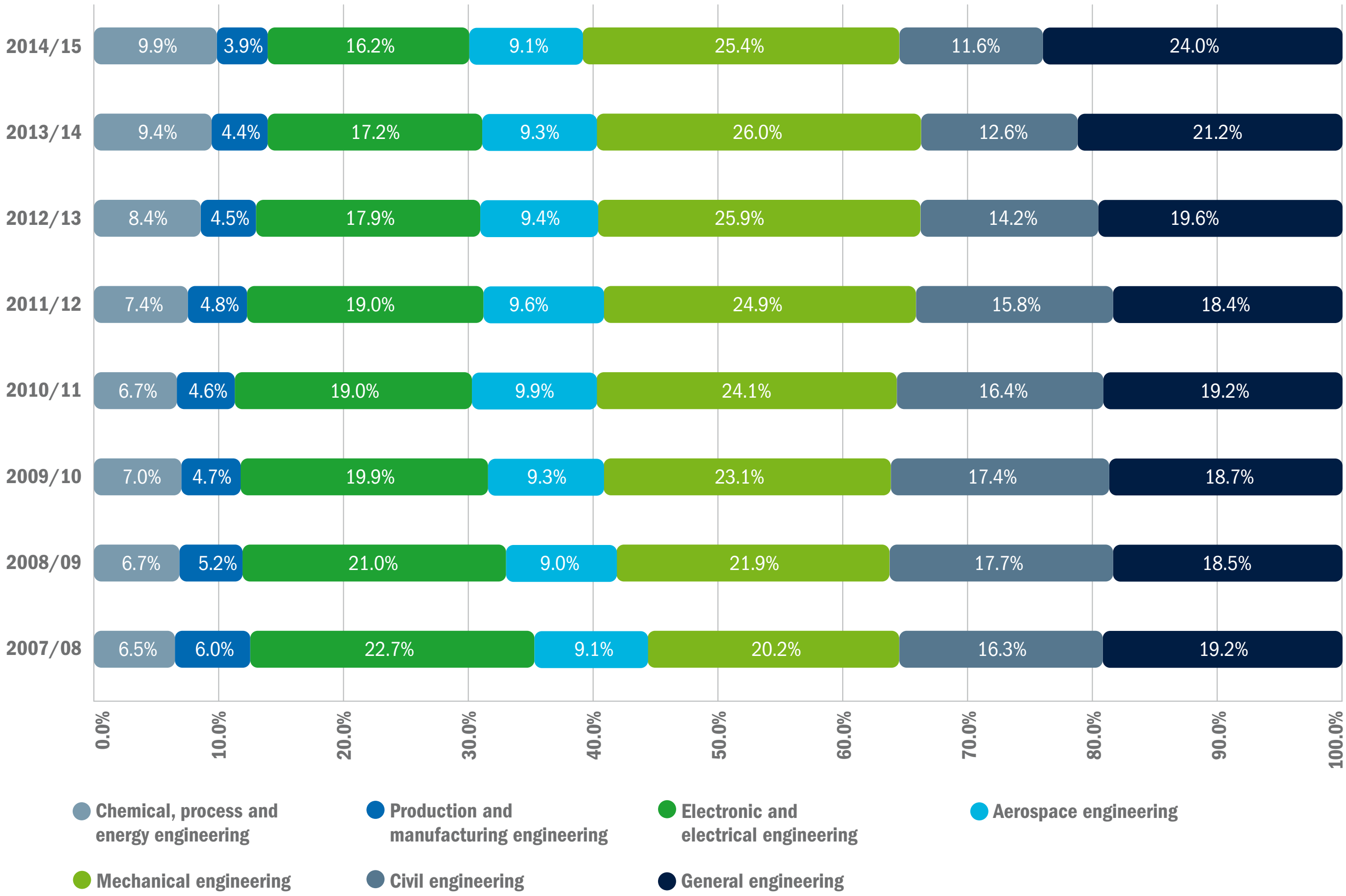
11.5 Accepted applicants

As Table 11.6 shows, accepted applicants to engineering degrees increased by 7.2% this year, from 27,155 to 29,110. The increase in the number of accepts was lower than the increase in applicants, suggesting that the surge in demand for engineering degrees is not fully translating to an increased supply.

However, the numbers of female applicants accepted to engineering degrees during this period grew by the largest amount of any subject, increasing by 21%, from 3,640 to 4,405. This increase is more in line with the increase in female applicants of 26.7%. As a result, the proportion of female accepts to engineering degrees has increased from 13.4% in 2013/14 to 15.1% in 2014/15.

Numbers of international students accepted to engineering degrees increased this year, by 4.8% for EU students and 3.6% for those outside the EU. However, as a percentage of all students, non-UK students declined by 0.6 percentage points over the last year and by 7.5 percentage points since 2007.

Figure 11.5: Proportion of engineering sub-disciplines by applicants (2007/08-2014/15) – all domiciles



Source: UCAS

Table 11.6: Accepted applicants to STEM subjects by domicile and gender (2007/08-2014/15)

Subject		2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change 1 year	Change 7 years
Biological sciences	UK	29,810	31,840	34,125	35,600	36,760	36,175	40,650	44,610	9.7%	49.6%
	EU (excluding UK)	1,320	1,325	1,590	1,730	1,895	1,805	1,980	2,255	13.9%	70.8%
	Not EU	1,060	1,115	1,240	1,490	1,485	1,645	1,785	1,945	9.0%	83.5%
	Total	**32,190**	**34,280**	**36,955**	**38,820**	**40,140**	**39,625**	**44,415**	**48,810**	**9.9%**	**51.6%**
	Female	19,495	20,420	21,725	22,380	23,415	23,090	25,900	28,470	9.9%	46.0%
	Percentage female	60.6%	59.6%	58.8%	57.7%	58.3%	58.3%	58.3%	58.3%	0.0%p	-2.2%p
	Percentage UK	92.6%	92.9%	92.3%	91.7%	91.6%	91.3%	91.5%	91.4%	-0.1%p	-1.2%p
	Percentage not-UK	7.4%	7.1%	7.7%	8.3%	8.4%	8.7%	8.5%	8.6%	0.1%p	1.2%p
Physical sciences	UK	14,245	14,855	15,715	16,275	16,755	16,630	17,580	18,070	2.8%	26.9%
	EU (excluding UK)	585	585	715	775	780	700	780	755	-3.2%	29.1%
	Not EU	650	765	860	950	900	940	965	1,095	13.5%	68.5%
	Total	**15,480**	**16,205**	**17,290**	**18,000**	**18,435**	**18,270**	**19,325**	**19,920**	**3.1%**	**28.7%**
	Female	6,270	6,555	6,930	7,200	7,310	7,050	7,605	8,050	5.9%	28.4%
	Percentage female	40.5%	40.5%	40.1%	40.0%	39.7%	38.6%	39.4%	40.4%	1.1%p	-0.1%p
	Percentage UK	92.0%	91.7%	90.9%	90.4%	90.9%	91.0%	91.0%	90.7%	-0.3%p	-1.3%p
	Percentage not-UK	8.0%	8.3%	9.1%	9.6%	9.1%	9.0%	9.0%	9.3%	0.3%p	1.3%p
Mathematical sciences	UK	4,875	5,320	6,330	6,540	6,930	6,625	7,080	7,065	-0.2%	44.9%
	EU (excluding UK)	280	265	335	350	385	345	320	385	20.3%	37.5%
	Not EU	680	810	1,040	1,040	1,045	1,130	1,075	1,025	-4.7%	50.7%
	Total	**5,835**	**6,395**	**7,705**	**7,930**	**8,360**	**8,100**	**8,475**	**8,475**	**0.0%**	**45.2%**
	Female	2,345	2,565	3,140	3,140	3,390	3,105	3,130	3,160	1.0%	34.8%
	Percentage female	40.2%	40.1%	40.8%	39.6%	40.6%	38.3%	36.9%	37.3%	-2.9%p	-2.9%p
	Percentage UK	83.5%	83.2%	82.2%	82.5%	82.9%	81.8%	83.5%	83.4%	-0.2%p	-0.2%p
	Percentage not-UK	16.5%	16.8%	17.8%	17.5%	17.1%	18.2%	16.5%	16.6%	0.2%p	0.2%p
Engineering	UK	14,605	16,350	18,255	18,645	19,435	19,050	20,660	22,325	8.1%	52.9%
	EU (excluding UK)	1,925	1,820	2,080	2,115	2,080	1,865	1,820	1,885	3.6%	-2.1%
	Not EU	4,570	4,770	5,105	5,300	4,480	4,380	4,675	4,900	4.8%	7.2%
	Total	**21,100**	**22,940**	**25,440**	**26,060**	**25,995**	**25,295**	**27,155**	**29,110**	**7.2%**	**38.0%**
	Female	2,570	2,850	3,130	3,255	3,250	3,385	3,640	4,405	21.0%	71.4%
	Percentage female	12.2%	12.4%	12.3%	12.5%	12.5%	13.4%	13.4%	15.1%	1.7%p	3.0%p
	Percentage UK	69.2%	71.3%	71.8%	71.5%	74.8%	75.3%	76.1%	76.7%	0.6%p	7.5%p
	Percentage not-UK	30.8%	28.7%	28.2%	28.5%	25.2%	24.7%	23.9%	23.3%	-0.6%p	-7.5%p
Computer sciences	UK	15,210	16,475	18,150	18,005	18,295	17,415	19,590	21,020	7.3%	38.2%
	EU (excluding UK)	770	840	990	1,130	1,250	1,080	1,195	1,445	20.9%	87.7%
	Not EU	1,300	1,195	1,145	1,360	875	860	925	1,120	21.1%	-13.8%
	Total	**17,280**	**18,510**	**20,285**	**20,495**	**20,420**	**19,355**	**21,710**	**23,585**	**8.6%**	**36.5%**
	Female	2,580	2,840	3,065	3,100	2,970	2,715	2,925	3,125	6.8%	21.1%
	Percentage female	14.9%	15.3%	15.1%	15.1%	14.5%	14.0%	13.5%	13.2%	-0.2%p	-1.7%p
	Percentage UK	88.0%	89.0%	89.5%	87.9%	89.6%	90.0%	90.2%	89.1%	-1.1%p	1.1%p
	Percentage not-UK	12.0%	11.0%	10.5%	12.1%	10.4%	10.0%	9.8%	10.9%	1.1%p	-1.1%p

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Table 11.6: Accepted applicants to STEM subjects by domicile and gender (2007/08-2014/15) – continued

Subject		2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change 1 year	Change 7 years
Technologies	UK	2,215	2,375	2,685	2,755	2,450	1,980	2,135	2,135	0.0%	-3.6%
	EU (excluding UK)	130	135	155	160	135	155	165	190	15.2%	46.2%
	Not EU	250	210	240	320	230	215	260	260	0.0%	4.0%
	Total	**2,595**	**2,720**	**3,080**	**3,235**	**2,815**	**2,350**	**2,560**	**2,585**	**1.0%**	**-0.4%**
	Female	545	480	620	590	520	385	505	495	-2.0%	-9.2%
	Percentage female	21.0%	17.6%	20.1%	18.2%	18.5%	16.4%	19.7%	19.1%	-0.6%p	-1.9%p
	Percentage UK	85.4%	87.3%	87.2%	85.2%	87.0%	84.3%	83.4%	82.6%	-0.8%p	-2.8%p
	Percentage not-UK	14.6%	12.7%	12.8%	14.8%	13.0%	15.7%	16.6%	17.4%	0.8%p	2.8%p
All subjects	UK	363,365	403,860	423,955	423,430	430,055	406,245	433,600	447,435	3.2%	23.1%
	EU (excluding UK)	20,670	21,365	23,805	25,600	26,705	23,240	24,510	26,385	7.6%	27.6%
	Not EU	29,405	31,405	34,100	38,290	35,255	35,445	37,480	38,535	2.8%	31.0%
	Total	**413,440**	**456,630**	**481,860**	**487,320**	**492,015**	**464,930**	**495,590**	**512,355**	**3.4%**	**23.9%**
	Female	223,740	251,925	263,675	267,240	270,160	256,625	273,525	285,095	4.2%	27.4%
	Percentage female	54.1%	55.2%	54.7%	54.8%	54.9%	55.2%	55.2%	55.6%	0.5%p	1.5%p
	Percentage UK	87.9%	88.4%	88.0%	86.9%	87.4%	87.4%	87.5%	87.3%	-0.2%p	-0.6%p
	Percentage not-UK	12.1%	11.6%	12.0%	13.1%	12.6%	12.6%	12.5%	12.7%	0.2%p	0.6%p

Source: UCAS

11.5.1 Accepted applicants by engineering sub-discipline

As Table 11.7 illustrates, in line with general applicant trends, chemical, process and energy engineering had the largest increase in accepted applicants of any engineering sub-discipline, with numbers increasing by 27.2% this year from 2,810 to 3,575. This equals a seven-year increase of 148.3%.

Numbers of female accepts increased in line with these figures, resulting in the proportion of female students remaining fairly stable since 2007 at around 25%.

The small numbers of accepted applicants to production and manufacturing engineering continued to decline, dropping by 7.6% this year from 655 to 605. General engineering saw the largest growth in the number of female accepted applicants, with a 50% increase from 605 to 930. As a result, the proportion of female accepts rose from 16.1% to 20.5%, a significant jump compared to the gradual increase since 2007.

Table 11.7: Accepted applicants to engineering disciplines by domicile and gender (2007/08-2014/15)

		2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change 1 year	Change 7 years
General engineering	UK	2,320	2,530	2,765	2,680	2,350	2,730	3,110	3,780	21.5%	62.9%
	EU (excluding UK)	180	165	235	220	195	200	220	265	20.5%	47.2%
	Not EU	395	405	395	360	370	445	435	490	12.6%	24.1%
	Total	**2,895**	**3,100**	**3,395**	**3,260**	**2,915**	**3,375**	**3,765**	**4,535**	**20.5%**	**56.6%**
	Female	365	405	430	455	445	570	605	930	53.7%	154.8%
	Percentage female	12.6%	13.1%	12.7%	14.0%	15.3%	16.9%	16.1%	20.5%	4.4%p	7.9%p
	Percentage UK	80.1%	81.6%	81.4%	82.2%	80.6%	80.9%	82.6%	83.4%	0.7%p	3.2%p
	Percentage not-UK	19.9%	18.4%	18.6%	17.8%	19.4%	19.1%	17.4%	16.6%	-0.7%p	-3.2%p
Civil engineering	UK	2,620	3,135	3,370	3,415	3,545	3,100	2,990	2,805	-6.2%	7.1%
	EU (excluding UK)	565	670	685	620	510	350	275	265	-3.6%	-53.1%
	Not EU	555	605	650	900	785	780	820	810	-1.2%	45.9%
	Total	**3,740**	**4,410**	**4,705**	**4,935**	**4,840**	**4,230**	**4,085**	**3,880**	**-5.0%**	**3.7%**
	Female	505	670	700	790	720	675	660	725	9.8%	43.6%
	Percentage female	13.5%	15.2%	14.9%	16.0%	14.9%	16.0%	16.2%	18.7%	2.5%p	5.2%p
	Percentage UK	70.1%	71.1%	71.6%	69.2%	73.2%	73.3%	73.2%	72.3%	-0.9%p	2.2%p
	Percentage not-UK	29.9%	28.9%	28.4%	30.8%	26.8%	26.7%	26.8%	27.7%	0.9%p	-2.2%p

Table 11.7: Accepted applicants to engineering disciplines by domicile and gender (2007/08-2014/15) – continued

		2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change 1 year	Change 7 years
Mechanical engineering	UK	3,325	4,030	4,670	4,940	5,225	5,260	5,800	6,070	4.7%	82.6%
	EU (excluding UK)	380	355	440	445	455	485	505	550	8.9%	44.7%
	Not EU	1,005	1,010	1,165	1,215	1,025	1,105	1,225	1,265	3.3%	25.9%
	Total	**4,710**	**5,395**	**6,275**	**6,600**	**6,705**	**6,850**	**7,530**	**7,885**	**4.7%**	**67.4%**
	Female	340	355	465	465	500	550	645	710	10.1%	108.8%
	Percentage female	7.2%	6.6%	7.4%	7.0%	7.5%	8.0%	8.6%	9.0%	0.4%p	1.8%p
	Percentage UK	70.6%	74.7%	74.4%	74.8%	77.9%	76.8%	77.0%	77.0%	0.0%p	6.4%p
	Percentage not-UK	29.4%	25.3%	25.6%	25.2%	22.1%	23.2%	23.0%	23.0%	0.0%p	-6.4%p
Aerospace engineering	UK	1,445	1,505	1,775	1,800	1,930	1,910	2,100	2,425	15.5%	67.8%
	EU (excluding UK)	110	95	140	160	175	175	170	190	11.8%	72.7%
	Not EU	310	330	435	475	430	310	315	375	19.0%	21.0%
	Total	**1,865**	**1,930**	**2,350**	**2,435**	**2,535**	**2,395**	**2,585**	**2,990**	**15.7%**	**60.3%**
	Female	205	200	220	250	280	255	280	340	21.4%	65.9%
	Percentage female	11.0%	10.4%	9.4%	10.3%	11.0%	10.6%	10.8%	11.4%	0.5%p	0.4%p
	Percentage UK	77.5%	78.0%	75.5%	73.9%	76.1%	79.7%	81.2%	81.1%	-0.1%p	3.6%p
	Percentage not-UK	22.5%	22.0%	24.5%	26.1%	23.9%	20.3%	18.8%	18.9%	0.1%p	-3.6%p
Electrical and electronic engineering	UK	2,765	2,870	3,265	3,230	3,520	3,210	3,425	3,350	-2.2%	21.2%
	EU (excluding UK)	375	305	350	380	395	375	380	350	-7.9%	-6.7%
	Not EU	1,575	1,545	1,475	1,505	1,090	1,060	1,045	1,085	3.8%	-31.1%
	Total	**4,715**	**4,720**	**5,090**	**5,115**	**5,005**	**4,645**	**4,850**	**4,785**	**-1.3%**	**1.5%**
	Female	520	505	565	545	480	470	470	540	14.9%	3.8%
	Percentage female	11.0%	10.7%	11.1%	10.7%	9.6%	10.1%	9.7%	11.3%	1.6%p	0.3%p
	Percentage UK	58.6%	60.8%	64.1%	63.1%	70.3%	69.1%	70.6%	70.0%	-0.6%p	11.4%p
	Percentage not-UK	41.4%	39.2%	35.9%	36.9%	29.7%	30.9%	29.4%	30.0%	0.6%p	-11.4%p
Production and manufacturing engineering	UK	600	585	575	660	625	565	575	515	-10.4%	-14.2%
	EU (excluding UK)	50	45	40	25	60	55	40	35	-12.5%	-30.0%
	Not EU	100	105	95	50	45	30	40	55	37.5%	-45.0%
	Total	**750**	**735**	**710**	**735**	**730**	**650**	**655**	**605**	**-7.6%**	**-19.3%**
	Female	185	175	145	155	155	150	150	120	-20.0%	-35.1%
	Percentage female	24.7%	23.8%	20.4%	21.1%	21.2%	23.1%	22.9%	19.8%	-3.1%p	-4.8%p
	Percentage UK	80.0%	79.6%	81.0%	89.8%	85.6%	86.9%	87.8%	85.1%	-2.7%p	5.1%p
	Percentage not-UK	20.0%	20.4%	19.0%	10.2%	14.4%	13.1%	12.2%	14.9%	2.7%p	-5.1%p
Chemical, process and energy engineering	UK	940	1,075	1,200	1,205	1,475	1,600	2,010	2,685	33.6%	185.6%
	EU (excluding UK)	80	60	75	85	115	105	125	150	20.0%	87.5%
	Not EU	420	490	555	555	540	515	675	740	9.6%	76.2%
	Total	**1,440**	**1,625**	**1,830**	**1,845**	**2,130**	**2,220**	**2,810**	**3,575**	**27.2%**	**148.3%**
	Female	355	425	490	500	550	600	720	885	22.9%	149.3%
	Percentage female	24.7%	26.2%	26.8%	27.1%	25.8%	27.0%	25.6%	24.8%	-0.9%p	0.1%p
	Percentage UK	65.3%	66.2%	65.6%	65.3%	69.2%	72.1%	71.5%	75.1%	3.6%p	9.8%p
	Percentage not-UK	34.7%	33.8%	34.4%	34.7%	30.8%	27.9%	28.5%	24.9%	-3.6%p	-9.8%p

Source: UCAS

11.5.2 Accepted applicants by institution

Although numbers of engineering students are increasing, compared to other subjects, provision is relatively concentrated to a small number of universities. As Table 11.8 shows, the top 10 universities for engineering acceptances accounted for over a quarter of total acceptances. Furthermore, there is a northern bias with regard to location, with only two of the top ten institutions situated in the south of England.

Table 11.8: Top higher education institutions for accepted applicants in engineering (2014/15) – UK

Institution	Number of engineering acceptances	Percentage of all engineering acceptances in UK HEIs
1. The University of Manchester	6,735	3.3%
2. Loughborough University	6,620	3.3%
3. The University of Sheffield	5,500	2.7%
4. Imperial College London	5,425	2.7%
5. Kingston University	5,105	2.5%
6. Coventry University	4,790	2.4%
7. The University of Nottingham	4,675	2.3%
8. University of Leeds	4,605	2.3%
9. The University of Strathclyde	4,535	2.2%
10. Newcastle University	4,235	2.1%
Total	**52,225**	**25.7%**

Source: UCAS

11.5.3 Accepted applicants by ethnicity

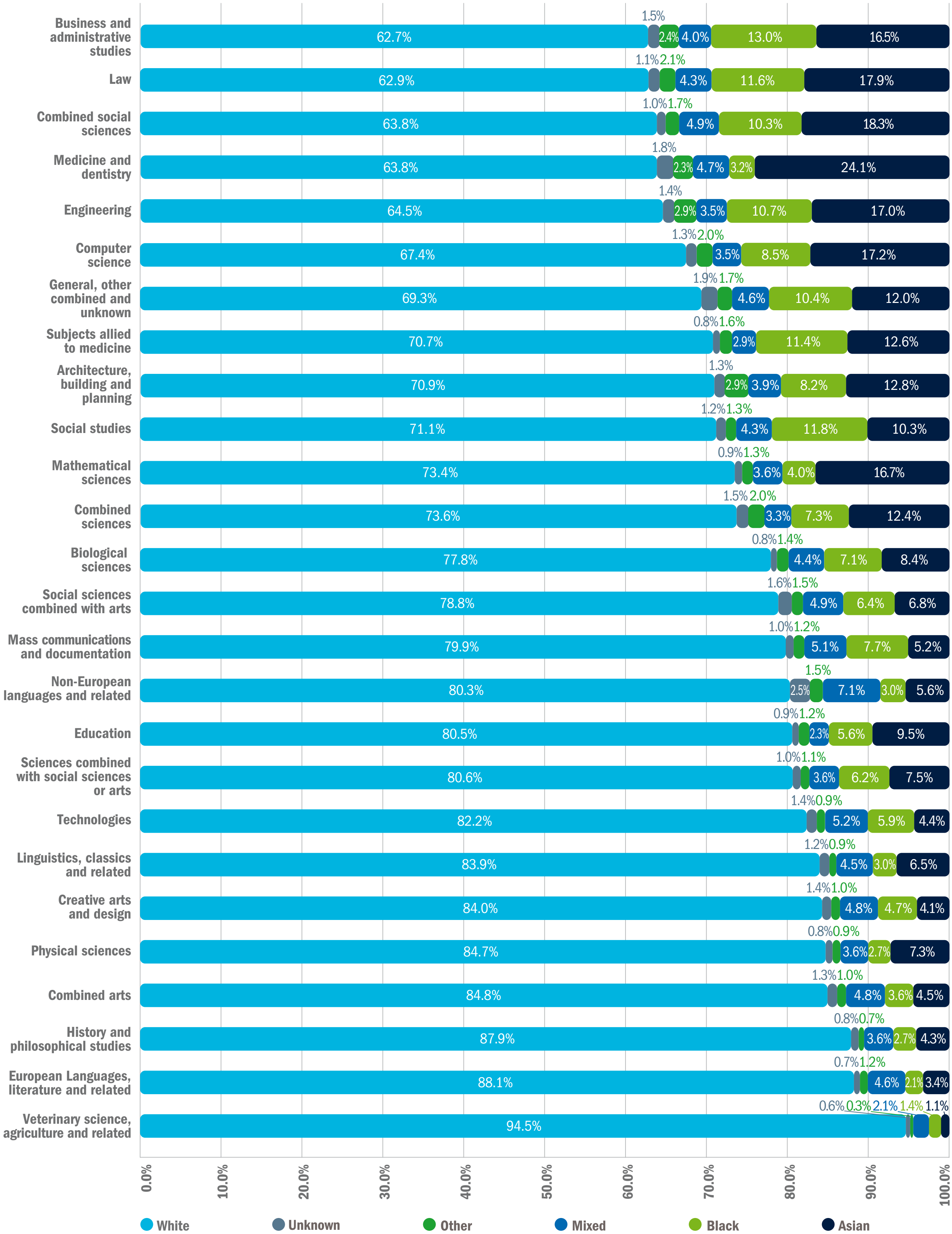
As Table 11.9 and Figure 11.6 show, compared with other subject groups, engineering performs well with regard to ethnic diversity. Out of 26 subject groups, engineering ranks 5th highest for the proportion of non-white students, and the highest of all STEM subjects (Figure 11.6). Physical sciences is the least ethnically-diverse of the STEM subjects, with 84.7% of accepted applicants identifying as white, and only 2.7% as black and 7.3% as Asian.

Table 11.9: Accepted applicants by ethnicity and subject (2014/15) – all domiciles

	'Asian'		'Black'		'Mixed'		'Other'		'Unknown'		'White'		Grand Total
Medicine and dentistry	1,900	24.1%	250	3.2%	370	4.7%	185	2.3%	145	1.8%	5,030	63.8%	**7,880**
Subjects allied to medicine	6,205	12.6%	5,590	11.4%	1,415	2.9%	775	1.6%	410	0.8%	34,785	70.7%	**49,180**
Biological sciences	3,765	8.4%	3,185	7.1%	1,955	4.4%	620	1.4%	375	0.8%	34,710	77.8%	**44,610**
Veterinary sciences, agriculture and related	70	1.1%	85	1.4%	130	2.1%	20	0.3%	35	0.6%	5,895	94.5%	**6,235**
Physical sciences	1,325	7.3%	485	2.7%	645	3.6%	165	0.9%	150	0.8%	15,300	84.7%	**18,070**
Mathematical sciences	1,180	16.7%	285	4.0%	255	3.6%	95	1.3%	65	0.9%	5,180	73.4%	**7,060**
Engineering	3,790	17.0%	2,395	10.7%	785	3.5%	645	2.9%	305	1.4%	14,400	64.5%	**22,320**
Computer sciences	3,625	17.2%	1,795	8.5%	735	3.5%	420	2.0%	280	1.3%	14,165	67.4%	**21,020**
Technologies	95	4.4%	125	5.9%	110	5.2%	20	0.9%	30	1.4%	1,755	82.2%	**2,135**
Architecture, building and planning	780	12.8%	500	8.2%	240	3.9%	180	2.9%	80	1.3%	4,335	70.9%	**6,115**
Social studies	3,870	10.3%	4,430	11.8%	1,625	4.3%	505	1.3%	465	1.2%	26,790	71.1%	**37,685**
Law	3,350	17.9%	2,175	11.6%	800	4.3%	395	2.1%	215	1.1%	11,765	62.9%	**18,700**
Business and admin studies	8,290	16.5%	6,495	13.0%	1,990	4.0%	1,200	2.4%	740	1.5%	31,405	62.7%	**50,120**
Mass communication and documentation	570	5.2%	845	7.7%	560	5.1%	130	1.2%	115	1.0%	8,815	79.9%	**11,035**
Linguistics, classics and related	755	6.5%	345	3.0%	525	4.5%	100	0.9%	135	1.2%	9,725	83.9%	**11,585**
European languages, literature and related	115	3.4%	70	2.1%	155	4.6%	40	1.2%	25	0.7%	3,000	88.1%	**3,405**
Non-european languages, literature and related	55	5.6%	30	3.0%	70	7.1%	15	1.5%	25	2.5%	795	80.3%	**990**
History and philosophical studies	620	4.3%	390	2.7%	525	3.6%	100	0.7%	110	0.8%	12,700	87.9%	**14,445**
Creative arts and design	1,985	4.1%	2,255	4.7%	2,330	4.8%	480	1.0%	695	1.4%	40,635	84.0%	**48,380**
Education	1,730	9.5%	1,015	5.6%	420	2.3%	215	1.2%	170	0.9%	14,625	80.5%	**18,175**
Combined arts	430	4.5%	345	3.6%	460	4.8%	95	1.0%	120	1.3%	8,120	84.8%	**9,570**
Combined sciences	885	12.4%	520	7.3%	235	3.3%	140	2.0%	105	1.5%	5,255	73.6%	**7,140**
Combined social sciences	750	18.3%	420	10.3%	200	4.9%	70	1.7%	40	1.0%	2,610	63.8%	**4,090**
Sciences combined with social sciences or arts	1,015	7.5%	840	6.2%	490	3.6%	145	1.1%	130	1.0%	10,910	80.6%	**13,530**
Social sciences combined with arts	575	6.8%	545	6.4%	415	4.9%	130	1.5%	135	1.6%	6,690	78.8%	**8,490**
General, other combined and unknown	655	12.0%	565	10.4%	250	4.6%	95	1.7%	105	1.9%	3,775	69.3%	**5,445**
Total	48,385	10.8%	35,980	8.0%	17,690	4.0%	6,980	1.6%	5,205	1.2%	333,170	74.5%	**447,410**

Source: UCAS

Figure 11.6: Breakdown of accepted applicants by ethnicity (2014/15) – all domiciles



Source: UCAS

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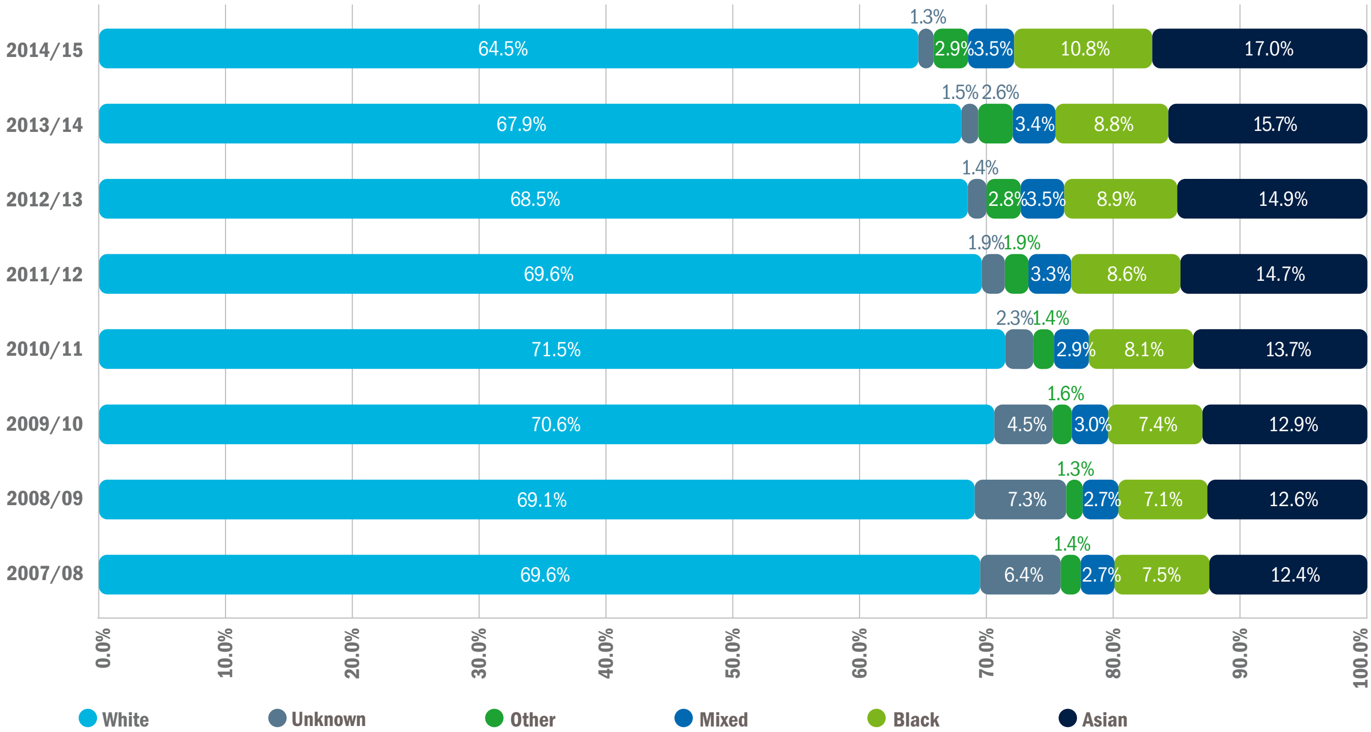
Figure 11.7 shows the percentage spilt of engineering applications by ethnicity over a seven year period. The percentage of white students accepted to engineering degrees fell this year from 67.9% to 64.5%. This is a decrease of 5.1 percentage points from the 2007 figure of 69.6%. Likewise, the percentage of black students accepted rose this year from 8.8% to 10.8%, an increase of 3.3% percentage points since the 2007 figure of 7.5%. The proportion of Asian students accepted has also increased substantially this year, from 15.7% to 17%. This is 4.4 percentage points higher than the 2007 figure of 12.6%.

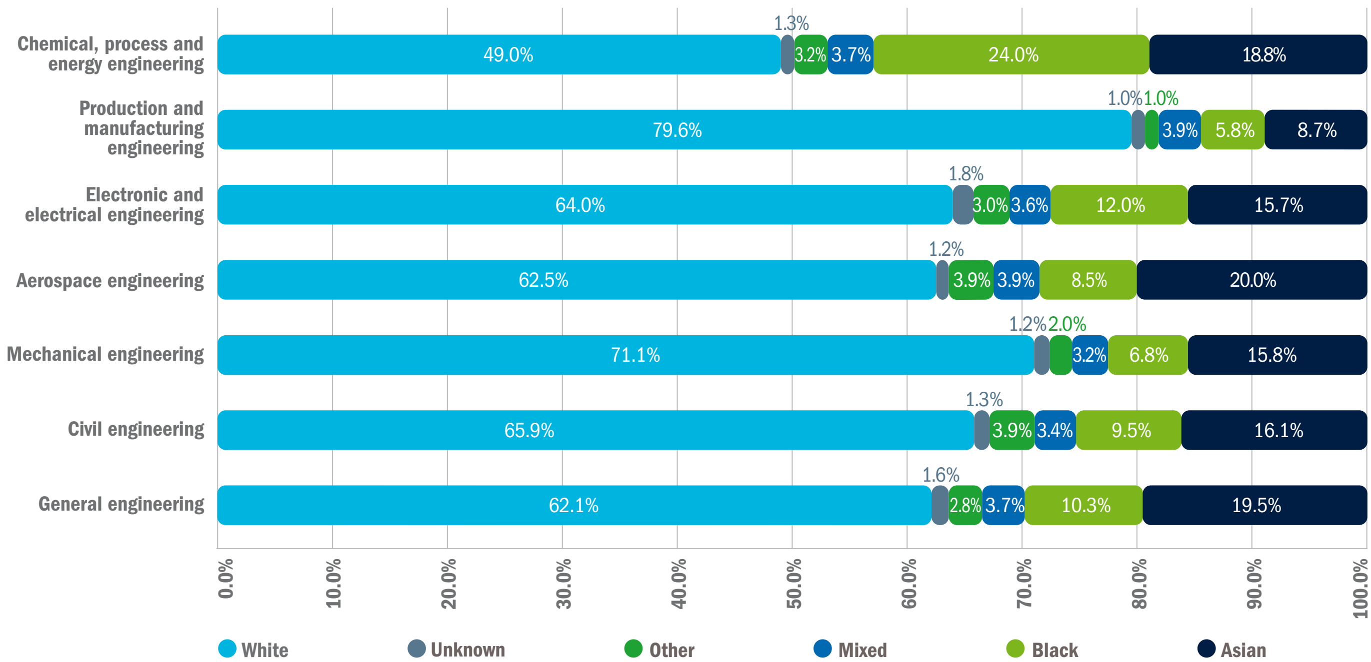
There are clear differences in the distribution of different ethnicity by engineering sub-discipline (Figure 11.8). As with gender, chemical, process and energy engineering has the most even distribution of student demographics, with only 49% of accepted applicants being white. This compares with 79.6% of those accepted to production and manufacturing engineering. Nearly a quarter of accepted applicants to chemical, process and energy engineering were black, over twice as many as for other engineering sub-disciplines.

Figure 11.7: Percentage split of engineering applicants by ethnic group (2007/08-2014/15) – all domiciles



Source: UCAS

Figure 11.8: Ethnicity of accepted applicants to engineering sub-disciplines (2014/15) – all domiciles



Source: UCAS

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11.6 BTEC Higher National Certificates (HNCs) Higher National Diplomas (HNDs) and foundation degrees

Higher National Certificates (HNCs), Higher National Diplomas (HNDs) and foundation degrees are higher level vocational qualifications designed to allow progression to professional registration, higher education study or enhanced career prospects.

HNCs are level 4 qualifications equivalent to the first year of study on an honours degree. They usually take one year to complete on a full time basis and two years when studied part time. HNDs are level 5 qualifications and correspond to the first two years of study on an honours degree. They take two years to complete on a full time basis.

HNCs and HNDs are assessed through a combination of assignments, projects and practical tasks that are undertaken throughout the period of study. They are graded as either being a pass, merit or distinction.

Successful completion of either an HNC or HND enables individuals to progress to the second or third year of a related honours degree respectively.[856]

Foundation degrees are relatively new qualifications designed to enable people from non-academic educational backgrounds to progress onto higher education. There are no nationally established entry requirements for entry onto foundation degrees. Admission is assessed individually, based on having previous qualifications and relevant industry experience. Foundation degrees are level 5 qualifications, equivalent to two years' study of an honours degree. As they are work-based qualifications, they enable learners to take paid employment whilst studying. Foundation degrees are developed in close collaboration with employers and are available through local universities and colleges and work-based learning.

HNDs and HNCs currently fall within the scope of the higher education funding system. However, the government is currently consulting on the idea of re-allocating their funding to Advanced Learning Loans, which are the standard funding route for further education qualifications.[857]

11.6.1 Entrants to HND/Cs and foundation degrees

Table 11.10 shows that in 2013/14 there were 8,540 students enrolled on HND programmes, of whom around a quarter were studying engineering and technology subjects (2,115).

HNC programmes attracted 10,205 students, 54.2% of whom (5,530) were taking an HNC in engineering and technology. Foundation degrees were by far the largest qualification in terms of enrolments, with 36,050 students studying for one. However, engineering and technology related degrees represented a much smaller proportion of foundation degrees, with only 8.4% (3,015) entrants.

Engineering and technology was the most popular of all STEM subjects for both full-time and part-time HNCs (5,530 entrants) and HNDs (2,115 entrants). The popularity of part-time and full-time provision was opposite for the two types of higher national qualifications. For HNDs, most provision was on a full time basis (1,250), with 865 (40.9%) of students studying part-time.

However for HNCs, the vast majority of study was undertaken on a part time basis with 4,845 (87.6%) of pupils, in comparison to only 1,250 studying full-time.

At foundation degree level, engineering and technology was the second most popular of all STEM subjects, with 3,015 entrants in 2013/14. This was slightly behind biological sciences, which attracted 3,230 entrants. Part time and full time provision was much more balanced, with 1,735 students studying full time and 1,280 enrolled on a part time basis. As previously mentioned, a key aim of HNDs, HNCs and foundation degrees is to enable individuals to develop higher level vocational skills so that they can progress to work or further study. It is encouraging to note that the 2013/14 progression rates to employment or further study six months after qualifying are almost universally over 95% across all subjects.

Table 11.10: Entrants to HND/Cs and foundation degrees (2013/14)[858]

	Entrants to HND programmes				
Subject area	**Full-time programmes**	**% Work or further study**	**Part-time programmes**	**% Work or further study**	**Total**
Biological sciences	505	96.3%	15	95.4%	520
Physical sciences	40	98.1%	5	97.6%	45
Mathematical sciences	0	N/A	0	N/A	0
Computer sciences	995	92.1%	70	95.7%	1,065
Engineering and technology	1,250	93.7%	865	97.9%	2,115
Total STEM	**2,790**	**94.6%**	**955**	**96.9%**	**3,745**
Total all subjects	**7,055**	**-**	**1,485**	**-**	**8,540**
% STEM	39.5%	-	64.3%	-	43.9%
% Engineering and technology	17.7%	-	58.2%	-	24.8%
	Entrants to HNC programmes				
Biological sciences	225	95.7%	35	N/A	260
Physical sciences	25	N/A	60	N/A	85
Mathematical sciences	0	N/A	0	N/A	0
Computer sciences	340	87.0%	245	N/A	585
Engineering and technology	685	93.1%	4,845	97.3%	5,530
Total STEM	**1,275**	**91.1%**	**5,185**	**96.9%**	**6,460**
Total all subjects	**2,750**	**-**	**7,455**	**-**	**10,205**
% STEM	46.4%	-	69.6%	-	63.3%
% Engineering and technology	24.9%	-	65.0%	-	54.2%
	Entrants to foundation degree programmes				
Biological sciences	2,680	94.4%	550	N/A	3,230
Physical sciences	350	N/A	75	100.0%	425
Mathematical sciences	25	N/A	5	N/A	30
Computer sciences	1,530	88.9%	555	84.2%	2,085
Engineering and technology	1,735	94.4%	1,280	98.3%	3,015
Total STEM	**2,790**	**92.8%**	**955**	**98.0%**	**8,785**
Total all subjects	**25,680**	**-**	**10,370**	**-**	**36,050**
% STEM	10.9%	-	9.2%	-	24.4%
% Engineering and technology	6.8%	-	12.3%	-	8.4%

Source: Higher Education Funding Council for England

856 http://www.nidirect.gov.uk/higher-national-certificates-and-higher-national-diplomas **857** Department for Business, Innovation and Skills: Further Education: Future Development of Loans Expanding and Simplifying the Program, June 2014, p6. **858** N/A = Percentages based on numbers less than 23 are not counted.

As Table 11.11 shows, entrants to both part and full time HNDs and foundation degrees have declined over the last six years by 14% and 15.9% respectively. In contrast, HNCs have seen steady growth since 2008, with total numbers up by 845 (18.0%) to 5,530. It is interesting to note that most of this growth occurred in the last two years, which saw an increase of 1,230 (28.6%) from a low of 4,300 in 2011/12. In further contrast to HNDs and foundation degrees, the numbers of those studying part time HNCs is far lower as a proportion of those undertaking full time study.

Table 11.11: Trends in engineering and technology HNC/Ds and foundation degree entrants (2008/09-2013/14)

		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 6 years
Entrants to HNC programmes	Full time programmes	135	195	530	430	640	685	7.0%	407.4%
	Non-UK	-	-	-	115	115	140	21.7%	-
	% non-UK								
	Female	-	-	-	10	25	35	40.0%	-
	% female				2.3%	3.9%	5.1%	1.2%p	
	Part time programmes	4,550	4,285	4,275	3,870	4,155	4,845	16.6%	6.5%
	Non-UK	-	-	-	85	80	30	-62.5%	-
	% non-UK								
	Female	-	-	-	210	220	245	11.4%	-
	% female				5.4%	5.3%	5.1%	-0.2%p	
	Total entrants	**4,685**	**4,485**	**4,810**	**4,300**	**4,800**	**5,530**	**15.2%**	**18.0%**
	Non-UK	**-**	**-**	**-**	**200**	**195**	**170**	**-12.8%**	**-**
	Total female	**-**	**-**	**-**	**220**	**245**	**280**	**14.3%**	**-**
Entrants to HND programmes	Full time programmes	1,515	1,665	1,210	1,135	1,285	1,250	-2.7%	-17.5%
	Non-UK	-	-	-	405	435	340	-21.8%	-
	% non-UK								
	Female	-	-	-	55	70	80	14.3%	-
	% female				4.8%	5.4%	6.4%	1.0%p	
	Part time programmes	945	675	740	1,730	900	865	-3.9%	-8.5%
	Non-UK	-	-	-	10	5	50	900.0%	-
	% non-UK								
	Female	-	-	-	85	40	45	12.5%	-
	% female				4.9%	4.4%	5.2%	0.8%p	
	Total entrants	**2,460**	**2,335**	**1,950**	**2,865**	**2,185**	**2,115**	**-3.2%**	**-14.0%**
	Non-UK	**-**	**-**	**-**	**415**	**440**	**390**	**-11.4%**	**-**
	Total female	**-**	**-**	**-**	**140**	**110**	**125**	**13.6%**	**-**
	% female				**4.9%**	**5.0%**	**5.9%**	**0.9%p**	
Entrants to foundation degree programmes	Full time programmes	2,210	2,545	2,285	1,955	1,715	1,735	1.2%	-21.5%
	Non-UK				75	45	50	11.1%	-
	% non-UK								
	Female	-	-	-	300	210	220	4.8%	-
	% female				15.3%	12.2%	12.7%	0.4%p	
	Part time programmes	1,375	1,295	1,665	1,765	1,340	1,280	-4.5%	-6.9%
	Non-UK	-	-	-	20	20	30	50.0%	-
	% non-UK								
	Female	-	-	-	140	70	80	14.3%	-
	% female				7.9%	5.2%	6.3%	1.0%p	
	Total entrants	**3,585**	**3,840**	**3,945**	**3,720**	**3,055**	**3,015**	**-1.3%**	**-15.9%**
	Total non-UK	**-**	**-**	**-**	**95**	**65**	**80**	**23.1%**	**-**
	% Non-UK								
	Total female	**-**	**-**	**-**	**440**	**280**	**300**	**7.1%**	**-**
	% female				**11.8%**	**9.2%**	**10.0%**	**0.8%p**	

Source: Higher Education Funding Council for England

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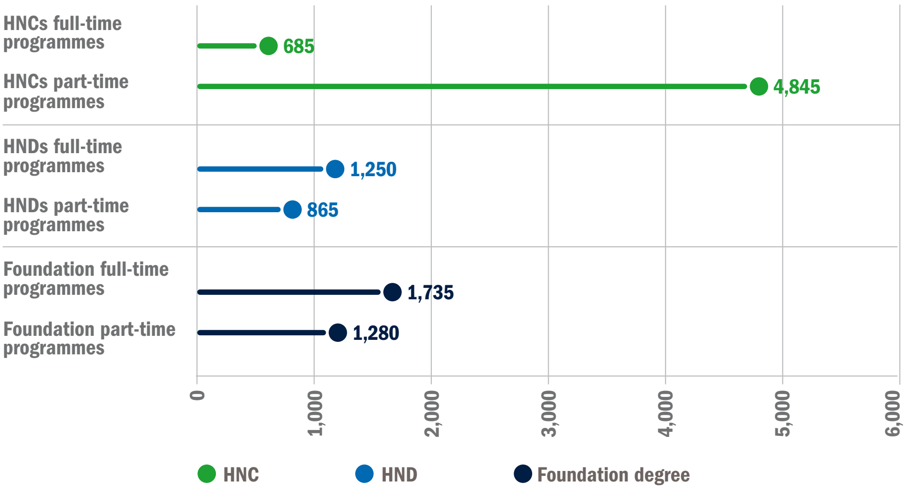
As Figure 11.9 shows, in 2013/14 only 685 (14.1%) of HNC students in engineering and technology were studying full time. However, this number has quadrupled since its 2008 figure of 135 (3%). Part time provision is of value to those already in work or who have other commitments which mean they need a more flexible option to pursue higher level technical qualifications. These figures are in contrast to undergraduate degrees, where numbers of part time enrolments are low.

Figure 11.9: Number of HNC/Ds and foundation degree entrants by mode of study (2013/14)



Source: Higher Education Funding Council for England

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Degree accreditation and professional registration

Accreditation of degree programmes by recognised professional and statutory bodies is a mark of assurance that the programmes meet the standards set by a profession. In the UK, the Engineering Council sets and maintains standards for the engineering profession and sets the overall requirements for accreditation.

The Engineering Council licenses 22 professional engineering institutions to undertake the accreditation within these requirements – interpreting them as appropriate for their own sector of the profession – and maintains the public and searchable registers of HE (degree) programmes that are accredited for the purposes of Incorporated Engineer (IEng) or Chartered Engineer (CEng) registration. The engineering institutions use the accreditation process to assess whether specific educational programmes provide some or all of the underpinning knowledge, understanding and skills for eventual registration as IEng or CEng.

Bachelor's degrees, with or without honours, may be accredited as fully meeting the academic requirements for IEng status. Bachelor's degrees with honours may be accredited as partially meeting the academic requirements for CEng status, and such accredited degrees will also meet the academic requirements for IEng. Integrated MEng degrees may be accredited as fully meeting the academic requirements for CEng status. Postgraduate degrees (MSc or EngD) may be accredited as further learning for the purposes of CEng (for holders of accredited bachelor's degrees). Foundation degrees may be accredited as partially meeting the academic requirements for IEng, and/or approved for the purposes of registration as Engineering Technician (EngTech) or ICT Technician (ICTTech).

Accreditation is an accepted and rigorous process that commands respect both in the UK and internationally. It helps students, their parents and advisers choose quality degree programmes. It also confers market advantage to graduates from accredited programmes, both when they are seeking employment and when they decide to seek professional registration. Some employers require graduation from an accredited programme as a minimum qualification.

Universities with accredited degree programmes (from foundation degree through to engineering doctorates) may promote this status through use of the Engineering Council Accredited Degree logo, provided it is related to the relevant programme. All accredited courses are listed on the Engineering Council's website.[859]

Accredited degrees are delivered in a range of study modes to diverse learners. There are opportunities for working engineers to study to bachelor's or master's level and beyond, without necessarily leaving their jobs. Engineering degrees may be achieved through part time study, distance learning, blended learning and work-based pathways such as Engineering Gateways. As professional recognition requires demonstration of skills as well as academic achievement, those who work in an engineering role alongside their studies or complete an engineering work placement, may be able to reduce their time to IEng or CEng status if they begin to record evidence of their work-based experience early.

Increasingly, the advantages of professional accreditation are being recognised internationally. The UK engineering profession participates in several major international accords, within and outside Europe, which establish the equivalence of engineering and technology degrees. In each case, the system of accreditation applied in the UK is fundamental to the acceptance of UK degrees elsewhere. With increasing globalisation, such accords and frameworks are assuming growing importance with employers as a means by which they can be confident in the skills and professionalism of the engineers involved. An accredited programme also has a market advantage for education providers wishing to attract international students to the UK.

859 www.engc.org.uk/courses

11.7 Qualifications obtained

This section considers the number of students who have been awarded STEM degrees, and are thus eligible to enter the job market and directly contribute to the supply of a skilled STEM workforce. As Table 11.12 shows, with the exception of first degrees, the number of qualifications obtained declined in 2013/14. Across all subjects, the total number of qualifications obtained declined by 1.4% from 761,935 in 2012/13 to 751,160 in 2013/14. First degree attainment did increase slightly, rising by 4.4% from 403,770 to 421,635. However, this is in stark contrast to the sharp fall in foundation degrees achievements, which fell by a quarter from 25,240 to 18,930.

The numbers of qualifications obtained in engineering and technology have remained relatively steady, with a 0.3% decline from 50,345 in 2012/13 to 50,185 in 2013/14. However, in line with the all-subject trend, all qualifications except first degrees saw sharp declines in the numbers obtained. First degrees grew by 4.5% whilst foundation degrees fell by 11.3%.

Table 11.12: Number of HE qualifications obtained by subject and level (2012/13-2013/14) – all domiciles [860, 861]

		2012/13	2013/14	% change
Medicine & dentistry	Other undergraduate	340	340	0.3%
	Foundation degree	-	-	0.0%
	First degree	10,180	9,780	-3.9%
	Other postgraduate	5,810	6,070	4.5%
	Doctorate	2,090	2,050	-2.0%
	All qualifications	**18,425**	**18,245**	**-1.0%**
Subjects allied to medicine	Other undergraduate	27,385	22,000	-19.7%
	Foundation degree	2,940	2,115	-28.1%
	First degree	39,480	41,450	5.0%
	Other postgraduate	16,930	17,405	2.8%
	Doctorate	1,350	1,300	-3.5%
	All qualifications	**88,085**	**84,265**	**-4.3%**
Biological sciences	Other undergraduate	4,745	4,410	-7.0%
	Foundation degree	1,825	1,265	-30.6%
	First degree	38,945	42,580	9.3%
	Other postgraduate	11,275	11,265	-0.1%
	Doctorate	3,365	3,190	-5.1%
	All qualifications	**60,150**	**62,715**	**4.3%**
Veterinary science	Other undergraduate	15	40	129.4%
	Foundation degree	-	-	0.0%
	First degree	845	900	6.3%
	Other postgraduate	130	160	20.8%
	Doctorate	65	60	-10.8%
	All qualifications	**1,060**	**1,155**	**9.0%**
Agriculture & related subjects	Other undergraduate	665	805	20.7%
	Foundation degree	1,370	935	-31.8%
	First degree	2,775	2,950	6.3%
	Other postgraduate	1,310	1,185	-9.4%
	Doctorate	185	190	4.1%
	All qualifications	**6,300**	**6,060**	**-3.8%**
Physical sciences	Other undergraduate	1,990	1,815	-8.9%
	Foundation degree	495	510	3.1%
	First degree	16,400	17,300	5.5%
	Other postgraduate	5,440	5,410	-0.6%
	Doctorate	2,845	2,745	-3.5%
	All qualifications	**27,170**	**27,775**	**2.2%**

860 Data excludes PGCE courses 861 Figures have been rounded to nearest multiple of 5. Percentages based on unrounded figures.

Table 11.12: Number of HE qualifications obtained by subject and level (2012/13-2013/14) – all domiciles – continued

		2012/13	2013/14	% change
Mathematical sciences	Other undergraduate	1,095	810	-26.2%
	Foundation degree	-	-	0.0%
	First degree	8,430	8,605	2.1%
	Other postgraduate	2,260	2,210	-2.1%
	Doctorate	655	555	-15.1%
	All qualifications	**12,445**	**12,180**	**-2.1%**
Computer science	Other undergraduate	3,310	2,740	-17.3%
	Foundation degree	1,055	660	-37.5%
	First degree	15,565	16,080	3.3%
	Other postgraduate	7,480	6,705	-10.4%
	Doctorate	925	795	-14.0%
	All qualifications	**28,340**	**26,980**	**-4.8%**
Engineering & technology	Other undergraduate	5,115	4,665	-8.8%
	Foundation degree	1,875	1,660	-11.3%
	First degree	24,755	25,870	4.5%
	Other postgraduate	15,715	15,150	-3.6%
	Doctorate	2,885	2,835	-1.7%
	All qualifications	**50,345**	**50,185**	**-0.3%**
Architecture, building & planning	Other undergraduate	2,215	1,955	-11.7%
	Foundation degree	575	295	-48.1%
	First degree	10,040	9,435	-6.0%
	Other postgraduate	7,610	6,750	-11.3%
	Doctorate	290	295	1.8%
	All qualifications	**20,730**	**18,735**	**-9.6%**
Social studies	Other undergraduate	7,990	5,945	-25.6%
	Foundation degree	2,400	1,960	-18.3%
	First degree	40,115	42,720	6.5%
	Other postgraduate	22,205	22,280	0.3%
	Doctorate	1,875	1,805	-3.8%
	All qualifications	**74,585**	**74,715**	**0.2%**
Law	Other undergraduate	2,645	2,155	-18.4%
	Foundation degree	95	115	23.7%
	First degree	17,495	17,885	2.2%
	Other postgraduate	12,065	11,340	-6.0%
	Doctorate	400	385	-4.2%
	All qualifications	**32,695**	**31,880**	**-2.5%**
Business & administrative studies	Other undergraduate	13,480	9,035	-33.0%
	Foundation degree	3,640	2,665	-26.8%
	First degree	60,890	64,000	5.1%
	Other postgraduate	59,435	58,165	-2.1%
	Doctorate	1,040	1,070	2.9%
	All qualifications	**138,490**	**134,940**	**-2.6%**

		2012/13	2013/14	% change
Mass communications & documentation	Other undergraduate	1,015	900	-11.4%
	Foundation degree	480	375	-22.4%
	First degree	11,615	12,350	6.3%
	Other postgraduate	6,215	6,140	-1.2%
	Doctorate	190	155	-16.8%
	All qualifications	**19,515**	**19,920**	**2.1%**
Languages	Other undergraduate	4,785	4,385	-8.4%
	Foundation degree	15	15	14.3%
	First degree	23,770	24,160	1.6%
	Other postgraduate	7,175	6,935	-3.3%
	Doctorate	1,200	1,165	-2.8%
	All qualifications	**36,945**	**36,660**	**-0.8%**
Historical & philosophical studies	Other undergraduate	2,085	1,750	-16.0%
	Foundation degree	360	355	-1.7%
	First degree	18,145	18,645	2.8%
	Other postgraduate	6,335	6,040	-4.6%
	Doctorate	1,300	1,235	-4.9%
	All qualifications	**28,220**	**28,025**	**-0.7%**
Creative arts & design	Other undergraduate	4,210	4,050	-3.7%
	Foundation degree	3,535	2,230	-36.9%
	First degree	41,495	43,645	5.2%
	Other postgraduate	11,325	11,175	-1.3%
	Doctorate	620	610	-1.4%
	All qualifications	**61,175**	**61,705**	**0.9%**
Education	Other undergraduate	7,085	5,620	-20.7%
	Foundation degree	4,580	3,740	-18.3%
	First degree	18,270	18,865	3.3%
	Other postgraduate	20,015	19,835	-0.9%
	Doctorate	885	790	-10.6%
	All qualifications	**50,835**	**48,855**	**-3.9%**
Combined	Other undergraduate	1,790	1,620	-9.4%
	Foundation degree	15	40	171.4%
	First degree	4,555	4,415	-3.1%
	Other postgraduate	75	90	21.1%
	Doctorate	-	5	N/A
	All qualifications	**6,435**	**6,165**	**-4.2%**
All subjects	Other undergraduate	91,965	75,045	-18.4%
	Foundation degree	25,240	18,930	-25.0%
	First degree	403,770	421,635	4.4%
	Other postgraduate	218,800	214,310	-2.1%
	Doctorate	22,160	21,240	-4.2%
	All qualifications	**761,935**	**751,160**	**-1.4%**

Source: Higher Education Statistics Agency

Closer examination suggests that the decline in qualifications obtained was predominately driven by the decline of part-time students. As Figure 11.10 shows, part-time awardees accounted for two thirds of the overall decline in non-first degree qualifications obtained, with numbers 19,580 lower in 2012/13 than in the preceding year.

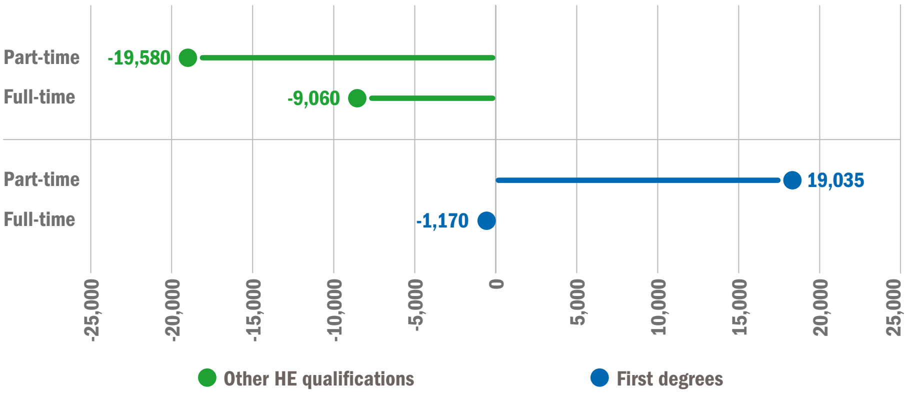
11.7.1 First degree obtainment

First degrees obtained in 2013/14 bucked the trend of general decline in all other qualifications. First degree attainment has grown substantially over the last decade, and this trend continues (Table 11.13). Three STEM subjects saw a larger than average percentage growth in the number of first degrees awarded between 2012/13 and 2013/14: biological sciences (up 9.3%) and physical sciences (up 5.5%).

Encouragingly, engineering and technology grew by 4.5%. This compares with an all-subject growth of 4.4%. However, as a proportion of all subjects, the percentage of engineering and STEM first degrees awarded has declined slightly over the last year and over the ten-year period. In 2004/05, engineering and technology accounted for 6.4% of all first degrees awarded. In 2013/14, this number declined slightly to 6.1% – although this was a slight improvement from an absolute low of 6.0% in 2011/12.

Actual numbers of engineering and technology first degree achievements are at an all-time high, with 25,870 first degrees awarded in 2013/14, an increase of 1,115 over the previous year. Proportionally, however, first degrees in engineering and technology are declining, suggests that the subject is losing ground to other disciplines.

Figure 11.10: Change in numbers of qualifications obtained by level of award and mode of study (2012/13-2013/14)



Source: Higher Education Statistics Agency

Table 11.13: Numbers of first degrees achieved in STEM subjects (2004/05-2013/14) – all domiciles

	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 10 years
Biological sciences	27,200	27,840	29,095	31,185	30,720	32,185	33,800	35,920	38,945	42,580	9.3%	56.5%
Physical sciences	12,530	12,900	12,480	13,015	13,510	13,795	14,745	15,360	16,400	17,300	5.5%	38.1%
Mathematical sciences	5,270	5,500	5,645	5,815	5,980	6,470	6,965	7,445	8,430	8,605	2.1%	63.3%
Computer science	20,095	18,840	16,445	14,915	14,035	14,255	14,505	15,225	15,565	16,080	3.3%	-20.0%
Engineering and technology	19,575	19,765	19,900	20,420	20,805	21,955	22,905	23,595	24,755	25,870	4.5%	32.2%
Total STEM	84,670	84,845	83,565	85,350	85,050	88,660	92,920	97,545	104,095	110,435	6.1%	30.4%
All subjects	306,365	315,985	319,260	334,890	333,720	350,860	369,010	390,985	403,770	421,635	4.4%	37.6%
% STEM	27.6%	26.9%	26.2%	25.5%	25.5%	25.3%	25.2%	24.9%	25.8%	26.2%	0.4%p	-1.4%p
% Engineering and technology	6.4%	6.3%	6.2%	6.1%	6.2%	6.3%	6.2%	6.0%	6.1%	6.1%	0.0%p	-0.3%p

Source: Higher Education Statistics Agency

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11.7.2 Level of qualifications obtained

Table 11.14 displays the numbers of HE qualifications achieved by different levels in 2013/14 for STEM subjects and engineering sub-disciplines.

It is interesting to note that, in contrast to other STEM subjects, the proportion of female students achieving an award grows as the level of qualification increases. For example, in physical sciences, 41.5% of first degree awardees were females, compared with only 36.5% for doctorates. In biological sciences, 60% of first degree awardees were females, compared with 67.6% for doctorates. However, engineering and technology bucks this trend: at first degree level, only 15% of awardees were female. This proportion increases to 23.9% for postgraduate degrees and 24.4% for doctorates.

Table 11.14: Levels of qualifications achieved in STEM subjects and engineering sub-disciplines by gender (2013/14) – all domiciles

		Level of qualification					
Subject area		**Foundation degree**	**First degree**	**Other undergraduate**	**Postgraduate**	**Doctorate**	**Total**
Biological sciences	**Total**	**1,265**	**42,575**	**4,410**	**11,265**	**3,190**	**62,710**
	Female	565	25,555	2,395	7,620	2,045	38,180
	Male	700	17,020	2,015	3,645	1,150	24,530
	% female	44.8%	60.0%	54.3%	67.6%	64.0%	60.9%
Physical sciences	**Total**	**510**	**17,300**	**1,815**	**5,410**	**2,740**	**27,770**
	Female	245	7,175	650	2,435	1,000	11,505
	Male	265	10,120	1,165	2,975	1,740	16,265
	% female	48.2%	41.5%	35.8%	45.0%	36.5%	41.4%
Mathematical sciences	**Total**	**-**	**8,605**	**810**	**2,210**	**555**	**12,180**
	Female	-	3,630	315	875	180	5,005
	Male	-	4,975	495	1,330	375	7,175
	% female	0.0%	42.2%	39.0%	39.7%	32.7%	41.1%
Computer science	**Total**	**660**	**16,080**	**2,735**	**6,705**	**795**	**26,980**
	Female	95	2,710	395	1,695	190	5,085
	Male	565	13,375	2,345	5,005	605	21,895
	% female	14.3%	16.8%	14.4%	25.3%	24.1%	18.8%
Engineering & technology	**Total**	**1,660**	**25,865**	**4,665**	**15,150**	**2,835**	**50,180**
	Female	160	3,875	355	3,620	690	8,705
	Male	1,500	21,990	4,310	11,530	2,145	41,475
	% female	9.7%	15.0%	7.7%	23.9%	24.4%	17.3%
General Engineering	**Total**	**215**	**2,225**	**835**	**1,630**	**585**	**5,490**
	Female	30	390	80	375	150	1,030
	Male	180	1,835	755	1,255	435	4,460
	% female	15.2%	17.6%	9.8%	23.1%	25.7%	18.8%
Civil engineering	**Total**	**70**	**4,595**	**595**	**3,085**	**310**	**8,660**
	Female	5	740	60	885	90	1,780
	Male	65	3,855	535	2,200	220	6,875
	% female	9.9%	16.1%	9.7%	28.7%	29.4%	20.6%
Mechanical engineering	**Total**	**210**	**6,060**	**735**	**1,840**	**390**	**9,235**
	Female	10	490	45	210	65	825
	Male	195	5,570	690	1,630	325	8,410
	% female	5.1%	8.1%	6.1%	11.5%	17.2%	8.9%
Aerospace engineering	**Total**	**255**	**1,840**	**345**	**760**	**120**	**3,320**
	Female	15	190	20	110	20	350
	Male	240	1,650	330	650	105	2,970
	% female	5.9%	10.4%	5.2%	14.3%	14.6%	10.5%
Electronic & electrical engineering	**Total**	**355**	**5,500**	**1,130**	**3,250**	**710**	**10,945**
	Female	20	705	55	645	135	1,560
	Male	335	4,795	1,075	2,605	575	9,385
	% female	6.0%	12.8%	5.0%	19.8%	19.0%	14.3%
Production & manufacturing engineering	**Total**	**50**	**940**	**135**	**1,095**	**95**	**2,315**
	Female	5	140	20	315	30	505
	Male	45	800	115	785	65	1,810
	% female	5.5%	14.8%	15.9%	28.6%	29.6%	21.8%
Chemical, process & energy engineering	**Total**	**50**	**1,910**	**105**	**1,370**	**305**	**3,740**
	Female	20	535	5	370	105	1,040
	Male	30	1,375	100	1,000	200	2,705
	% female	41.2%	28.1%	5.6%	27.1%	33.7%	27.7%
All subjects	**Total**	**18,930**	**421,635**	**75,045**	**214,310**	**21,240**	**751,160**
	Female	11,500	237,505	44,805	121,670	9,930	425,415
	Male	7,430	184,095	30,230	92,595	11,300	325,655
	% female	60.8%	56.3%	59.7%	56.8%	46.8%	56.6%

Source: Higher Education Statistics Agency

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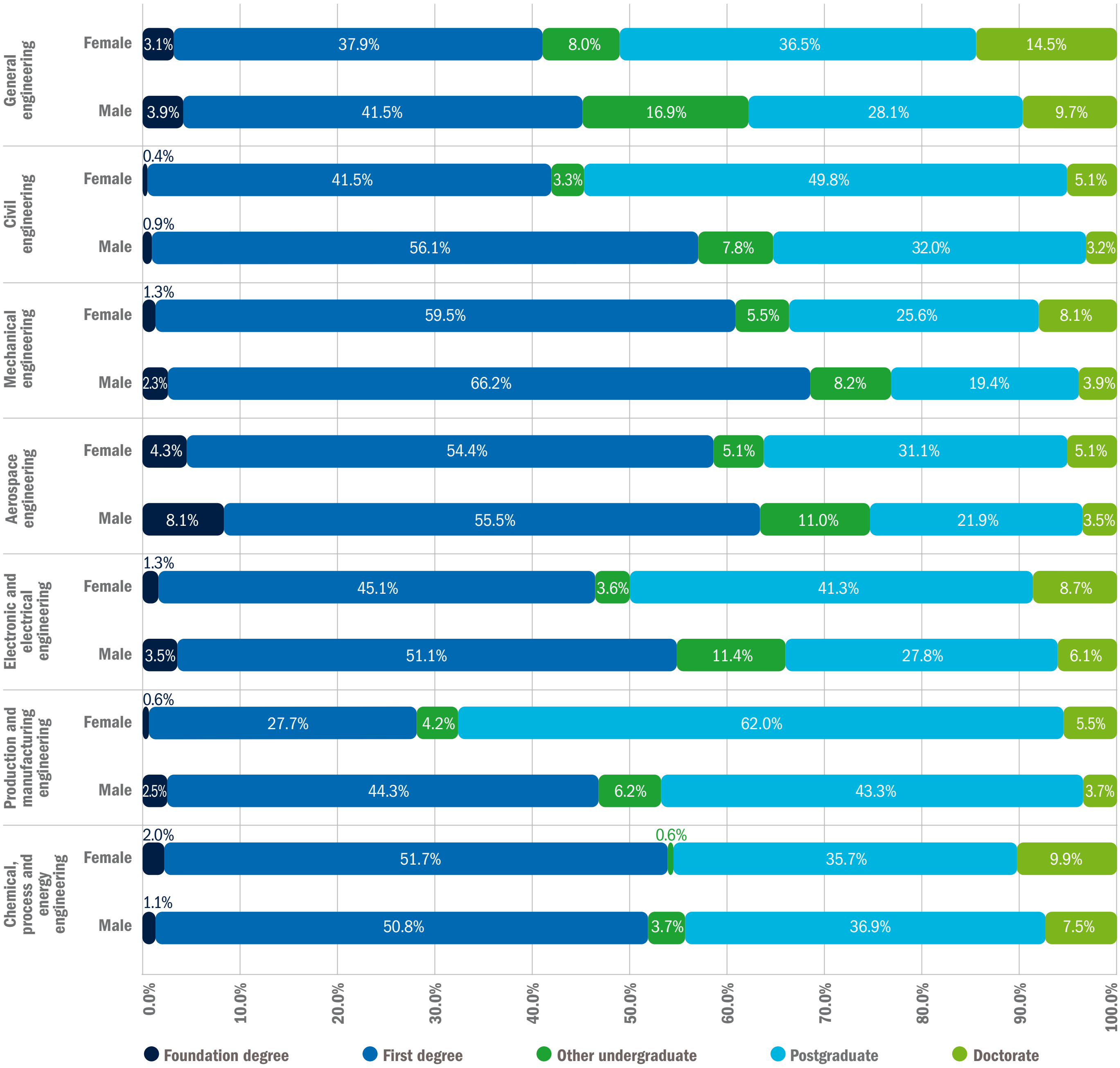
When it comes to the level of degree, females were more likely than males to be awarded a post-graduate degree in all the engineering sub-disciplines (Figure 11.11). In several areas, the majority of female awardees were at either the postgraduate or doctorate level. For example, nearly 70% of female awards in production and manufacturing engineering were at postgraduate and doctorate level, compared with only around 45% for males.

Chemical, process and energy engineering was the only sub-discipline to display a relatively equal proportion of female and males achieving postgraduate degrees, and it is interesting to note that this is the sub-discipline with the highest number of female awardees in general (27.7%). Thus, the data reveals a curious pattern; subjects with the lowest representation of female students, tend to have the highest proportion of female students achieving higher level degrees.

This pattern is corroborated by data of qualifications obtained from either Russell Group or non-Russell Group universities.

Figure 11.11: Levels of degrees obtained in engineering sub-disciplines by gender (2013/14) – all domiciles



Source: Higher Education Statistics Agency

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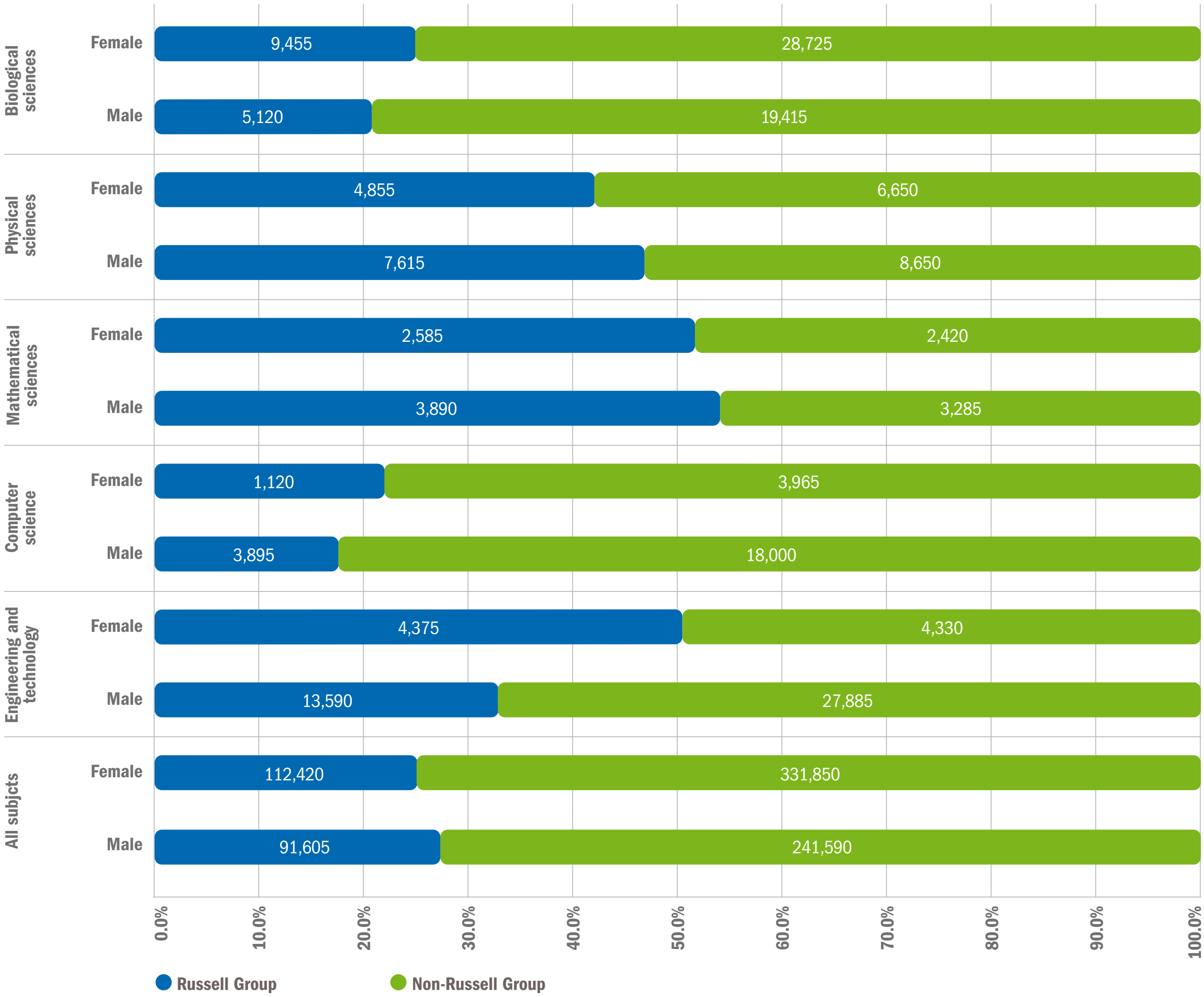
11.7.3 Qualifications achieved by university mission group

Figure 11.12 reveals that far more female than male engineering and technology students were awarded their qualifications by a Russell Group university. This contrasts to other STEM subjects, which have a roughly equal gender balance. For example, in biological sciences, 25.8% of female awardees and 20.9% of male awardees graduated from a Russell Group institution. However, in engineering & technology, around half (50.3%) of female awardees graduated from a Russell Group institution, compared with only 32.8% of male awardees. This finding, coupled with the increased female achievement of postgraduate level degrees in engineering subjects, seems to suggest that subjects with a greater gender imbalance against females tend to attract female students who are higher achieving.

From figure 11.12 it can be calculated that engineering and technology students are more likely to be awarded a qualification from a Russell Group institution than the all subject average (35.8% vs 26.2%). This finding is unsurprising, as engineering and technology is a relatively expensive subject for HEs to deliver, and thus more affluent Russell Group institutions are better placed to facilitate such provision.

Figure 11.12: Numbers of all STEM qualifications achieved at Russell Group and non-Russell group institutions (all levels) (2013/14) – all domiciles[862]



Source: Higher Education Statistics Agency

862 Data excludes PGCE courses

The fact that engineering degrees are more likely than average to be awarded from Russell Group institutions may have an impact on social mobility. As figure 11.13 shows, over 35% of students from households where the main earner was involved in a higher managerial and professional occupation achieved a qualification from a Russell Group institution. This compares with only 10% of those affiliated with the 'routine occupations' category.

11.7.4 Level of qualification achieved by domicile

Table 11.15 displays the level of qualification achieved by STEM subjects and engineering sub-disciplines.

Of all the STEM subjects, engineering and technology has the highest proportion of international students achieving qualifications: 43.8% in 2013/14. This is significantly higher than the average of 26.1% for all subjects and only 12.3% for biological sciences (Table 11.15).

Furthermore, non-UK awardees were more likely to have obtained a postgraduate degree in engineering and technology than those who studied other subjects. For example, 73.3% of students awarded a postgraduate degree and 58.8% who achieved a doctorate in engineering and technology were from outside the UK. This compares with an all-subject average of 50.9% for postgraduate degrees and 43.5% for doctorates.

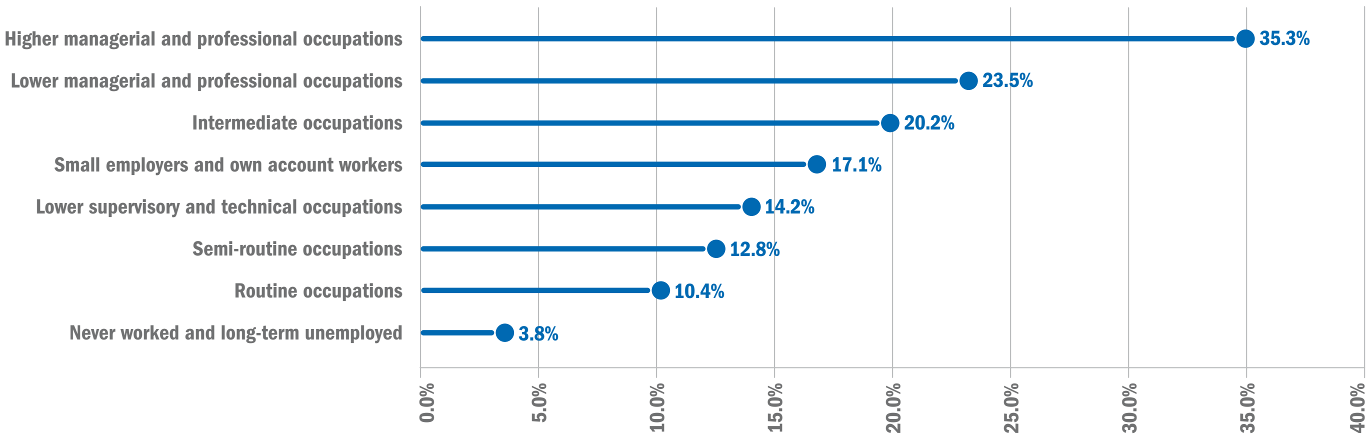
The higher number of non-UK engineering and technology graduates poses potential issues for the supply of engineers to the UK economy, as international students are much less likely to progress to employment in the UK.

Drilling down to the sub-disciplines, electrical and electronic engineering has the highest proportion of international students achieving awards (51.8%). This is in contrast to aerospace engineering, where 38.8% of graduating students were from outside of the UK.

Table 11.15: Level of qualification achieved in STEM subjects and engineering sub-disciplines by domicile (2013/14)[863]

		Level of qualification					
Subject area		**Foundation degree**	**First degree**	**Other undergraduate**	**Postgraduate**	**Doctorate**	**Total**
Biological sciences	UK	1,245	39,270	4,120	8,090	2,265	54,990
	EU	10	1,705	155	1,110	400	3,380
	Non-EU	10	1,605	135	2,065	530	4,345
	Total	**1,265**	**42,580**	**4,410**	**11,265**	**3,195**	**62,715**
	Total non-UK	20	3,310	295	3,175	930	7,725
	% non-UK	1.4%	7.8%	6.7%	28.2%	29.1%	12.3%
Physical sciences	UK	495	15,730	1,635	2,755	1,770	22,390
	EU	10	690	85	655	365	1,810
	Non-EU	5	875	90	1,995	610	3,575
	Total	**510**	**17,295**	**1,810**	**5,405**	**2,745**	**27,775**
	Total non-UK	15	1,570	180	2,655	975	5,385
	% non-UK	2.6%	9.1%	9.8%	49.0%	35.5%	19.4%
Mathematical sciences	UK	-	6,940	720	755	270	8,680
	EU	-	390	25	350	110	880
	Non-EU	-	1,275	65	1,105	180	2,620
	Total	**-**	**8,605**	**810**	**2,210**	**560**	**12,180**
	Total non-UK	-	1,665	90	1,455	285	3,500
	% non-UK	0.0%	19.4%	11.2%	65.9%	51.5%	28.7%
Computer science	UK	650	13,455	2,505	2,215	320	19,145
	EU	5	1,030	100	825	130	2,085
	Non-EU	5	1,595	135	3,665	350	5,755
	Total	**660**	**16,080**	**2,740**	**6,705**	**800**	**26,985**
	Total non-UK	10	2,625	235	4,490	480	7,840
	% non-UK	1.5%	16.3%	8.6%	67.0%	60.0%	29.1%

Figure 11.13: Percentage of all qualifications awarded from Russell Group institutions by socio-economic status of main household income earner (2013/14) – all domiciles



Source: Higher Education Statistics Agency

863 Data excludes PGCE courses

Table 11.15: Level of qualification achieved in STEM subjects and engineering sub-disciplines by domicile (2013/14) – continued

		Level of qualification					
Subject area		**Foundation degree**	**First degree**	**Other undergraduate**	**Postgraduate**	**Doctorate**	**Total**
Engineering & technology	UK	1,570	17,625	3,795	4,055	1,170	28,220
	EU	15	1,855	195	2,325	400	4,790
	Non-EU	75	6,385	675	8,775	1,270	17,175
	Total	**1,660**	**25,865**	**4,665**	**15,155**	**2,840**	**50,185**
	Total non-UK	90	8,240	870	11,100	1,665	21,965
	% non-UK	5.4%	31.9%	18.6%	73.3%	58.8%	43.8%
General Engineering	UK	175	1,630	670	630	260	3,360
	EU	-	185	15	230	85	520
	Non-EU	35	410	155	770	240	1,610
	Total	**210**	**2,225**	**840**	**1,630**	**585**	**5,490**
	Total non-UK	35	595	165	1,000	325	2,130
	% non-UK	17.4%	26.8%	19.9%	61.5%	55.9%	38.8%
Civil engineering	UK	70	3,170	510	900	135	4,780
	EU	-	445	35	560	45	1,080
	Non-EU	-	985	50	1,630	135	2,800
	Total	**70**	**4,600**	**595**	**3,090**	**315**	**8,660**
	Total non-UK	-	1,430	85	2,190	180	3,880
	% non-UK	1.4%	31.1%	14.3%	70.9%	57.2%	44.8%
Mechanical engineering	UK	205	4,285	620	410	165	5,680
	EU	5	410	55	340	65	870
	Non-EU	-	1,370	65	1,090	165	2,685
	Total	**210**	**6,065**	**740**	**1,840**	**395**	**9,235**
	Total non-UK	5	1,775	120	1,435	225	3,560
	% non-UK	1.4%	29.3%	16.0%	77.8%	58.2%	38.5%
Aerospace engineering	UK	245	1,280	300	170	60	2,055
	EU	-	165	20	235	25	445
	Non-EU	10	400	25	355	35	825
	Total	**255**	**1,845**	**345**	**760**	**120**	**3,325**
	Total non-UK	10	560	45	590	60	1,270
	% non-UK	3.5%	30.5%	12.7%	77.9%	51.2%	38.2%
Electronic & electrical engineering	UK	345	3,140	1,025	525	235	5,270
	EU	-	310	40	260	95	705
	Non-EU	10	2,050	65	2,460	380	4,965
	Total	**355**	**5,500**	**1,130**	**3,245**	**710**	**10,940**
	Total non-UK	10	2,360	105	2,725	475	5,675
	% non-UK	2.5%	42.9%	9.3%	83.8%	66.8%	51.8%
Production & manufacturing engineering	UK	50	715	105	210	45	1,115
	EU	-	40	5	200	15	255
	Non-EU	-	190	25	690	40	945
	Total	**50**	**945**	**135**	**1,100**	**100**	**2,315**
	Total non-UK	-	230	30	890	50	1,195
	% non-UK	0.0%	24.3%	21.3%	80.9%	55.0%	51.7%
Chemical, process & energy engineering	UK	50	1,240	90	340	115	1,830
	EU	-	90	-	200	45	335
	Non-EU	-	585	15	830	145	1,575
	Total	**50**	**1,915**	**105**	**1,370**	**305**	**3,740**
	Total non-UK	-	670	20	1,030	190	1,910
	% non-UK	0.0%	35.2%	16.6%	75.2%	62.5%	51.0%
All subjects	UK	18,170	353,715	65,970	105,205	12,010	555,070
	EU	260	21,680	2,075	21,460	2,920	48,395
	Non-EU	500	46,240	6,995	87,645	6,310	147,695
	Total	**18,930**	**421,635**	**75,040**	**214,310**	**21,240**	**751,160**
	Total non-UK	760	67,920	9,070	109,105	9,230	196,090
	% non-UK	4.0%	16.1%	12.1%	50.9%	43.5%	26.1%

Source: Higher Education Statistics Agency

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11.8 Trends in qualifications obtained

This section discusses the changing pattern of qualifications obtained over time, broken down by gender, domicile and qualification level.

11.8.1 First degrees obtained

The number of first degrees awarded in engineering is at an all-time high of 23,340, growth of 4.8% between 2012/13 and 2013/14 and 34.1% over 10 years (Table 11.16). Growth in female achievements has outstripped that in males, growing by 42.5% over the 10-year period, from 2,260 to 3,220. However, the most recent year's data shows a smaller percentage increase for females than males, at 1.6% vs 5.4% respectively. As a result, the proportion of females achieving first degrees decreased from 14.2% in 2012/13 to 13.8% in 2013/14.

The growth in first degree graduation is mainly being driven by increased domestic uptake: UK-domiciled awardees showed the largest percentage increase between 2012/13 and 2013/14, with first degree achievements rising by 6.8% to 15,615. This rate of growth outstripped the average for all domiciles. For example, the percentage of non-UK awardees declined from 34.3% to 33.1%, led by a decline in EU awardees of 4.3%.

The numbers of first degree awardees from outside of the EU increased by 2.7% between 2012/13 and 2013/14. Over a 10-year period from 2004/05 to 2013/14, this demographic saw the largest increase in awardees, growing by 78.8% from 3,380 to 6,045.

Of the engineering sub-disciplines, general engineering saw the largest growth in awardees, with numbers growing by 15.1% between 2012/13 and 2013/14 (Table 11.17).

Production and manufacturing saw the largest percentage decline in awardees, down 3.2%. However, this decline was due to a 75% drop in the numbers of EU students obtaining first degrees, whilst the numbers of UK awardees actually increased by 10%.

Chemical, process and energy engineering has the largest percentage of female first degree awardees, at 28.1%. Encouragingly, this sub-discipline experienced the second largest percentage increase in awardees, with numbers growing by 13.8% between 2012/13 and 2013/14.

Table 11.16: First degrees achieved in engineering (2004/05-2013/14) – all domiciles

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 10 years
Engineering	**Total**	**17,395**	**17,465**	**17,420**	**17,785**	**18,155**	**19,125**	**19,970**	**20,855**	**22,265**	**23,340**	**4.8%**	**34.2%**
	Female	2,260	2,430	2,280	2,370	2,405	2,650	2,710	2,925	3,170	3,220	1.6%	42.5%
	Male	15,135	15,035	15,140	15,415	15,750	16,475	17,260	17,930	19,095	20,120	5.4%	32.9%
	% female	13.0%	13.9%	13.1%	13.3%	13.2%	13.9%	13.6%	14.0%	14.2%	13.8%	-0.4%p	0.8%p
	UK	12,435	11,900	11,990	11,955	12,085	12,295	12,865	13,680	14,620	15,615	6.8%	25.6%
	EU	1,575	1,625	1,690	2,745	1,715	1,860	1,780	1,720	1,755	1,680	-4.3%	6.7%
	Non-EU	3,380	3,940	3,740	4,085	4,350	4,970	5,320	5,460	5,890	6,045	2.7%	78.8%
	Non-UK	4,955	5,565	5,430	6,830	6,065	6,830	7,100	7,180	7,645	7,725	1.1%	55.9%
	% non-UK	28.5%	31.9%	31.2%	38.4%	33.4%	35.7%	35.6%	34.4%	34.3%	33.1%	-1.2%p	4.6%p

Source: Higher Education Statistics Agency

Table 11.17: First degrees achieved in engineering sub disciplines (2004/05-2013/14)

		2004/05 (UK only)	2005/06 (UK only)	2006/07 (UK only)	2007/08 (UK only)	2008/09 (UK only)	2009/10 (UK only)	2010/2011 (UK only)	2011/12 (UK only)	2012/2013 (All domiciles)	2013/2014 (All domiciles)	Change over 1 year
General engineering	**Total**	**1,680**	**1,680**	**1,745**	**1,470**	**1,420**	**1,350**	**1,475**	**1,510**	**1,935**	**2,225**	**15.1%**
	Female	225	260	245	230	205	200	190	230	330	390	17.6%
	Male	1,455	1,420	1,500	1,235	1,220	1,155	1,280	1,280	1,600	1,835	14.7%
	% female	13.4%	15.5%	14.0%	15.6%	14.4%	14.8%	12.9%	15.2%	17.2%	17.6%	0.4%p
	UK	1,680	1,680	1,745	1,470	1,420	1,350	1,475	1,510	1,430	1,630	13.9%
	EU	-	-	-	-	-	-	-	-	155	185	18.9%
	Non-EU	-	-	-	-	-	-	-	-	345	410	18.6%
	Non-UK	-	-	-	-	-	-	-	-	500	595	18.7%
	% non-UK	-	-	-	-	-	-	-	-	26.0%	26.8%	0.8%p
Civil engineering	**Total**	**1,735**	**1,605**	**1,900**	**2,230**	**2,515**	**2,640**	**2,835**	**2,940**	**4,370**	**4,595**	**5.2%**
	Female	235	220	275	310	355	385	405	430	745	740	-0.8%
	Male	1,500	1,380	1,620	1,920	2,160	2,255	2,430	2,510	3,625	3,855	6.4%
	% female	13.5%	13.7%	14.5%	13.9%	14.1%	14.6%	14.3%	14.6%	17.1%	16.1%	-1.0%p
	UK	1,735	1,605	1,900	2,230	2,515	2,640	2,835	2,940	3,015	3,170	5.2%
	EU	-	-	-	-	-	-	-	-	495	445	-10.7%
	Non-EU	-	-	-	-	-	-	-	-	860	985	14.3%
	Non-UK	-	-	-	-	-	-	-	-	1,360	1,430	5.2%
	% non-UK	-	-	-	-	-	-	-	-	31.1%	31.1%	0.0%p

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Table 11.17: First degrees achieved in engineering sub disciplines (2004/05-2013/14) – continued

		2004/05 (UK only)	2005/06 (UK only)	2006/07 (UK only)	2007/08 (UK only)	2008/09 (UK only)	2009/10 (UK only)	2010/2011 (UK only)	2011/12 (UK only)	2012/2013 (All domiciles)	2013/2014 (All domiciles)	Change over 1 year
Mechanical engineering	**Total**	**2,635**	**2,650**	**2,765**	**2,800**	**2,895**	**2,980**	**3,155**	**3,435**	**5,665**	**6,060**	**6.9%**
	Female	205	205	210	225	215	230	270	260	470	490	4.3%
	Male	2,430	2,445	2,555	2,570	2,680	2,755	2,885	3,175	5,195	5,570	7.2%
	% female	7.8%	7.7%	7.6%	8.0%	7.4%	7.7%	8.6%	7.6%	8.3%	8.1%	-0.2%p
	UK	2,635	2,650	2,765	2,800	2,895	2,980	3,155	3,435	3,935	4,285	8.9%
	EU	-	-	-	-	-	-	-	-	375	410	8.4%
	Non-EU	-	-	-	-	-	-	-	-	1,355	1,370	1.1%
	Non-UK	-	-	-	-	-	-	-	-	1,730	1,775	2.7%
	% non-UK	-	-	-	-	-	-	-	-	30.5%	29.3%	-1.2%p
Aerospace engineering	**Total**	**1,035**	**1,030**	**1,000**	**965**	**1,050**	**1,000**	**1,000**	**1,095**	**1,750**	**1,840**	**5.3%**
	Female	95	105	105	90	105	100	105	100	185	190	3.6%
	Male	945	925	895	875	940	900	895	990	1,565	1,650	5.5%
	% female	9.2%	10.2%	10.5%	9.3%	10.0%	10.0%	10.5%	9.1%	10.5%	10.3%	-0.2%p
	UK	1,735	1,605	1,900	2,230	2,515	2,640	2,835	2,940	1,185	1,280	7.7%
	EU	-	-	-	-	-	-	-	-	120	165	39.1%
	Non-EU	-	-	-	-	-	-	-	-	445	400	-10.5%
	Non-UK	-	-	-	-	-	-	-	-	560	560	-0.1%
	% non-UK	-	-	-	-	-	-	-	-	32.2%	30.5%	-1.6%p
Electronic and electrical engineering	**Total**	**3,565**	**3,222**	**3,060**	**2,980**	**2,770**	**2,765**	**2,775**	**3,005**	**5,650**	**5,500**	**-2.6%**
	Female	360	310	280	315	255	275	290	335	740	705	-4.9%
	Male	3,210	2,915	2,775	2,655	2,515	2,490	2,485	2,675	4,910	4,795	-2.3%
	% female	10.1%	9.6%	9.2%	10.6%	9.2%	9.9%	10.5%	11.1%	13.1%	12.8%	-0.3%p
	UK	3,565	3,222	3,060	2,980	2,770	2,765	2,775	3,005	3,250	3,140	-3.5%
	EU	-	-	-	-	-	-	-	-	340	310	-8.2%
	Non-EU	-	-	-	-	-	-	-	-	2,060	2,050	-0.4%
	Non-UK	-	-	-	-	-	-	-	-	2,400	2,360	-1.5%
	% non-UK	-	-	-	-	-	-	-	-	42.5%	42.9%	0.5%p
Production and manufacturing engineering	**Total**	**1,105**	**1,010**	**875**	**805**	**755**	**735**	**665**	**640**	**975**	**940**	**-3.2%**
	Female	155	140	145	115	130	135	95	110	190	140	-25.5%
	Male	955	870	730	690	620	600	570	525	785	800	2.1%
	% female	14.0%	13.9%	16.6%	14.3%	17.2%	18.4%	14.3%	17.2%	19.3%	14.8%	-4.4%p
	UK	1,105	1,010	875	805	755	735	665	640	650	715	10.0%
	EU	-	-	-	-	-	-	-	-	150	40	-75.1%
	Non-EU	-	-	-	-	-	-	-	-	175	190	9.5%
	Non-UK	-	-	-	-	-	-	-	-	325	230	-29.6%
	% non-UK	-	-	-	-	-	-	-	-	33.4%	24.3%	-9.1%p
Chemical, process and energy engineering	**Total**	**535**	**520**	**500**	**570**	**580**	**690**	**810**	**890**	**1,680**	**1,910**	**13.8%**
	Female	125	140	120	140	130	155	195	185	475	535	12.8%
	Male	405	385	380	430	450	535	615	705	1,205	1,375	14.1%
	% female	23.4%	26.9%	24.0%	24.6%	22.4%	22.5%	24.1%	20.8%	28.4%	28.1%	-0.2%p
	UK	535	520	500	570	580	690	810	890	1,010	1,240	22.4%
	EU	-	-	-	-	-	-	-	-	65	90	37.6%
	Non-EU	-	-	-	-	-	-	-	-	605	585	-3.3%
	Non-UK	-	-	-	-	-	-	-	-	665	670	0.6%
	% non-UK	-	-	-	-	-	-	-	-	39.8%	35.2%	-4.6%p

Source: Higher Education Statistics Agency

Table 11.18 reveals that 65.6% of engineering and technology awardees achieved a first or upper second class degree in 2013/14. This figure is in line with the average of 65.9% for all subjects, and an increase on the previous year's figure of 64.5%. Among STEM subjects, at 61.7%, computer sciences have the lowest percentage of students achieving a first or upper second class degree.

11.8.2 Postgraduate degrees obtained

Whilst the number of first degrees awarded grew by 4.8% between 2012/13 and 2013/14, the number of postgraduate degrees obtained saw a decline of 3.0% (Table 11.19). This was solely due to a drop in male awardees, which fell from 11,035 to 10,560 (4.3%) over the year. In contrast, the number of female students obtaining postgraduate degrees in engineering grew by 1.6%, from 2,950 to 3,000.

Postgraduate qualifications obtained also showed a different pattern to first degrees in the engineering sub-disciplines (Table 11.20). For example, the numbers achieving a postgraduate qualification in general engineering declined by 11.4%, from 1,840 to 1,630 – a drop of over 200. This decline occurred across all genders and domiciles, with EU students declining the most (down 15.3%). However, some sub-disciplines did buck the downward trend. Postgraduate awards in aerospace grew by 16.5% from 655 to 760. The number of female awardees surged by 35.7% though, due to low original numbers, this amounted to an increase of just 30 more students.

Table 11.18: First degrees obtained by subject and class of degree (2013/14) – all domiciles[864]

	First	Upper second	Lower second	Third/ Pass	Un-classified	Total first degree	Percentage first and upper second	
							2012/13	2013/14
Medicine & dentistry total	405	675	155	50	8,495	9,780	14.3%	11.0%
Subjects allied to medicine total	8,685	16,835	9,190	2,470	4,390	41,625	58.8%	61.3%
Biological sciences total	7,645	21,710	10,340	1,905	975	42,580	66.2%	68.9%
Veterinary sciences total	5	55	5	-	830	900	4.7%	6.7%
Agriculture & related subjects total	505	1,320	830	175	115	2,950	60.5%	61.9%
Physical sciences total	4,250	8,100	3,785	830	330	17,300	68.0%	71.4%
Mathematical sciences total	3,005	3,015	1,765	630	190	8,605	67.9%	70.0%
Computer sciences total	4,155	5,770	3,895	1,340	925	16,080	59.5%	61.7%
Engineering & technology total	**6,820**	**10,155**	**5,820**	**1,550**	**1,520**	**25,870**	**64.5%**	**65.6%**
Architecture, building & planning total	1,775	4,220	2,455	555	435	9,435	63.8%	63.5%
Total – Science subjects	37,250	71,850	38,245	9,505	18,205	175,125	60.1%	62.3%
Social studies total	7,075	22,965	9,900	1,890	885	42,720	67.4%	70.3%
Law total	2,025	9,880	4,660	850	515	17,925	64.2%	66.4%
Business & administrative studies total	10,745	28,010	18,045	4,690	2,515	64,000	57.9%	60.6%
Mass communications & documentation total	1,780	7,070	2,850	440	205	12,350	68.8%	71.7%
Languages total	4,725	14,880	3,840	510	205	24,160	79.4%	81.1%
Historical & philosophical studies total	3,475	11,615	2,940	390	220	18,645	79.8%	80.9%
Creative arts & design total	8,845	21,810	9,950	2,220	820	43,645	68.4%	70.2%
Education total	3,065	9,055	4,820	1,045	880	18,865	61.5%	64.2%
Combined total	445	1,270	770	370	1,550	4,415	39.1%	38.8%
Total – all subjects	79,440	198,405	96,030	21,915	26,000	421,850	63.6%	65.9%

Source: HESA

Table 11.19: Postgraduate degrees achieved in engineering (2004/05-2013/14)[865]

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 10 years
Engineering	**Total**	**9,260**	**9,700**	**9,540**	**10,005**	**10,035**	**12,400**	**15,285**	**15,620**	**13,985**	**13,560**	**-3.0%**	**46.4%**
	Female	1,780	1,865	1,735	1,880	1,790	2,140	2,775	2,945	2,950	3,000	1.6%	68.5%
	Male	7,480	7,835	7,805	8,125	8,245	10,260	12,510	12,675	11,035	10,560	-4.3%	41.2%
	% female	19.2%	19.2%	18.2%	18.8%	17.8%	17.3%	18.2%	18.9%	21.1%	22.1%	1.0%p	2.9%p
	UK	2,960	2,860	2,760	2,815	2,925	3,170	4,030	3,900	3,655	3,365	-8.0%	13.7%
	EU	1,735	1,665	1,755	1,550	1,420	1,670	2,105	2,235	2,170	2,175	0.2%	25.4%
	Non-EU	4,565	5,175	5,025	5,640	5,690	7,560	9,145	9,485	8,160	8,020	-1.7%	75.7%
	Non-UK	6,300	6,840	6,780	7,190	7,110	9,230	11,250	11,720	10,330	10,195	-1.3%	61.8%
	% non-UK	68.0%	70.5%	71.1%	71.9%	70.9%	74.4%	73.6%	75.0%	73.9%	75.2%	1.3%p	7.2%p

Source: Higher Education Statistics Agency

864 Figures ending 0, 1, 2 are rounded to 0. All other numbers are rounded up or down to the nearest multiple of 5. 865 Data excludes PGCE courses

Table 11.20: Postgraduate degrees achieved in engineering sub-disciplines (2004/05-2013/14)[866]

		2004/05 (UK only)	2005/06 (UK only)	2006/07 (UK only)	2007/08 (UK only)	2008/09 (UK only)	2009/10 (UK only)	2010/2011 (UK only)	2011/12 (UK only)	2012/2013 (All domiciles)	2013/2014 (All domiciles)	Change over 1 year
General engineering	**Total**	**735**	**720**	**620**	**575**	**550**	**595**	**625**	**625**	**1,840**	**1,630**	**-11.4%**
	Female	110	110	85	80	85	100	110	90	410	375	-8.5%
	Male	625	610	535	500	465	490	515	535	1,430	1,255	-12.2%
	% female	15.0%	15.3%	13.7%	13.9%	15.5%	16.8%	17.6%	14.4%	22.3%	23.1%	0.8%p
	UK	735	720	620	575	550	595	625	625	685	630	-8.0%
	EU	-	-	-	-	-	-	-	-	275	230	-16.4%
	Non-EU	-	-	-	-	-	-	-	-	880	770	-12.5%
	Non-UK	-	-	-	-	-	-	-	-	1,155	1,000	-13.4%
	% non-UK	-	-	-	-	-	-	-	-	62.8%	61.5%	-1.3%p
Civil engineering	**Total**	**550**	**555**	**670**	**750**	**895**	**1,000**	**1,375**	**1,310**	**3,145**	**3,090**	**-1.7%**
	Female	160	140	195	205	230	260	370	310	855	885	3.5%
	Male	390	410	470	545	665	740	1,005	1,000	2,290	2,200	-3.9%
	% female	29.1%	25.2%	29.1%	27.3%	25.7%	26.0%	26.9%	23.7%	27.2%	28.7%	1.6%p
	UK	550	555	670	750	895	1,000	1,375	1,310	1,050	900	-14.3%
	EU	-	-	-	-	-	-	-	-	550	560	1.8%
	Non-EU	-	-	-	-	-	-	-	-	1,545	1,630	5.5%
	Non-UK	-	-	-	-	-	-	-	-	2,095	2,190	4.5%
	% non-UK	-	-	-	-	-	-	-	-	66.6%	70.9%	4.2%p
Mechanical engineering	**Total**	**300**	**250**	**255**	**380**	**310**	**330**	**470**	**425**	**1,785**	**1,840**	**3.1%**
	Female	35	25	20	70	35	35	45	40	215	210	-2.3%
	Male	265	225	235	310	275	295	425	385	1,570	1,630	3.8%
	% female	11.7%	10.0%	7.8%	18.4%	11.3%	10.6%	9.6%	9.4%	11.9%	11.5%	0.5%p
	UK	300	250	255	380	310	330	470	425	440	410	-6.8%
	EU	-	-	-	-	-	-	-	-	335	340	1.5%
	Non-EU	-	-	-	-	-	-	-	-	1,005	1,090	8.5%
	Non-UK	-	-	-	-	-	-	-	-	1,345	1,435	6.7%
	% non-UK	-	-	-	-	-	-	-	-	75.3%	77.8%	2.4%p
Aerospace engineering	**Total**	**125**	**135**	**110**	**125**	**140**	**135**	**190**	**225**	**655**	**760**	**16.0%**
	Female	20	20	20	10	15	20	25	20	80	110	37.5%
	Male	105	115	90	115	130	120	165	205	575	650	13.0%
	% female	16.0%	14.8%	18.2%	8.0%	10.7%	14.8%	13.2%	8.9%	12.3%	14.3%	2.0%p
	UK	125	135	110	125	140	135	190	225	130	170	30.8%
	EU	-	-	-	-	-	-	-	-	225	235	4.4%
	Non-EU	-	-	-	-	-	-	-	-	295	355	20.3%
	Non-UK	-	-	-	-	-	-	-	-	520	590	13.5%
	% non-UK	-	-	-	-	-	-	-	-	79.9%	77.9%	-2.0%p
Electronic and electrical engineering	**Total**	**700**	**635**	**605**	**525**	**550**	**545**	**595**	**530**	**3,645**	**3,250**	**-10.8%**
	Female	150	105	100	80	75	50	65	75	705	705	-0.0%
	Male	555	525	505	445	475	495	530	460	2,940	4,795	63.1%
	% female	21.4%	16.5%	16.5%	15.2%	13.6%	9.2%	10.9%	14.2%	19.4%	21.7%	2.3%p
	UK	735	720	620	575	550	595	625	625	580	525	-9.5%
	EU	-	-	-	-	-	-	-	-	330	260	-21.2%
	Non-EU	-	-	-	-	-	-	-	-	2,740	2,460	-10.2%
	Non-UK	-	-	-	-	-	-	-	-	3,065	2,725	-11.1%
	% non-UK	-	-	-	-	-	-	-	-	84.1%	83.8%	-0.3%p

866 Data excludes PGCE courses

Table 11.20: Postgraduate degrees achieved in engineering sub-disciplines (2004/05-2013/14) – continued

		2004/05 (UK only)	2005/06 (UK only)	2006/07 (UK only)	2007/08 (UK only)	2008/09 (UK only)	2009/10 (UK only)	2010/2011 (UK only)	2011/12 (UK only)	2012/2013 (All domiciles)	2013/2014 (All domiciles)	Change over 1 year
Production and manufacturing engineering	**Total**	**300**	**280**	**250**	**230**	**210**	**210**	**305**	**290**	**1,170**	**1,095**	**-6.4%**
	Female	50	50	30	45	30	35	55	40	300	315	5.0%
	Male	250	230	220	185	175	175	250	245	875	785	-10.3%
	% female	16.7%	17.9%	12.0%	19.6%	14.3%	16.7%	18.0%	13.8%	25.5%	28.6%	3.1%p
	UK	300	280	250	230	210	210	305	290	275	210	-23.6%
	EU	-	-	-	-	-	-	-	-	185	200	8.1%
	Non-EU	-	-	-	-	-	-	-	-	710	690	-2.8%
	Non-UK	-	-	-	-	-	-	-	-	895	890	-0.6%
	% non-UK	-	-	-	-	-	-	-	-	76.3%	80.9%	4.6%p
Chemical, process and energy engineering	**Total**	**190**	**185**	**160**	**140**	**185**	**245**	**300**	**335**	**1,310**	**1,370**	**4.6%**
	Female	60	60	40	30	50	50	60	70	335	370	10.4%
	Male	130	125	125	110	135	195	240	270	975	1,000	2.6%
	% female	31.6%	32.4%	25.0%	21.4%	27.0%	20.4%	20.0%	20.9%	25.5%	27.1%	1.6%p
	UK	190	185	160	140	185	245	300	335	320	340	6.3%
	EU	-	-	-	-	-	-	-	-	175	200	14.3%
	Non-EU	-	-	-	-	-	-	-	-	810	830	2.5%
	Non-UK	-	-	-	-	-	-	-	-	985	1,030	4.6%
	% non-UK	-	-	-	-	-	-	-	-	75.4%	75.2%	-0.2%p

Source: Higher Education Statistics Agency

11.8.3 Doctorates obtained

As Table 11.21 shows, the numbers of students achieving doctorates in engineering declined slightly between 2012/13 and 2013/14, falling by 1.1% from 2,555 to 2525. However, the number of female awardees grew substantially by 11.8%, resulting in 65 more female engineering doctorates in 2014 than in 2013.

Of the engineering sub-disciplines (Table 11.22), aerospace saw the largest increase in doctorates awarded, with growth of 36.9% between 2012/13 and 2013/14. Electronic and electrical engineering saw a substantial decline in awardees, with 85 fewer students obtaining doctorates in 2013/14 than in 2012/13.

Table 11.21: Doctorates achieved in engineering (2004/05-2013/14)[867]

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 10 years
Engineering	**Total**	**1,810**	**1,965**	**2,145**	**1,900**	**2,100**	**2,225**	**2,290**	**2,410**	**2,555**	**2,525**	**-1.1%**	**39.6%**
	Female	320	385	425	350	430	430	465	530	530	595	11.8%	85.2%
	Male	1,490	1,580	1,720	1,550	1,670	1,795	1,825	1,880	2,025	1,935	-4.5%	29.8%
	% female	17.7%	19.6%	19.8%	18.4%	20.5%	19.3%	20.3%	22.0%	20.7%	23.5%	2.7%p	5.8%p
	UK	750	760	850	690	780	810	810	855	985	1,010	2.4%	34.5%
	EU	265	300	285	295	320	350	345	330	360	375	4.0%	41.3%
	Non-EU	790	910	1,010	915	1,000	1,060	1,135	1,225	1,205	1,145	-5.1%	44.7%
	Non-UK	1,055	1,210	1,295	1,210	1,320	1,410	1,480	1,555	1,565	1,520	-3.0%	43.9%
	% non-UK	58.3%	61.6%	60.4%	63.7%	62.9%	63.4%	64.6%	64.5%	61.3%	60.1%	-1.2%p	1.8%p

Source: Higher Education Statistics Agency

867 Data excludes PGCE courses

Table 11.22: Doctorates achieved in engineering sub-disciplines (2004/05-2013/14)[868]

		2004/05 (UK only)	2005/06 (UK only)	2006/07 (UK only)	2007/08 (UK only)	2008/09 (UK only)	2009/10 (UK only)	2010/2011 (UK only)	2011/12 (UK only)	2012/2013 (All domiciles)	2013/2014 (All domiciles)	Change over 1 year
General engineering	**Total**	**170**	**175**	**175**	**145**	**165**	**190**	**190**	**210**	**540**	**585**	**7.7%**
	Female	25	40	25	20	30	35	40	30	110	150	37.8%
	Male	140	135	150	125	135	160	150	180	435	435	0.2%
	% female	14.7%	22.9%	14.3%	13.8%	18.2%	18.4%	21.1%	14.3%	20.1%	25.7%	5.6%p
	UK	170	175	175	145	165	190	190	210	210	260	22.8%
	EU	-	-	-	-	-	-	-	-	85	85	0.4%
	Non-EU	-	-	-	-	-	-	-	-	245	240	-2.5%
	Non-UK	-	-	-	-	-	-	-	-	330	325	-1.7%
	% non-UK	-	-	-	-	-	-	-	-	61.3%	55.9%	-5.4%p
Civil engineering	**Total**	**95**	**105**	**105**	**90**	**80**	**85**	**95**	**90**	**325**	**310**	**-4.1%**
	Female	25	25	30	30	30	25	30	30	90	90	0.4%
	Male	70	75	70	65	50	60	65	55	235	220	-5.8%
	% female	26.3%	23.8%	28.6%	33.3%	37.5%	29.4%	31.6%	33.3%	28.1%	29.4%	1.3%p
	UK	95	105	105	90	80	85	95	90	130	135	4.0%
	EU	-	-	-	-	-	-	-	-	45	45	-3.0%
	Non-EU	-	-	-	-	-	-	-	-	150	135	-11.2%
	Non-UK	-	-	-	-	-	-	-	-	195	180	-9.3%
	% non-UK	-	-	-	-	-	-	-	-	60.6%	57.2%	-3.3%p
Mechanical engineering	**Total**	**125**	**135**	**180**	**105**	**125**	**140**	**145**	**150**	**440**	**390**	**-11.6%**
	Female	15	20	25	15	20	25	20	30	60	65	9.9%
	Male	110	115	150	90	105	115	125	120	380	325	-15.0%
	% female	12.0%	14.8%	13.9%	14.3%	16.0%	17.9%	13.8%	20.0%	13.8%	17.2%	3.4%p
	UK	190	185	160	140	185	245	300	335	180	165	-9.6%
	EU	-	-	-	-	-	-	-	-	55	65	17.1%
	Non-EU	-	-	-	-	-	-	-	-	205	165	-21.0%
	Non-UK	-	-	-	-	-	-	-	-	260	225	-13.0%
	% non-UK	-	-	-	-	-	-	-	-	59.1%	58.2%	-0.9%p
Aerospace engineering	**Total**	**25**	**25**	**50**	**30**	**45**	**40**	**40**	**40**	**90**	**120**	**36.9%**
	Female	5	0	10	5	10	5	5	5	15	20	24.2%
	Male	20	25	40	20	40	35	35	35	75	105	39.3%
	% female	20.0%	0.0%	20.0%	16.7%	22.2%	12.5%	12.5%	12.5%	16.1%	14.6%	-1.5%p
	UK	25	25	50	30	45	40	40	40	45	60	27.5%
	EU	-	-	-	-	-	-	-	-	20	25	15.1%
	Non-EU	-	-	-	-	-	-	-	-	20	35	81.0%
	Non-UK	-	-	-	-	-	-	-	-	40	60	47.2%
	% non-UK	-	-	-	-	-	-	-	-	47.6%	51.2%	3.6%p
Electronic and electrical engineering	**Total**	**200**	**175**	**235**	**190**	**230**	**235**	**210**	**225**	**795**	**710**	**-10.4%**
	Female	25	30	30	25	40	25	30	25	130	135	4.5%
	Male	175	145	205	165	185	210	180	200	665	575	-13.2%
	% female	12.5%	17.1%	12.8%	13.2%	17.4%	10.6%	14.3%	11.1%	16.3%	19.0%	2.7%p
	UK	190	185	160	140	185	245	300	335	265	235	-11.0%
	EU	-	-	-	-	-	-	-	-	100	95	-7.0%
	Non-EU	-	-	-	-	-	-	-	-	425	380	-10.8%
	Non-UK	-	-	-	-	-	-	-	-	530	475	-10.0%
	% non-UK	-	-	-	-	-	-	-	-	66.6%	66.8%	0.2%p

868 Data excludes PGCE courses

Table 11.22: Doctorates achieved in engineering sub-disciplines (2004/05-2013/14) – continued

		2004/05 (UK only)	2005/06 (UK only)	2006/07 (UK only)	2007/08 (UK only)	2008/09 (UK only)	2009/10 (UK only)	2010/2011 (UK only)	2011/12 (UK only)	2012/2013 (All domiciles)	2013/2014 (All domiciles)	Change over 1 year
Production and manufacturing engineering	**Total**	**35**	**45**	**30**	**45**	**40**	**30**	**40**	**35**	**95**	**95**	**-1.6%**
	Female	15	15	5	10	10	10	15	10	25	30	9.8%
	Male	25	30	20	35	30	20	25	25	70	65	-5.7%
	% female	42.9%	33.3%	16.7%	22.2%	25.0%	33.3%	37.5%	28.6%	26.6%	29.6%	3.1%p
	UK	190	185	160	140	185	245	300	335	45	45	-3.4%
	EU	-	-	-	-	-	-	-	-	25	15	-40.4%
	Non-EU	-	-	-	-	-	-	-	-	30	40	33.3%
	Non-UK	-	-	-	-	-	-	-	-	50	50	0.0%
	% non-UK	-	-	-	-	-	-	-	-	54.2%	55.0%	0.9%p
Chemical, process and energy engineering	Total	80	90	75	85	90	85	85	105	250	305	21.1%
	Female	20	25	20	30	20	25	30	35	100	105	3.5%
	Male	60	65	55	60	75	60	55	70	150	200	32.6%
	% female	25.0%	27.8%	26.7%	35.3%	22.2%	29.4%	35.3%	33.3%	39.4%	33.7%	-5.7%p
	UK	190	185	160	140	185	245	300	335	110	115	5.6%
	EU	-	-	-	-	-	-	-	-	25	45	76.5%
	Non-EU	-	-	-	-	-	-	-	-	120	145	23.4%
	Non-UK	-	-	-	-	-	-	-	-	145	190	32.9%
	% non-UK	-	-	-	-	-	-	-	-	57.0%	62.5%	5.5%p

Source: Higher Education Statistics Agency

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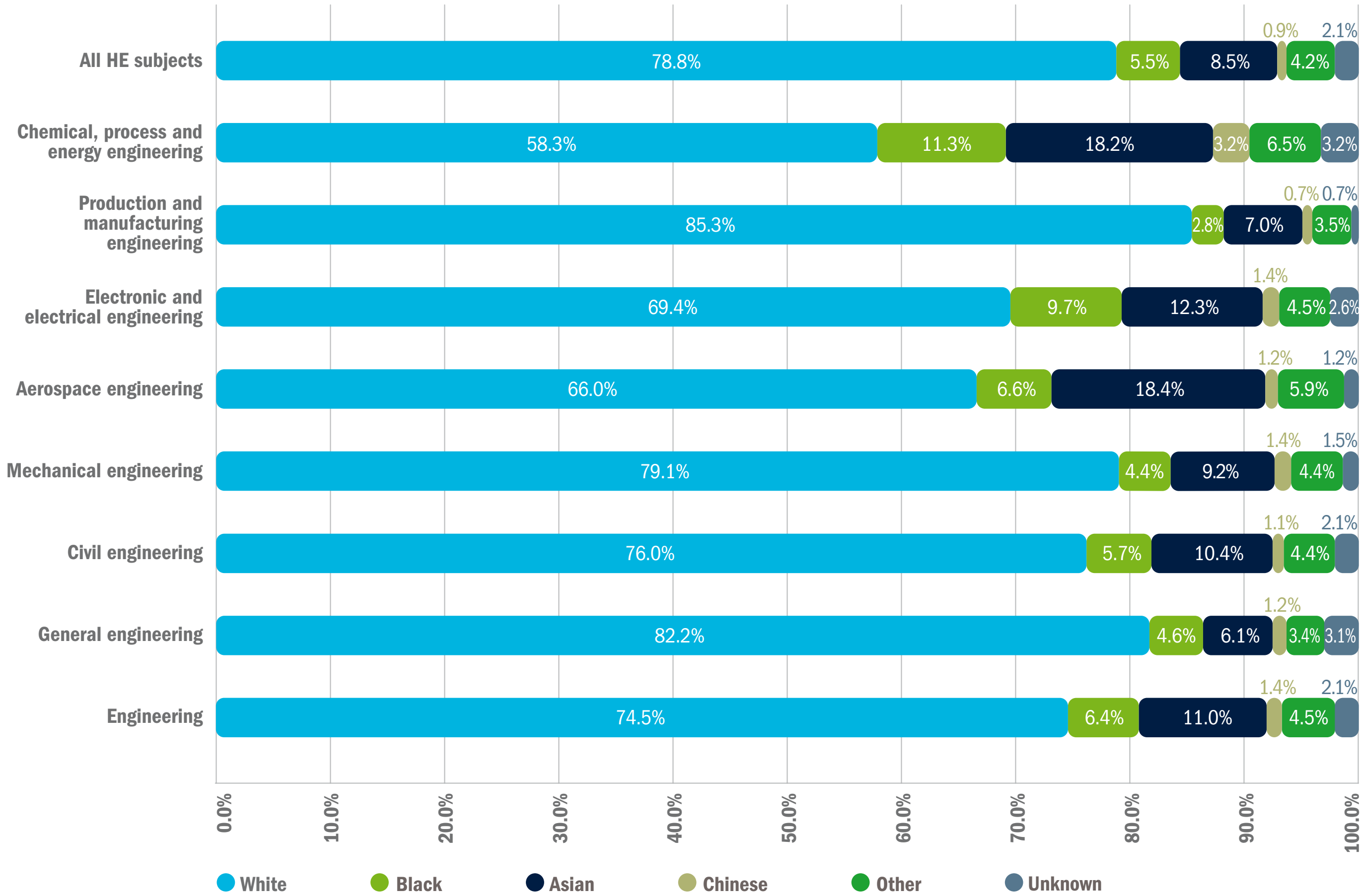
11.9 Ethnicity of engineering graduates

Engineering graduates have a slightly more diverse ethnic profile than graduates of other subjects. As Table 11.14 shows, 74.5% of first degrees were achieved by white students, compared with an all-subject average of 78.8%. In line with its relatively equal gender balance compared to engineering in general; chemical, process and energy engineering is also the most ethnically diverse sub-discipline: Just 58.3% of first degrees were completed by white students (Figure 11.14).

Figure 11.14: Proportion of first degrees obtained in engineering subjects by ethnicity (2013/14) – all domiciles



Source: Higher Education Statistics Agency

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Table 11.23: First degrees obtained in engineering and engineering sub-disciplines by ethnicity (2013/14) – all domiciles

	Sex	White		Black or black British – Caribbean		Black or black British – African		Other black background		Asian or Asian British – Indian		Asian or Asian British – Pakistani		Asian or Asian British – Bangladeshi		Chinese		Other Asian background		Other (including mixed)		Not known		Total
Engineering	Female	1,355	70.0%	20	1.0%	140	7.2%	5	0.3%	80	4.1%	50	2.6%	15	0.8%	45	2.3%	75	3.9%	100	5.2%	45	2.3%	1,935
	Male	10,270	75.1%	75	0.5%	730	5.3%	30	0.2%	575	4.2%	395	2.9%	100	0.7%	180	1.3%	430	3.1%	605	4.4%	290	2.1%	13,675
	Total	**11,625**	**74.5%**	**95**	**0.6%**	**870**	**5.6%**	**35**	**0.2%**	**655**	**4.2%**	**445**	**2.9%**	**115**	**0.7%**	**225**	**1.4%**	**505**	**3.2%**	**705**	**4.5%**	**335**	**2.1%**	**15,610**
	% female	–	11.7%	-	21.1%	-	16.1%	-	14.3%	-	12.2%	-	11.2%	-	13.0%	-	20.0%	-	14.9%	-	14.2%	-	13.4%	12.4%
General engineering	Female	225	78.9%	0	0.0%	15	5.3%	0	0.0%	10	3.5%	10	3.5%	0	0.0%	5	1.8%	5	1.8%	15	5.3%	5	1.8%	285
	Male	1,115	82.9%	10	0.7%	50	3.7%	0	0.0%	35	2.6%	20	1.5%	5	0.4%	15	1.1%	15	1.1%	40	3.0%	45	3.3%	1,345
	Total	**1,340**	**82.2%**	**10**	**0.6%**	**65**	**4.0%**	**0**	**0.0%**	**45**	**2.8%**	**30**	**1.8%**	**5**	**0.3%**	**20**	**1.2%**	**20**	**1.2%**	**55**	**3.4%**	**50**	**3.1%**	**1,630**
	% female	–	16.8%	-	0.0%	-	23.1%	-	0.0%	-	22.2%	-	33.3%	-	0.0%	-	25.0%	-	25.0%	-	27.3%	-	10.0%	17.5%
Civil engineering	Female	335	73.6%	5	1.1%	25	5.5%	0	0.0%	15	3.3%	5	1.1%	0	0.0%	10	2.2%	20	4.4%	25	5.5%	15	3.3%	455
	Male	2,075	76.4%	10	0.4%	135	5.0%	5	0.2%	100	3.7%	90	3.3%	15	0.6%	25	0.9%	85	3.1%	115	4.2%	50	1.8%	2,715
	Total	**2,410**	**76.0%**	**15**	**0.5%**	**160**	**5.0%**	**5**	**0.2%**	**115**	**3.6%**	**95**	**3.0%**	**15**	**0.5%**	**35**	**1.1%**	**105**	**3.3%**	**140**	**4.4%**	**65**	**2.1%**	**3,170**
	% female	–	13.9%	-	33.3%	-	15.6%	-	0.0%	-	13.0%	-	5.3%	-	0.0%	-	28.6%	-	19.0%	-	17.9%	-	23.1%	14.4%
Mechanical engineering	Female	265	76.8%	5	1.4%	15	4.3%	0	0.0%	10	2.9%	5	1.4%	5	1.4%	5	1.4%	15	4.3%	15	4.3%	5	1.4%	345
	Male	3,120	79.3%	20	0.5%	145	3.7%	5	0.1%	130	3.3%	90	2.3%	25	0.6%	55	1.4%	115	2.9%	175	4.4%	60	1.5%	3,935
	Total	**3,385**	**79.1%**	**25**	**0.6%**	**160**	**3.7%**	**5**	**0.1%**	**140**	**3.3%**	**95**	**2.2%**	**30**	**0.7%**	**60**	**1.4%**	**130**	**3.0%**	**190**	**4.4%**	**65**	**1.5%**	**4,280**
	% female	–	7.8%	-	20.0%	-	9.4%	-	0.0%	-	7.1%	-	5.3%	-	16.7%	-	8.3%	-	11.5%	-	7.9%	-	7.7%	8.1%
Aerospace engineering	Female	85	73.9%	0	0.0%	5	4.3%	0	0.0%	5	4.3%	5	4.3%	0	0.0%	0	0.0%	5	4.3%	5	4.3%	0	0.0%	115
	Male	760	65.2%	10	0.9%	70	6.0%	0	0.0%	100	8.6%	45	3.9%	15	1.3%	15	1.3%	60	5.2%	70	6.0%	15	1.3%	1,165
	Total	**845**	**66.0%**	**10**	**0.8%**	**75**	**5.9%**	**0**	**0.0%**	**105**	**8.2%**	**50**	**3.9%**	**15**	**1.2%**	**15**	**1.2%**	**65**	**5.1%**	**75**	**5.9%**	**15**	**1.2%**	**1,280**
	% female	–	10.1%	-	0.0%	-	6.7%	-	0.0%	-	4.8%	-	10.0%	-	0.0%	-	0.0%	-	7.7%	-	6.7%	-	0.0%	9.0%
Electronic & electrical engineering	Female	180	60.0%	10	3.3%	30	10.0%	0	0.0%	20	6.7%	15	5.0%	5	1.7%	10	3.3%	10	3.3%	15	5.0%	5	1.7%	300
	Male	1,995	70.4%	25	0.9%	230	8.1%	10	0.4%	125	4.4%	80	2.8%	30	1.1%	35	1.2%	100	3.5%	125	4.4%	75	2.6%	2,835
	Total	**2,175**	**69.4%**	**35**	**1.1%**	**260**	**8.3%**	**10**	**0.3%**	**145**	**4.6%**	**95**	**3.0%**	**35**	**1.1%**	**45**	**1.4%**	**110**	**3.5%**	**140**	**4.5%**	**80**	**2.6%**	**3,135**
	% female	–	8.3%	-	28.6%	-	11.5%	-	0.0%	-	13.8%	-	15.8%	-	14.3%	-	22.2%	-	9.1%	-	10.7%	-	6.3%	9.6%
Production & manufacturing engineering	Female	85	81.0%	0	0.0%	–	0.0%	0	0.0%	5	4.8%	–	0.0%	0	0.0%	0	0.0%	0	0.0%	5	4.8%	0	0.0%	105
	Male	525	86.1%	5	0.8%	15	2.5%	0	0.0%	15	2.5%	10	1.6%	5	0.8%	5	0.8%	15	2.5%	20	3.3%	5	0.8%	610
	Total	**610**	**85.3%**	**5**	**0.7%**	**15**	**2.1%**	**0**	**0.0%**	**20**	**2.8%**	**10**	**1.4%**	**5**	**0.7%**	**5**	**0.7%**	**15**	**2.1%**	**25**	**3.5%**	**5**	**0.7%**	**715**
	% female	–	13.9%	-	0.0%	-	0.0%	-	0.0%	-	25.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	20.0%	-	0.0%	14.7%
Chemical, process & energy engineering	Female	170	54.0%	0	0.0%	40	12.7%	5	1.6%	20	6.3%	15	4.8%	5	1.6%	10	3.2%	20	6.3%	25	7.9%	10	3.2%	315
	Male	550	59.8%	5	0.5%	85	9.2%	5	0.5%	60	6.5%	60	6.5%	10	1.1%	30	3.3%	35	3.8%	55	6.0%	30	3.3%	920
	Total	**720**	**58.3%**	**5**	**0.4%**	**125**	**10.1%**	**10**	**0.8%**	**80**	**6.5%**	**75**	**6.1%**	**15**	**1.2%**	**40**	**3.2%**	**55**	**4.5%**	**80**	**6.5%**	**40**	**3.2%**	**1,235**
	% female	–	23.6%	-	0.0%	-	32.0%	-	50.0%	-	25.0%	-	20.0%	-	33.3%	-	25.0%	-	36.4%	-	31.3%	-	25.0%	25.5%
All subjects	Female	160,110	79.0%	3,245	1.6%	8,235	4.1%	565	0.3%	6,590	3.3%	4,805	2.4%	1,765	0.9%	1,655	0.8%	2,950	1.5%	8,605	4.2%	4,165	2.1%	202,695
	Male	118,565	78.5%	1,480	1.0%	5,670	3.8%	335	0.2%	5,720	3.8%	4,040	2.7%	1,395	0.9%	1,510	1.0%	2,635	1.7%	6,340	4.2%	3,300	2.2%	150,990
	Total	**278,675**	**78.8%**	**4,725**	**1.3%**	**13,905**	**3.9%**	**900**	**0.3%**	**12,310**	**3.5%**	**8,845**	**2.5%**	**3,160**	**0.9%**	**3,165**	**0.9%**	**5,585**	**1.6%**	**14,945**	**4.2%**	**7,465**	**2.1%**	**353,685**
	% female	–	57.5%	-	68.7%	-	59.2%	-	62.8%	-	53.5%	-	54.3%	-	55.9%	-	52.3%	-	52.8%	-	57.6%	-	55.8%	57.3%

Source: Higher Education Statistics Agency

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As Table 11.24 shows, the proportion of non-white students achieving first degrees in engineering has been steadily increasing by 5.8% since 2004/05, when the proportion of white awardees was 79.1%. However, the most recent year recorded showed a slight increase in the proportion of white awardees (up 0.7%), driven by a 15.1% decline in black, black British Caribbean, Chinese, Asian or Asian British Bangladeshi recipients. Historically, the fastest growing ethnicity is black British African, which has seen a 184.2% increase in first degree awardees, from 305 in 2004/5 to 870 in 2013/14.

Tables 11.25 and 11.26 show the number of postgraduate and doctoral qualifications obtained in 2013/14, broken down by ethnicity. Compared with first degree achievements, postgraduate qualifications are obtained by a more ethnically-diverse demographic: 36.9% of postgraduate and 33.7% of doctorate awardees identified as non-white, compared with all-subject averages of 28.1% and 24.5%.

In general, female awardees were less likely to be white than males, with only 28.6% of female electronic and electrical postgraduate degree awardees identifying as white.

Table 11.24: First degrees achieved in engineering by ethnic origin (2004/05-2013/14) – UK domiciled

	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over 1 year	Change over 10 years
White	9,835	9,240	9,420	9,270	9,235	9,345	9,725	10,170	10,810	11,630	7.6%	18.2%
Black or black British – Caribbean	75	85	85	75	75	110	100	110	110	95	-15.1%	22.7%
Black or black British – African	305	375	360	485	515	530	640	750	820	870	5.9%	184.2%
Other black background	25	40	35	25	20	45	35	40	30	35	5.4%	42.7%
Asian or Asian British – Indian	485	510	450	515	460	525	545	550	635	655	3.2%	35.8%
Asian or Asian British – Pakistani	265	270	240	265	300	290	310	340	385	445	15.4%	68.6%
Asian or Asian British – Bangladeshi	90	75	70	90	90	95	105	115	120	115	-4.7%	28.1%
Chinese	240	215	250	230	260	220	225	200	240	225	-6.6%	-7.4%
Other Asian background	190	230	215	235	285	285	315	375	455	510	11.9%	166.9%
Other (including mixed) ethnicity	280	295	360	365	450	440	475	600	595	705	18.5%	154.2%
Unknown	650	565	505	400	400	415	400	430	420	340	-19.2%	-48.0%
Percentage white	79.1%	77.6%	78.6%	77.5%	76.4%	76.0%	75.6%	74.3%	73.9%	74.4%	0.7%p	-5.8%p
Total	12,435	11,900	11,990	11,955	12,085	12,295	12,865	13,680	14,620	15,625	6.8%	25.5%

Source: Higher Education Statistics Agency

Table 11.25: Postgraduate qualifications obtained in engineering subjects by ethnicity (2013/14)[869] – all domiciles

	Sex	White		Black or black British – Caribbean		Black or black British – African		Other black background		Asian or Asian British – Indian		Asian or Asian British – Pakistani		Asian or Asian British – Bangladeshi		Chinese		Other Asian background		Other (including mixed)		Not known		Total
Engineering	Female	335	58.8%	5	0.9%	45	7.9%	5	0.9%	25	4.4%	10	1.8%	5	0.9%	25	4.4%	35	6.1%	40	7.0%	50	8.8%	570
	Male	1785	64.0%	15	0.5%	230	8.2%	5	0.2%	120	4.3%	65	2.3%	20	0.7%	65	2.3%	95	3.4%	175	6.3%	225	8.1%	2,790
	Total	**2,120**	**63.1%**	**20**	**0.6%**	**275**	**8.2%**	**10**	**0.3%**	**145**	**4.3%**	**75**	**2.2%**	**25**	**0.7%**	**90**	**2.7%**	**130**	**3.9%**	**215**	**6.4%**	**275**	**8.2%**	**3,360**
	% female	-	15.8%	-	25.0%	-	16.4%	-	50.0%	-	17.2%	-	13.3%	-	20.0%	-	27.8%	-	26.9%	-	18.6%	18.2%		17.0%
General engineering	Female	70	60.9%	0	0.0%	10	8.7%	0	0.0%	5	4.3%	0	0.0%	0	0.0%	5	4.3%	5	4.3%	5	4.3%	10	8.7%	115
	Male	370	71.8%	0	0.0%	35	6.8%	0	0.0%	15	2.9%	10	1.9%	0	0.0%	5	1.0%	15	2.9%	30	5.8%	35	6.8%	515
	Total	**440**	**69.8%**	**0**	**0.0%**	**45**	**7.1%**	**0**	**0.0%**	**20**	**3.2%**	**10**	**1.6%**	**0**	**0.0%**	**10**	**1.6%**	**20**	**3.2%**	**35**	**5.6%**	**45**	**7.1%**	**630**
	% female	-	15.9%	-	0.0%	-	22.2%	-	0.0%	-	25.0%	-	0.0%	-	0.0%	-	50.0%	-	25.0%	-	14.3%		22.2%	18.3%
Civil engineering	Female	140	70.0%	5	2.5%	10	5.0%	0	0.0%	5	2.5%	0	0.0%	5	2.5%	5	2.5%	10	5.0%	15	7.5%	15	7.5%	200
	Male	470	67.6%	0	0.0%	50	7.2%	0	0.0%	20	2.9%	15	2.2%	5	0.7%	15	2.2%	25	3.6%	40	5.8%	45	6.5%	695
	Total	**610**	**68.2%**	**5**	**0.6%**	**60**	**6.7%**	**0**	**0.0%**	**25**	**2.8%**	**15**	**1.7%**	**10**	**1.1%**	**20**	**2.2%**	**35**	**3.9%**	**55**	**6.1%**	**60**	**6.7%**	**895**
	% female	-	23.0%	-	100.0%	-	16.7%	-	0.0%	-	20.0%	-	0.0%	-	50.0%	-	25.0%	-	28.6%	-	27.3%	-	25.0%	22.3%
Mechanical engineering	Female	20	44.4%	0	0.0%	5	11.1%	0	0.0%	5	11.1%	5	11.1%	0	0.0%	0	0.0%	0	0.0%	5	11.1%	5	11.1%	45
	Male	235	64.4%	0	0.0%	30	8.2%	0	0.0%	20	5.5%	5	1.4%	0	0.0%	10	2.7%	10	2.7%	30	8.2%	30	8.2%	365
	Total	**255**	**62.2%**	**0**	**0.0%**	**35**	**8.5%**	**0**	**0.0%**	**25**	**6.1%**	**10**	**2.4%**	**0**	**0.0%**	**10**	**2.4%**	**10**	**2.4%**	**35**	**8.5%**	**35**	**8.5%**	**410**
	% female	-	7.8%	-	0.0%	-	14.3%	-	0.0%	-	20.0%	-	50.0%	-	0.0%	-	0.0%	-	0.0%	-	14.3%	-	14.3%	11.0%
Aerospace engineering	Female	5	50.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	10
	Male	120	75.0%	0	0.0%	5	3.1%	0	0.0%	5	3.1%	5	3.1%	0	0.0%	0	0.0%	0	0.0%	5	3.1%	15	9.4%	160
	Total	**125**	**73.5%**	**0**	**0.0%**	**5**	**2.9%**	**0**	**0.0%**	**5**	**2.9%**	**5**	**2.9%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**5**	**2.9%**	**15**	**8.8%**	**170**
	% female	-	4.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	5.9%
Electronic & electrical engineering	Female	20	28.6%	0	0.0%	5	7.1%	0	0.0%	5	7.1%	0	0.0%	0	0.0%	10	14.3%	10	14.3%	5	7.1%	15	21.4%	70
	Male	205	45.1%	5	1.1%	50	11.0%	0	0.0%	25	5.5%	15	3.3%	5	1.1%	25	5.5%	20	4.4%	35	7.7%	70	15.4%	455
	Total	**225**	**42.9%**	**5**	**1.0%**	**55**	**10.5%**	**0**	**0.0%**	**30**	**5.7%**	**15**	**2.9%**	**5**	**1.0%**	**35**	**6.7%**	**30**	**5.7%**	**40**	**7.6%**	**85**	**16.2%**	**525**
	% female	-	8.9%	-	0.0%	-	9.1%	-	0.0%	-	16.7%	-	0.0%	-	0.0%	-	28.6%	-	33.3%	-	12.5%	-	17.6%	13.3%
Production & manufacturing engineering	Female	30	75.0%	0	0.0%	5	12.5%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	5	12.5%	0	0.0%	40
	Male	120	70.6%	0	0.0%	20	11.8%	0	0.0%	5	2.9%	5	2.9%	0	0.0%	0	0.0%	5	2.9%	5	2.9%	10	5.9%	170
	Total	**150**	**71.4%**	**0**	**0.0%**	**25**	**11.9%**	**0**	**0.0%**	**5**	**2.4%**	**5**	**2.4%**	**0**	**0.0%**	**0**	**0.0%**	**5**	**2.4%**	**10**	**4.8%**	**10**	**4.8%**	**210**
	% female	-	20.0%	-	0.0%	-	20.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	50.0%	-	0.0%	19.0%
Chemical, process & energy engineering	Female	35	50.0%	0	0.0%	10	14.3%	5	7.1%	5	7.1%	0	0.0%	0	0.0%	0	0.0%	5	7.1%	5	7.1%	5	7.1%	70
	Male	160	59.3%	5	1.9%	30	11.1%	0	0.0%	15	5.6%	5	1.9%	0	0.0%	5	1.9%	5	1.9%	20	7.4%	20	7.4%	270
	Total	**195**	**57.4%**	**5**	**1.5%**	**40**	**11.8%**	**5**	**1.5%**	**20**	**5.9%**	**5**	**1.5%**	**0**	**0.0%**	**5**	**1.5%**	**10**	**2.9%**	**25**	**7.4%**	**25**	**7.4%**	**340**
	% female	-	17.9%	-	0.0%	-	25.0%	-	100.0%	-	25.0%	-	0.0%	-	0.0%	-	0.0%	-	50.0%	-	20.0%	-	20.0%	20.6%
All subjects	Female	45,690	73.0%	745	1.2%	2,195	3.5%	170	0.3%	1,835	2.9%	840	1.3%	230	0.4%	810	1.3%	820	1.3%	2,280	3.6%	6,945	11.1%	62,560
	Male	29,880	70.1%	265	0.6%	2,040	4.8%	115	0.3%	1,570	3.7%	800	1.9%	250	0.6%	705	1.7%	830	1.9%	1,900	4.5%	4,260	10.0%	42,615
	Total	**75,570**	**71.9%**	**1,010**	**1.0%**	**4,235**	**4.0%**	**285**	**0.3%**	**3,405**	**3.2%**	**1,640**	**1.6%**	**480**	**0.5%**	**1,515**	**1.4%**	**1650**	**1.6%**	**4,180**	**4.0%**	**11,205**	**10.7%**	**105,175**
	% female	-	60.5%	-	73.8%	-	51.8%	-	59.6%	-	53.9%	-	51.2%	-	47.9%	-	53.5%	-	49.7%	-	54.5%	-	62.0%	59.5%

Source: Higher Education Statistics Agency

869 Data excludes PGCE courses

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Table 11.26: Doctorates obtained in engineering subjects by ethnicity (2013/14) – all domiciles

	Sex	White		Black or black British – Caribbean		Black or black British – African		Other black background		Asian or Asian British – Indian		Asian or Asian British – Pakistani		Asian or Asian British – Bangladeshi		Chinese		Other Asian background		Other (including mixed)		Not known		Total
Engineering	Female	145	64.4%	0	0.0%	5	2.2%	0	0.0%	5	2.2%	5	2.2%	0	0.0%	15	6.7%	5	2.2%	10	4.4%	30	13.3%	225
	Male	525	66.9%	0	0.0%	25	3.2%	0	0.0%	20	2.5%	10	1.3%	5	0.6%	25	3.2%	25	3.2%	40	5.1%	110	14.0%	785
	Total	**670**	**66.3%**	**0**	**0.0%**	**30**	**3.0%**	**0**	**0.0%**	**25**	**2.5%**	**15**	**1.5%**	**5**	**0.5%**	**40**	**4.0%**	**30**	**3.0%**	**50**	**5.0%**	**140**	**13.9%**	**1,010**
	% female	-	21.6%	-	0.0%	-	16.7%	-	0.0%	-	20.0%	-	33.3%	-	0.0%	-	37.5%	-	16.7%	-	20.0%	-	21.4%	22.3%
General engineering	Female	50	71.4%	0	0.0%	0	0.0%	0	0.0%	5	7.1%	0	0.0%	0	0.0%	5	7.1%	5	7.1%	5	7.1%	5	7.1%	70
	Male	140	73.7%	0	0.0%	5	2.6%	0	0.0%	5	2.6%	0	0.0%	0	0.0%	5	2.6%	5	2.6%	10	5.3%	15	7.9%	190
	Total	**190**	**73.1%**	**0**	**0.0%**	**5**	**1.9%**	**0**	**0.0%**	**10**	**3.8%**	**0**	**0.0%**	**0**	**0.0%**	**10**	**3.8%**	**10**	**3.8%**	**15**	**5.8%**	**20**	**7.7%**	**260**
	% female		26.3%	-	0.0%	-	0.0%	-	0.0%	-	50.0%	-	0.0%	-	0.0%	-	50.0%	-	50.0%	-	33.3%	-	25.0%	26.9%
Civil engineering	Female	25	62.5%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	5	12.5%	0	0.0%	0	0.0%	5	12.5%	40
	Male	65	68.4%	0	0.0%	5	5.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	5	5.3%	0	0.0%	5	5.3%	15	15.8%	95
	Total	**90**	**66.7%**	**0**	**0.0%**	**5**	**3.7%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**10**	**7.4%**	**0**	**0.0%**	**5**	**3.7%**	**20**	**14.8%**	**135**
	% female		27.8%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	50.0%	-	0.0%	-	0.0%	-	25.0%	29.6%
Mechanical engineering	Female	15	60.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	5	20.0%	25
	Male	90	64.3%	0	0.0%	0	0.0%	0	0.0%	5	3.6%	5	3.6%	0	0.0%	0	0.0%	5	3.6%	5	3.6%	25	17.9%	140
	Total	**105**	**63.6%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**5**	**3.0%**	**5**	**3.0%**	**0**	**0.0%**	**0**	**0.0%**	**5**	**3.0%**	**5**	**3.0%**	**30**	**18.2%**	**165**
	% female		14.3%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	16.7%	15.2%
Aerospace engineering	Female	10	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	5	50.0%	10
	Male	35	70.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.7%	0	0.0%	5	10.0%	5	10.0%	50
	Total	**45**	**75.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.6%**	**0**	**0.0%**	**5**	**8.3%**	**10**	**16.7%**	**60**
	% female		22.2%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	50.0%	16.7%
Electronic & electrical engineering	Female	15	50.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	5	16.7%	5	16.7%	0	0.0%	0	0.0%	30
	Male	130	61.9%	0	0.0%	5	2.4%	0	0.0%	10	4.8%	0	0.0%	5	2.4%	10	4.8%	10	4.8%	10	4.8%	35	16.7%	210
	Total	**145**	**60.4%**	**0**	**0.0%**	**5**	**2.1%**	**0**	**0.0%**	**10**	**4.2%**	**0**	**0.0%**	**5**	**2.1%**	**15**	**6.3%**	**15**	**6.3%**	**10**	**4.2%**	**35**	**14.6%**	**240**
	% female		10.3%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	33.3%	-	33.3%	-	0.0%	-	0.0%	12.5%
Production & manufacturing engineering	Female	15	75.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	20
	Male	15	60.0%	0	0.0%	5	20.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	25
	Total	**30**	**66.7%**	**0**	**0.0%**	**5**	**11.1%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**45**
	% female		50.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%		0.0%	-	0.0%	44.4%
Chemical, process & energy engineering	Female	20	57.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	5	14.3%	0	0.0%	0	0.0%	5	14.3%	35
	Male	45	56.3%	0	0.0%	5	6.3%	0	0.0%	5	6.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	5	6.3%	15	18.8%	80
	Total	**65**	**56.5%**	**0**	**0.0%**	**5**	**4.3%**	**0**	**0.0%**	**5**	**4.3%**	**0**	**0.0%**	**0**	**0.0%**	**5**	**4.3%**	**0**	**0.0%**	**5**	**4.3%**	**20**	**17.4%**	**115**
	% female		30.8%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	100.0%	-	0.0%	-	0.0%	-	25.0%	30.4%
All subjects	Female	4,455	75.5%	30	0.5%	50	0.8%	5	0.1%	125	2.1%	55	0.9%	15	0.3%	105	1.8%	80	1.4%	200	3.4%	775	13.1%	5,900
	Male	4,495	73.6%	10	0.2%	110	1.8%	10	0.2%	160	2.6%	50	0.8%	15	0.2%	95	1.6%	105	1.7%	225	3.7%	830	13.6%	6,105
	Total	**8,950**	**74.6%**	**40**	**0.3%**	**160**	**1.3%**	**15**	**0.1%**	**285**	**2.4%**	**105**	**0.9%**	**30**	**0.2%**	**200**	**1.7%**	**185**	**1.5%**	**425**	**3.5%**	**1,605**	**13.4%**	**12,005**
	% female		49.8%	-	75.0%	-	31.3%	-	33.3%	-	43.9%	-	52.4%	-	50.0%	-	52.5%	-	43.2%	-	47.1%	-	48.3%	49.1%

Source: Higher Education Statistics Agency

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11.10 BTEC HNC and HND completions

Table 11.27 presents the number of students completing selected level 4 and 5 BTEC HNCs and HND subjects by gender and domicile between 2005/06 and 2014/13.

Overall, there were 30,497 completions for all BTEC subjects, which was an increase on 10% on the previous year. Of this, 22.3% of all completions – 6,795 in total – were in engineering, an increase of 10% on the previous year.

Table 11.27: Number of students completing selected STEM BTEC HNC and HND subjects, by gender and domicile (2005/06-2014/15) – all domiciles

		2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change over 1 year	Change over 10 years
	UK	152	119	79	84	49	78	71	118	148	147	-0.7%	-3.3%
	International	0	0	0	0	0	0	105	40	51	134	162.7%	
	Female	88	68	40	29	32	52	101	94	132	177	34.1%	101.1%
	Aged under 19	0	0	1	0	0	0	1	0	3	3		
Biology	Aged 19-24	52	49	34	45	34	51	155	123	159	226	42.1%	334.6%
	Aged 25+	22	46	25	20	15	27	20	35	37	52	40.5%	136.4%
	Total	**152**	**119**	**79**	**84**	**49**	**78**	**176**	**158**	**199**	**281**	**41.2%**	**84.9%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	59.7%	25.3%	25.6%	47.7%	22.1%p	
	Percentage female	57.9%	57.1%	50.6%	34.5%	65.3%	66.7%	57.4%	59.5%	66.3%	63.0%	-3.3%p	5.1%p
	UK	127	53	53	56	41	79	67	65	60	104	73.3%	-18.1%
	International	0	0	0	0	0	0	157	66	99	86	-13.1%	
	Female	40	16	20	27	11	41	103	64	94	106	12.8%	165.0%
	Aged under 19	1	0	0	0	0	1	0	0	1	1		0.0%
Chemistry	Aged 19-24	36	24	22	25	26	40	158	103	138	159	15.2%	341.7%
	Aged 25+	26	10	11	29	15	32	63	26	17	29	70.6%	11.5%
	Total	**127**	**53**	**53**	**56**	**41**	**79**	**224**	**131**	**159**	**190**	**19.5%**	**49.6%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	70.1%	50.4%	62.3%	45.3%	-17.0%p	
	Percentage female	31.5%	30.2%	37.7%	48.2%	26.8%	51.9%	46.0%	48.9%	59.1%	55.8%	-3.3%p	24.3%p
	UK	477	298	401	476	476	298	139	48	53	1	-98.1%	-99.8%
	International	34	14	12	19	10	11	24	31	64	72	12.5%	111.8%
	Female	92	74	44	40	26	35	45	48	73	42	-42.5%	-54.3%
	Aged under 19	2	1	1	1	0	1	0	0	0	0		-100.0%
Other sciences	Aged 19-24	96	73	107	149	85	182	93	46	63	38	-39.7%	-60.4%
	Aged 25+	364	212	295	345	401	126	70	33	54	35	-35.2%	-90.4%
	Total	**511**	**312**	**413**	**495**	**486**	**309**	**163**	**79**	**117**	**73**	**-37.6%**	**-85.7%**
	Percentage non-UK	7.1%	4.7%	3.0%	4.0%	2.1%	3.7%	14.7%	39.2%	54.7%	98.6%	43.9%p	91.5%p
	Percentage female	18.0%	23.7%	10.7%	8.1%	5.3%	11.3%	27.6%	60.8%	62.4%	57.5%	-4.9%p	39.5%p
	UK	4,829	3,648	3,660	3,667	3,604	4,268	4,225	4,294	4,561	5,284	15.9%	9.4%
	International	1,007	1,093	1,208	981	1,257	1,026	2,142	1,907	1,618	1,511	-6.6%	50.0%
	Female	543	467	513	508	579	590	748	671	800	664	-17.0%	22.3%
	Aged under 19	10	10	5	8	8	19	32	23	32	52	62.5%	420.0%
Engineering	Aged 19-24	2,722	2,507	2,688	2,904	3,328	3,448	4,332	4,163	4,110	4,613	12.2%	69.5%
	Aged 25+	1,876	1,681	1,685	1,729	1,525	1,825	2,001	2,015	2,037	2,129	4.5%	13.5%
	Total	**5,836**	**4,741**	**4,868**	**4,648**	**4,861**	**5,294**	**6,367**	**6,201**	**6,179**	**6,795**	**10.0%**	**16.4%**
	Percentage non-UK	20.9%	30.0%	33.0%	26.8%	34.9%	24.0%	33.6%	30.8%	26.2%	22.2%	-3.9%p	1.4%p
	Percentage female	9.3%	9.9%	10.5%	10.9%	11.9%	11.1%	11.7%	10.8%	12.9%		-12.9%p	

Table 11.27: Number of students completing selected STEM BTEC HNC and HND subjects, by gender and domicile (2005/06-2014/15) – all domiciles – continued

		2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Change over 1 year	Change over 10 years
ICT/ computing	UK	2,352	1,740	1,499	1,218	1,096	1,224	1,135	1,197	1,224	1,409	15.1%	-40.1%
	International	1,972	2,394	1,413	1,732	1,271	1,427	2,344	2,278	2,052	1,874	-8.7%	-5.0%
	Female	1,060	1,023	905	964	565	583	822	738	661	543	-17.9%	-48.8%
	Aged under 19	18	31	14	13	19	19	23	38	24	57	137.5%	216.7%
	Aged 19-24	2,243	2,230	1,698	1,828	1,681	1,998	2,558	2,645	2,483	2,382	-4.1%	6.2%
	Aged 25+	1,440	1,449	975	1,095	663	634	898	792	769	844	9.8%	-41.4%
	Total	**4,324**	**4,134**	**2,912**	**2,950**	**2,367**	**2,651**	**3,479**	**3,475**	**3,276**	**3,283**	**0.2%**	**-24.1%**
	Percentage non-UK	83.8%	137.6%	94.3%	142.2%	116.0%	116.6%	67.4%	65.6%	62.6%	57.1%	-5.6%p	-26.8%p
	Percentage female	24.5%	24.7%	31.1%	32.7%	23.9%	22.0%	23.6%	21.2%	20.2%	16.5%	-3.6%p	-8.0%p
Construction	UK	2,655	2,533	2,646	2,753	2,800	2,569	2,176	2,038	1,702	1,658	-2.6%	-37.6%
	International	205	479	444	391	815	711	610	504	499	835	67.3%	307.3%
	Female	390	438	481	468	604	430	358	269	217	223	2.8%	-42.8%
	Aged under 19	3	4	1	3	2	3	1	4	8	34	325.0%	1033.3%
	Aged 19-24	1,121	1,256	1,282	1,609	1,937	1,759	1,495	1,187	1,036	1,259	21.5%	12.3%
	Aged 25+	1,048	1,099	1,122	1,519	1,674	1,518	1,290	1,351	1,157	1,200	3.7%	14.5%
	Total	**2,860**	**3,012**	**3,090**	**3,144**	**3,615**	**3,280**	**2,786**	**2,542**	**2,201**	**2,493**	**13.3%**	**-12.8%**
	Percentage non-UK	7.7%	18.9%	16.8%	14.2%	29.1%	27.7%	28.0%	24.7%	29.3%	50.4%	21.0%p	42.6%p
	Percentage female	13.6%	14.5%	15.6%	14.9%	16.7%	13.1%	12.8%	10.6%	9.9%	8.9%	-0.9%p	-4.7%p
All subjects (including STEM and non STEM)	UK	24,195	18,948	17,121	15,605	15,517	16,974	16,216	18,096	17,099	19,481	13.9%	-19.5%
	International	4,708	5,862	11,009	12,880	21,393	15,434	11,364	11,385	10,617	11,016	3.8%	134.0%
	Female	10,807	8,893	12,402	12,476	17,278	13,331	9,328	9,819	10,134	11,109	9.6%	2.8%
	Aged under 19	63	97	605	762	972	822	199	279	269	432	60.6%	585.7%
	Aged 19-24	12,905	12,163	16,954	19,129	27,152	23,095	19,043	20,317	19,182	19,611	2.2%	52.0%
	Aged 25+	9,278	8,208	7,654	8,338	8,750	8,485	8,336	8,885	8,265	10,453	26.5%	12.7%
	Total	**28,903**	**24,810**	**28,130**	**28,485**	**36,910**	**32,408**	**27,580**	**29,481**	**27,716**	**30,497**	**10.0%**	**5.5%**
	Percentage non-UK	19.5%	30.9%	64.3%	82.5%	137.9%	90.9%	70.1%	62.9%	62.1%	56.5%	-5.5%p	37.1%p
	Percentage female	37.4%	35.8%	44.1%	43.8%	46.8%	41.1%	33.8%	33.3%	36.6%	36.4%	-0.1%p	-1.0%p

Source: Pearson

11.11 Non-continuation rates

In last year's Engineering UK report we provided data on the percentage of pupils who left their degree without achieving a qualification (non-continuation rate) and the degree to which prior attainment in maths and physics influenced this figure.[870] In this year's report we have expanded on this analysis by incorporating data on the socio-economic backgrounds of students.

As Table 11.28 shows, the non-continuation rate for engineering and technology was 5.6%. This is equal to the average for all STEM subjects but slightly higher than the all-subject average (5.3%). In general, female students were less likely to leave their course of study with no award than males. In the case of engineering, the non-continuation rate was 5.9% for males compared with 4% for female students. This higher male non-continuation rate holds true for all categories, except for students from low-participation neighbourhoods, where the gender proportion is equal.

For engineering and technology students, compared with an average non-continuation rate of 5.6%, students from low participation neighbourhoods had a non-continuation rate of 7.5%. Furthermore, 6.7% of students who studied at state schools did not continue their engineering and technology studies, compared with only 2.9% of students from privately funded schools.

As expected, not having A levels in maths or physics doubled the likelihood of a student not continuing their studies compared with those who have both, with the non-continuation rate increasing from 3.3% to 7.2%.

Interestingly, the data suggest that possession of an A level in maths is slightly more important than an A level in physics for reducing the incidence of leaving with no award. The non-continuation rate for students with an A level win maths but not physics was 4.6%, compared with a rate of 6.0% for those students who had an A level in physics but not maths.

870 Engineering UK 2015 The State of Engineering in the UK, December 2014, p184

Table 11.28: Percentage of students leaving HE without a qualification (2013/14) – all domiciles[871, 872, 873]

STEM Subject area	Gender	All students	Low participation neighbourhood	A level in physics and maths	A level in physics (not maths)	A level in maths (not physics)	No A level in maths or physics	State school	Privately funded
Biological sciences	**Total**	**5.6%**	**6.4%**	**3.0%**	**3.0%**	**3.2%**	**6.4%**	**6.0%**	**3.3%**
	Male	6.9%	7.9%	3.2%	3.5%	4.2%	8.0%	7.3%	4.2%
	Female	4.7%	5.3%	2.6%	2.4%	2.7%	5.3%	5.1%	2.7%
Physical sciences	**Total**	**4.0%**	**5.3%**	**2.6%**	**3.8%**	**3.1%**	**5.5%**	**4.3%**	**2.7%**
	Male	4.1%	5.3%	2.7%	4.0%	3.6%	5.7%	4.4%	2.6%
	Female	4.0%	5.2%	2.2%	3.2%	2.7%	5.3%	4.2%	2.8%
Mathematical sciences	**Total**	**4.0%**	**4.0%**	**3.5%**	**N/A**	**4.8%**	**3.5%**	**4.3%**	**3.7%**
	Male	4.2%	3.9%	3.9%	N/A	4.7%	4.1%	4.5%	3.8%
	Female	3.5%	4.1%	2.6%	N/A	4.7%	2.8%	4.0%	4.8%
Computer science	Total	8.0%	9.4%	5.1%	4.1%	8.9%	8.9%	9.0%	5.5%
	Male	8.3%	9.5%	7.3%	4.3%	5.4%	9.3%	9.2%	6.5%
	Female	6.6%	8.7%	7.3%	0.0%	5.9%	9.3%	8.0%	6.7%
Engineering & technology	**Total**	**5.6%**	**7.5%**	**3.3%**	**6.0%**	**4.6%**	**7.2%**	**6.7%**	**2.9%**
	Male	5.9%	7.5%	3.4%	6.2%	6.0%	7.6%	7.0%	4.2%
	Female	4.0%	7.6%	2.7%	3.2%	3.7%	5.0%	4.9%	2.8%
General engineering	**Total**	**5.5%**	**4.9%**	**3.2%**	**N/A**	**7.0%**	**6.4%**	**7.4%**	**3.3%**
	Male	5.9%	4.9%	3.7%	N/A	7.1%	6.8%	8.0%	4.1%
	Female	3.0%	5.0%	0.9%	N/A	6.9%	3.8%	3.7%	0.0%
Civil engineering	**Total**	**5.1%**	**8.7%**	**3.9%**	**N/A**	**4.9%**	**6.1%**	**6.0%**	**3.7%**
	Male	5.2%	7.9%	3.9%	N/A	4.9%	6.2%	6.1%	3.7%
	Female	4.6%	14.4%	3.9%	N/A	4.7%	5.1%	5.5%	3.8%
Mechanical engineering	**Total**	**5.3%**	**6.5%**	**2.9%**	**N/A**	**6.9%**	**7.8%**	**6.0%**	**3.6%**
	Male	5.4%	6.2%	3.0%	N/A	7.6%	7.8%	6.2%	3.6%
	Female	4.3%	9.3%	2.1%	N/A	2.2%	7.6%	4.1%	3.0%
Aerospace engineering	**Total**	**5.2%**	**6.8%**	**4.4%**	**N/A**	**6.5%**	**8.0%**	**5.1%**	**6.9%**
	Male	5.0%	6.8%	4.5%	N/A	4.5%	7.9%	4.7%	7.8%
	Female	6.3%	6.8%	3.0%	N/A	16.3%	8.9%	8.0%	0.0%
Electronic & electrical engineering	**Total**	**6.6%**	**9.6%**	**4.4%**	**N/A**	**7.8%**	**7.2%**	**8.4%**	**5.9%**
	Male	6.9%	9.6%	4.5%	N/A	8.4%	7.7%	8.7%	6.3%
	Female	3.9%	9.9%	3.0%	N/A	2.6%	4.3%	5.1%	2.1%
Production & manufacturing engineering	**Total**	**4.2%**	**5.0%**	**3.5%**	**N/A**	**2.7%**	**4.6%**	**4.5%**	**6.8%**
	Male	4.0%	5.9%	2.6%	N/A	2.9%	4.4%	4.4%	4.0%
	Female	5.1%	0.0%	6.9%	N/A	2.2%	5.7%	4.9%	13.0%
Chemical, process & energy engineering	**Total**	**3.4%**	**6.2%**	**2.7%**	**N/A**	**2.2%**	**4.2%**	**4.1%**	**1.2%**
	Male	3.7%	6.0%	2.9%	N/A	2.0%	4.7%	4.2%	1.4%
	Female	2.6%	6.5%	2.2%	N/A	2.6%	3.1%	3.7%	0.9%
Total STEM subjects	**Total**	**5.6%**	**6.9%**	**3.3%**	**3.8%**	**4.0%**	**6.9%**	**6.2%**	**3.6%**
	Male	6.3%	7.7%	3.4%	4.3%	4.8%	7.9%	7.0%	3.9%
	Female	4.5%	5.6%	2.6%	2.5%	3.2%	5.3%	5.0%	3.0%
Total all subjects	**Total**	**5.3%**	**6.4%**	**3.2%**	**3.3%**	**3.3%**	**5.9%**	**6.2%**	**3.6%**
	Male	5.9%	7.4%	3.4%	3.7%	3.8%	6.8%	7.0%	3.9%
	Female	4.8%	5.7%	2.7%	2.5%	2.9%	5.2%	5.0%	3.0%

Source: Higher Education Statistics Agency

871 Low participation defined as students from POLAR3 Quintile 1 872 Figures this year are lower than last, as criteria for non-continuation rate is now the number of students recorded as 'leaving with no award'. Previous calculations included the additional criteria 'dormant or writing up' 873 N/A = sample size less than 20.

Looking at specific engineering sub-disciplines, slightly different patterns in non-continuation rates emerge. For example, electronic and electrical engineering had the highest non-continuation rate (6.6%), and chemical, process and energy engineering the lowest (3.4%). The female non-continuation rate was also the lowest for this sub-discipline, with only 2.6% of female students leaving the course with no qualification.

11.12 Effect of population decline upon graduate numbers

The projected decline in the UK's young population poses significant challenges to the future supply of highly-skilled graduates. Data from the Office for National Statistics (Figure 11.15) calculates that the number of 18- to 20-year-olds will decline by 193,602 (8.4%) between 2015 and 2020.

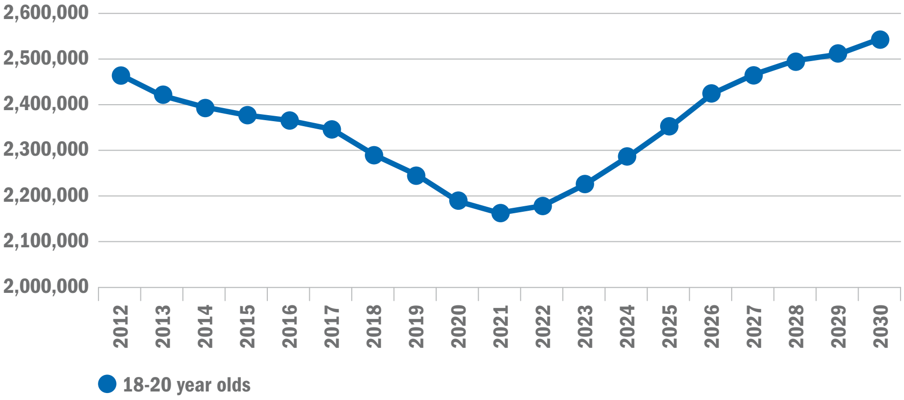
As our analysis shows in chapter 15, there is currently a shortfall of 40,267 per year in the supply of level 4+ skills needed to meet demand.[874] However, there is much capacity for growth in recruiting more students to engineering courses at higher education. Widening participation of disadvantaged and under-represented demographics, greater provision of part time study, and increasing recruitment of international students from growth countries, can all help to mitigate against the shortfall expected in the UK's young population. These factors are discussed in great detail in the subsequent sections.

11.13 Widening participation

Social mobility is closely linked to the wider performance of the economy; an OECD study warns that low mobility can curb economic growth and constrain productivity. This implies that, even from a narrow economic perspective, failure to tackle disadvantage and low aspirations has a negative impact on the UK's economic wellbeing.[875]

A key metric for measuring widening participation in HE is the Participation of Local Areas (POLAR) methodology. POLAR classifies local areas or 'wards' into five groups or 'quintiles', based on the proportion of 18-year-olds who enter HE aged 18 or 19 years old. These groups range from quintile 1 areas, with the lowest young participation (most disadvantaged), up to quintile 5 areas with the highest rates (most advantaged).

Figure 11.15: Numbers of 18- to 20-year-olds in the UK population (2012-2030)

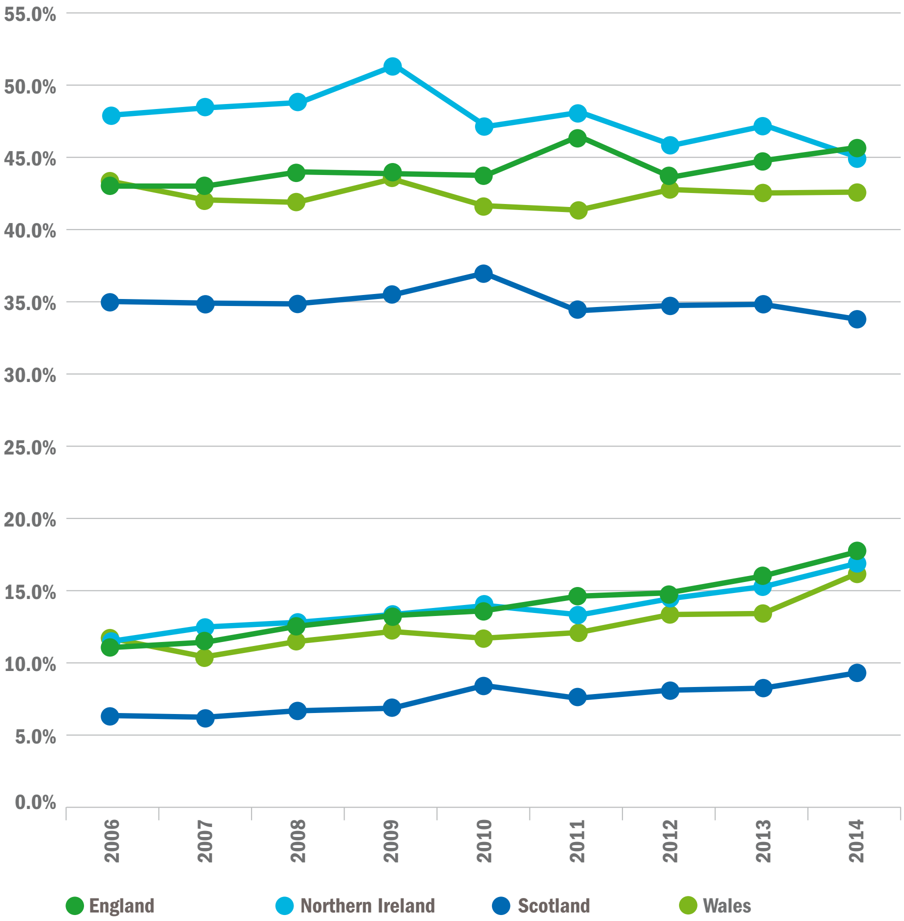


Source: ONS

Over the last 10 years, entry rates to HE for 18-year-olds living in advantaged areas have not increased by as much as for those in disadvantaged areas, reducing the difference in entry rates between the groups to new lows across the UK. Although advantaged 18-year-olds in England and Wales are around two and a half times more likely to enter higher education than disadvantaged 18-year-olds, this figure is down from almost four times more likely in 2006.[876]

As Figure 11.16 shows, HE entry rates for pupils from the most disadvantaged areas across all UK devolved nations (Q1) have increased steadily since 2006 to over 15%, whilst the rate for the most advantaged areas (Q5) have remained relatively stable at under 50%.[877] This trend has contributed to an overall narrowing in the gap between the most and least advantaged 18-year-olds in society.

Figure 11.16: 18-year-old entry rates by POLAR quintile and country of domicile (top Q5, bottom Q1 2006-2014)



Source: UCAS

874 Table 15.12 875 Universities UK: The economic role of UK universities, June 2015, p30 876 *Ibid*, p4 877 UCAS: End of Cycle Report, December 2014, p74.

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However, Figure 11.17 looks at the higher education entry rate of younger people by subject, and reveals that engineering and technology has a lower than average proportion of students from low participation neighbourhoods. Furthermore, whilst the rate for all subjects has remained stable between 2012/13 and 2013/14, the rate actually declined for engineering and technology, from 8.9% to 8.5%.

The entry rate for all subjects for students from state schools (Figure 11.18) has gradually increased, from 88.5% in 2008/09 to an all-time high of 89.7% in 2013/14. However, the entry rate trend for engineering and technology has been much more turbulent, currently sitting at 88.3%, 1.4 percentages points lower than the all-subject average.

It is worth pointing out that, according to analysis conducted by the Higher Education Funding Council for England, students from independent schools achieve better degree outcomes than their state school counterparts. In 2013/14, 73% of former state school students achieved a first or upper second degree, compared with 82% of private school students.[878]

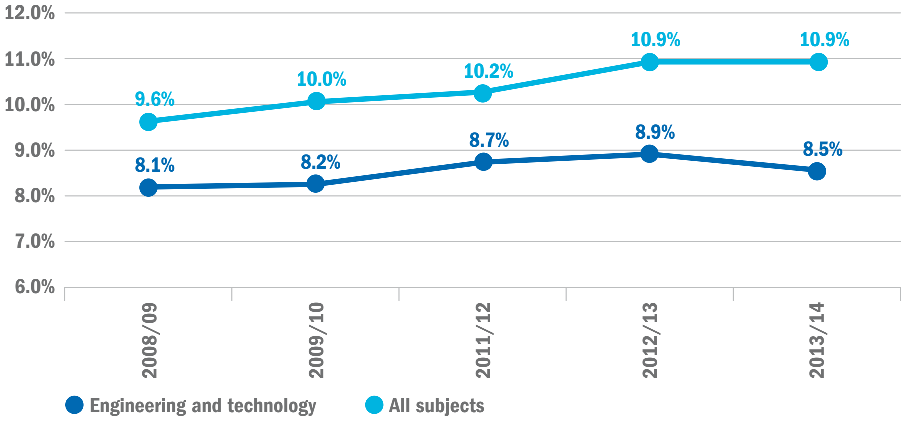
11.14 Part-time study

Part-time HE provision has the ability to increase the pool of potential HE recruits, by enabling more flexible modes of study. As BIS notes, the profile of part-time HE learners is often different, focusing more on learners already in work, such as apprentices, and those with existing qualifications who are seeking to develop particular knowledge and expertise to support their professional development. Furthermore, for employers, part-time provision enables their workforce to develop their skills and knowledge without having an impact on day-to-day business.[879]

As discussed in Section 15, a main impediment to employees addressing Hard-to-Fill vacancies is the lack of relevant work experience and general work preparedness. Therefore, by enabling students to combine work with learning, part time HE provision has a key role to play in the development of a graduate cohort able to fulfil employer demand. However, first year enrolments onto higher education courses have declined rapidly over the last five years. As Figure 11.19 shows, the numbers of part time first year enrolments to all HE courses declined from 467,795 in 2009/10 to just 281,590 in 2013/14.

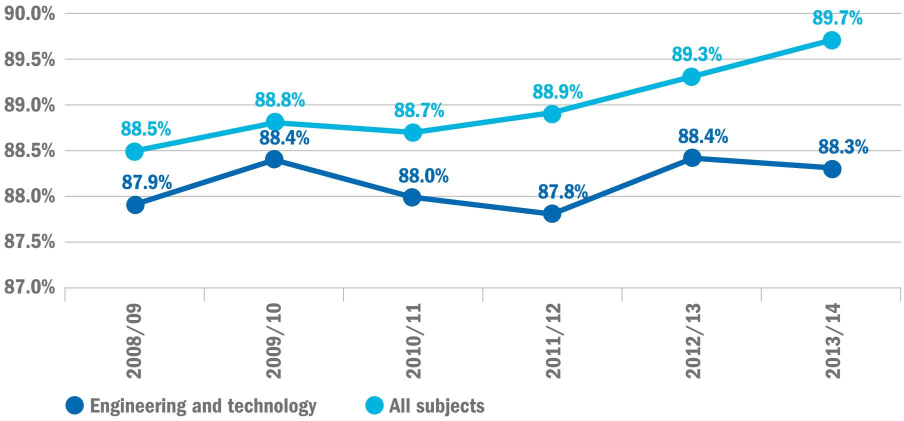
The decline in part-time provision not only poses implications for the skills shortages and the work preparedness of graduates. It also presents issues concerning social mobility and widening

Figure 11.17: Percentage of UK domiciled young entrants to full-time first degree courses from POLAR3 low participation neighbourhoods by subject and entry qualification (2008/09-2013/14)



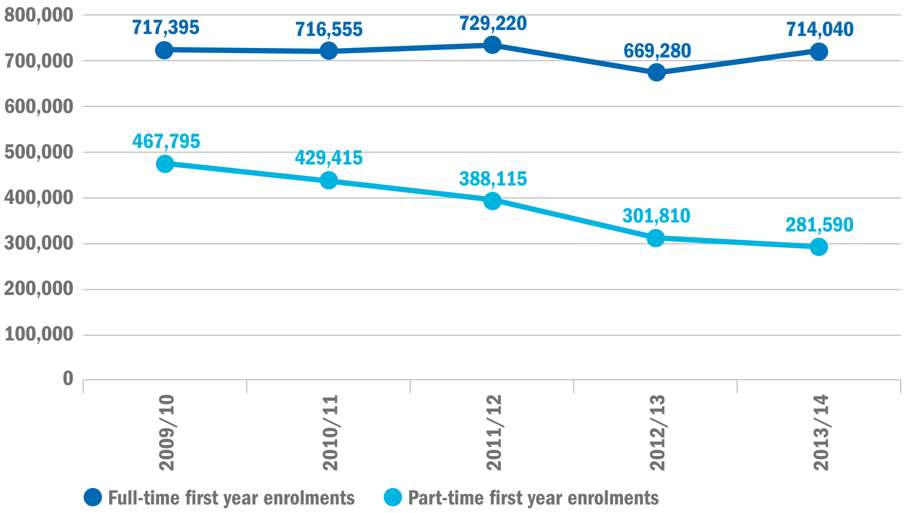
Source: Higher Education Statistics Agency

Figure 11.18: Percentage of UK domiciled young entrants to full-time first degree courses from state schools by subject (2008/09-2013/14)



Source: Higher Education Statistics Agency

Figure 11.19: Numbers of first year enrolments by mode of study (2009/10-2013/14)



Source: Higher Education Statistics Agency

878 HEFCE: Differences in degree outcomes: The effect of subject and student characteristics, 16 September, 2015, p22 879 Department of Business, Innovation and Skills: A dual mandate for adult vocational education, a consultation paper, March 2015

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participation. As the Office of Fair Access to Higher Education notes, part-time students are more likely to come from groups under-represented in higher education. The flexibility that part-time courses offer can provide an important second chance to pursue higher education for those who might not have been able to go straight to university after school.[880] In response to the rapid decline of part-time provision, the government has announced a relaxation and exemption to the Equivalent and Lower Qualifications Policy (ELQ), which will allow more learners studying a part-time first degree in technology, engineering and computer science to access tuition fee loans to retrain from 2015/16.[881]

11.15 International students

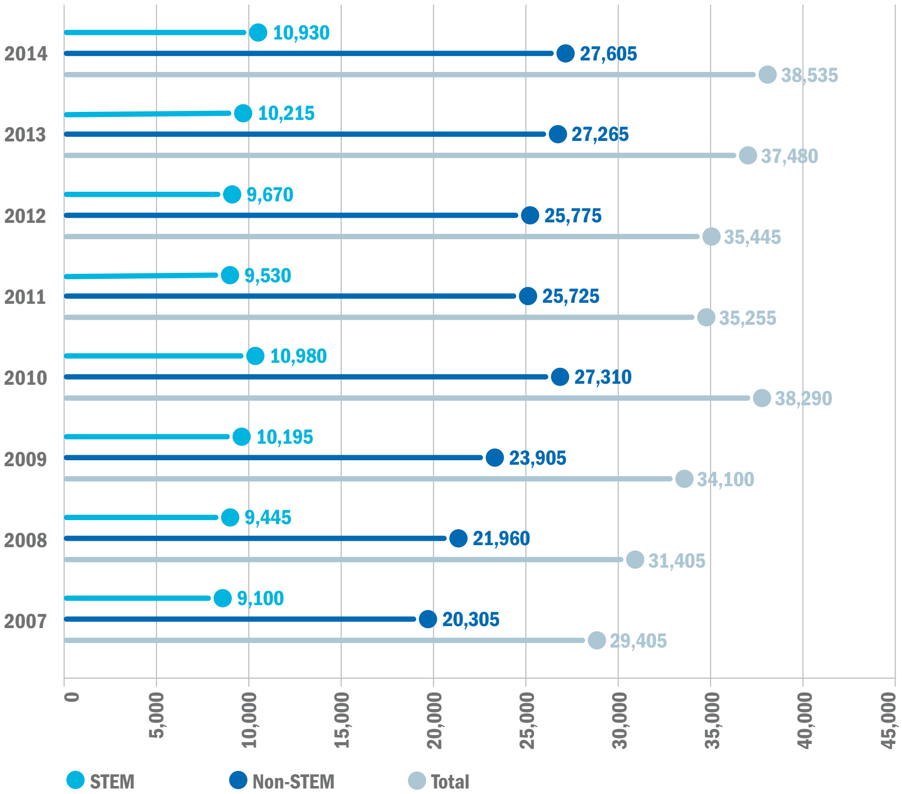
International students are of great importance to the UK higher education sector and to the country more widely.

The higher education sector as a whole now sources around one-eighth of its income from international students' tuition fees. Not only does their presence internationalise the academic environment and campus life, they also contribute more than £7 billion to the UK economy. Stagnating or fluctuating demand from prospective students overseas can therefore leave institutions vulnerable or affect their ability to plan strategically in the long-term.[882]

Students from outside the UK constituted 13% of all applicants to HE in 2014/15. However, 23% of those accepted to engineering courses were from outside of the UK, reflecting the importance that international students have for engineering recruitment.

Therefore, it is concerning to note that the rally of growth in international student numbers witnessed pre-2010 was followed by an abrupt decline following several reforms made to the immigration system (Figure 11.20). The numbers of non-EU students accepted onto STEM HE courses fell from 10,980 in 2010 to only 9,530 in 2011 – a decline of approximately 15%. This is more than double the percentage of decline for non-STEM subjects, which fell by just over 6%. Whilst non-EU students accepted onto non-STEM subjects have recently surpassed their 2010 peak, this is not yet the case for STEM subject accepts, with only 10,930 non-EU students undertaking a STEM degree in 2014.

Figure 11.20: Non-EU international accepts for STEM and non-STEM subjects (2007-2014)



Source: UCAS

880 Les Ebdon, director of the Office of Fair Access to Higher Education quoted in the Guardian newspaper: Number of part-time students plummets after 'perfect storm', 16th of October 2013. 881 Department of Business, Innovation and Skills: A dual mandate for adult vocational education, a consultation paper, March 2015, p34 882 Universities UK: International Students in Higher Education: The UK and its Competition, September 2014, p1

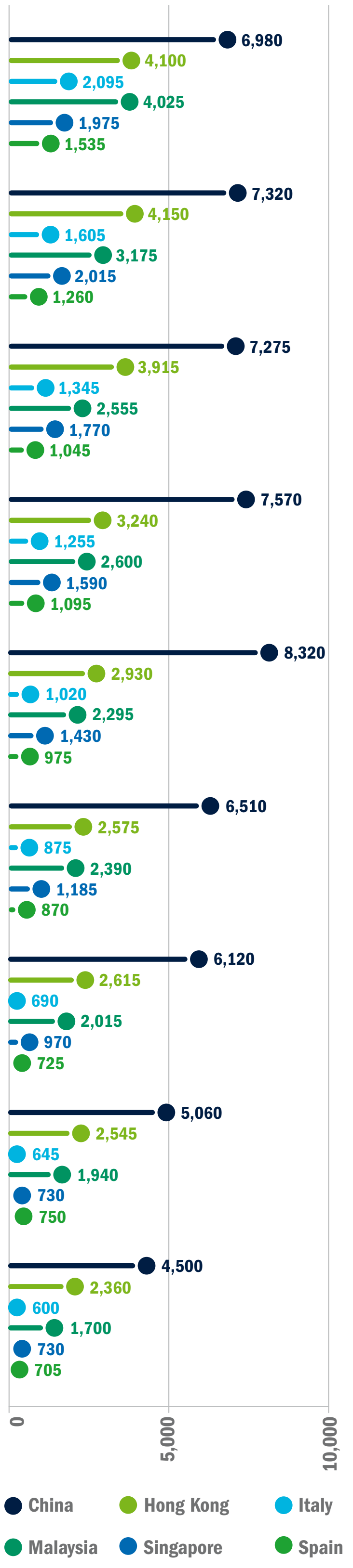
Between 2006 and 2010, the growth in international students was driven by China. However, the profile of international applicants has shifted during the last decade. Figure 11.21 shows that since 2010, accepts from China have stagnated, while countries such as Malaysia, Singapore and Hong Kong in East Asia, and Italy and Spain in the EU have taken up the slack.

Although numbers of international students accepted to UK HEI are increasing, recent government policy may impact this trend. For example, in July 2015, the Home Office announced reforms that will prevent non-EU students from applying for work visas unless they leave the country first. Furthermore, they will no longer allow non-EU students to work for up to 10 hours a week during their studies.[883]

Such reforms may have two impacts. Firstly, they may decrease the attractiveness of the UK to overseas students as a country to pursue higher education, thus reducing international applications and revenue. Secondly, it may result in a loss of talent, as highly skilled graduates trained in the UK will be forced to leave the country and thus may subsequently seek employment elsewhere.

However, public perception of international graduates are largely positive. For example, according to a 2014 survey commissioned by Universities UK, 75% agree that international students should be permitted to stay and work in the UK after UK higher education, whilst only 22% of the public consider international students as migrants.[884]

Figure 11.21: Accepted applicants by named country (2006-2014)



Source: UCAS

11.15.1 Transnational students

Transnational education, whereby a student studies for a degree awarded by a UK higher education institution whilst overseas, is becoming an increasingly important aspect of HE provision and funding. Overseas students may study with a UK HEI via a variety of means such as distance learning programmes, teaching partnerships, off-shore campuses and, recently, Massive Open Online Courses (MOOCs).[885] As Table 11.29 shows, in 2013/14, a total of 636,675 students were studying wholly overseas for a degree awarded by a UK HEI. This is an increase of 6.3% on last year's number 598,925.

BIS estimates the total UK revenue generated by transnational education at £496 million for 2012/13. Furthermore, transnational education represents around 11% of cumulative international fee revenues to UK higher education institutions.[886]

It is worth noting that over a third of all international first degree entrants are recruited from transnational courses delivered overseas by UK HE providers, or partners working on their behalf.[887] Furthermore, students starting their first degree through transnational pathways were found to have much higher progression rates into postgraduate study, with a third who started first degree programmes through transnational programmes continuing their studies at postgraduate level in the UK.

11.16 Staff in higher education

HESA collects data on the allocation of higher education staff to cost centres, which are mapped onto related academic departments by the HEI. Table 11.30 shows that, in line with student numbers, engineering and technology has the lowest proportion of female staff members of any cost centre: 17.3% in 2013/14. This compares with 29.7% for biological, mathematical and physical sciences, and 52.9% for medicine, dentistry and health. Research published by the Institute of Physics suggests that the environment, rather than inherent pupil preferences, influences subject choice. Thus the small percentage of female staff employed in engineering and technology departments may negatively affect female perceptions of the subject and sector in general.[888]

883 The Huffington Post UK: Theresa May Will Ban Foreign Students From Working While Studying, And Force Them To Leave After Graduation, 15th July 2015 884 British Future and Universities UK: International students and the UK immigration debate, August 2014, p6 885 HEFCE: Directions of travel: Transnational pathways into English higher education, November 2014, p10 886 Department and Business, Innovation and Skills: The value of Transnational Education to the UK, November 2014, p4 887 HEFCE: Directions of travel: Transnational pathways into English higher education, November 2014, p10 888 An Institute of Physics Report – Closing Doors: Exploring gender and subject choice in schools – December 2013 p5

Table 11.29: Numbers of students studying wholly overseas for a UK qualification by region and study level (2012/13-2013/14)

	Within the European Union					Outside the European Union					
	Postgraduate	First degree	Other undergraduate	Further education	All students	Postgraduate	First degree	Other undergraduate	Further education	All students	Total of EU and non-EU
2012/13	22,375	51,610	3,255	0	77,240	80,755	429,135	11,350	440	521,685	598,925
2013/14	22,240	49,975	2,960	N/A	75,170	84,905	464,500	12,100	N/A	561,505	636,675
Percentage change	-0.6%	-3.2%	-9.1%		-2.7%	5.1%	8.2%	6.6%		7.6%	6.3%

Source: Higher Education Statistics Agency

Table 11.30: Full-time academic staff (excluding atypical) by cost centre group and gender (2013/14)

Cost centre group		2013/14
Medicine, dentistry & health	Female	17,330
	Male	15,435
	Total	**32,765**
	% female	52.9%
Agriculture, forestry & veterinary science	Female	820
	Male	1,025
	Total	**1,845**
	% female	44.4%
Biological, mathematical & physical sciences	Female	7,180
	Male	16,980
	Total	**24,160**
	% female	29.7%
Engineering & technology	Female	3,060
	Male	14,610
	Total	**17,670**
	% female	17.3%
Architecture & planning	Female	660
	Male	1,580
	Total	**2,240**
	% female	29.5%
Administrative & business studies	Female	3,965
	Male	5,915
	Total	**9,880**
	% female	40.1%
Social studies	Female	6,140
	Male	8,840
	Total	**14,980**
	% female	41.0%
Humanities & language based studies & archaeology	Female	4,635
	Male	5,765
	Total	**10,400**
	% female	44.6%
Design, creative & performing arts	Female	2,225
	Male	3,270
	Total	**5,495**
	% female	40.5%
Education	Female	3,755
	Male	3,160
	Total	**6,915**
	% female	54.3%

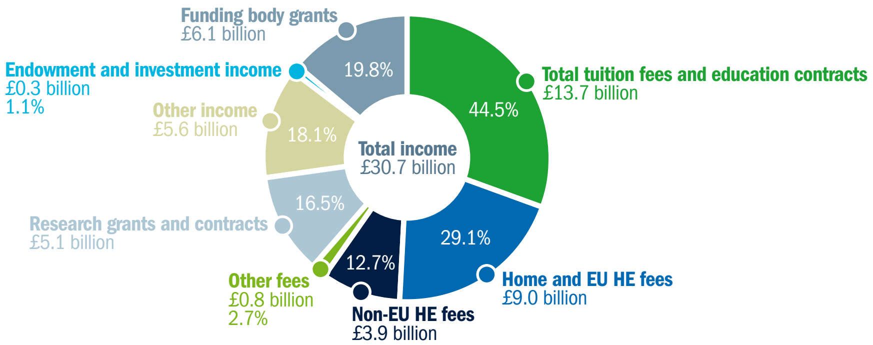
Source: Higher Education Statistics Agency

11.17 Higher education funding

According to data provided from HESA, UK higher education received a total income of £30.7 billion in 2013/14, 44.5% of which came from tuition fees and education contracts.

Students from outside the UK accounted for £3.9 billion of tuition fee income: 12.7% of total income. This attests to the significant contribution that international students make to the higher education sector (Figure 11.22).

Figure 11.22: Income of UK HE providers by source (2013/14)



Source: UCAS

As Table 11.31 shows, £1.4 billion of HE income was allocated to engineering and technology departments, which is only slightly lower than funding for biological, mathematical and physical science (almost £1.8 billion combined).

Dividing expenditure by the total number of students enrolled in a department provides an estimate of expenditure per student. According to this calculation, expenditure per student in engineering and technology was £8,804, which is 77.7% higher than the all subject average of £4,956.

Table 11.31: Expenditure of HE income by activity and academic department (2013/14)

Activity/ department	Expenditure	% of total expenditure
Medicine, dentistry and health	£2,628,643,000	8.9%
Biological, mathematical and physical sciences	£1,750,956,000	6.0%
Engineering and technology	£1,426,117,000	4.8%
Social studies	£1,422,787,000	4.8%
Administrative and business	£1,301,172,000	4.4%
Humanities and language based studies and archaeology	£907,910,000	3.1%
Education	£808,556,000	2.7%
Design, creative and performing arts	£750,811,000	2.6%
Architecture and planning	£224,026,000	0.8%
Agriculture, forestry and veterinary science	£173,608,000	0.6%
Administration and central services	£4,715,839,000	16.0%
Research grants and contracts	£4,209,602,000	14.3%
Premises	£3,398,072,000	11.6%
Academic services	£2,466,607,000	8.4%
Other expenditure	£1,726,417,000	5.9%
Residences and catering operations (including conferences)	£1,495,053,000	5.1%
Total	**£29,406,176,000**	**100%**
Total academic departments	**£11,394,586,000**	

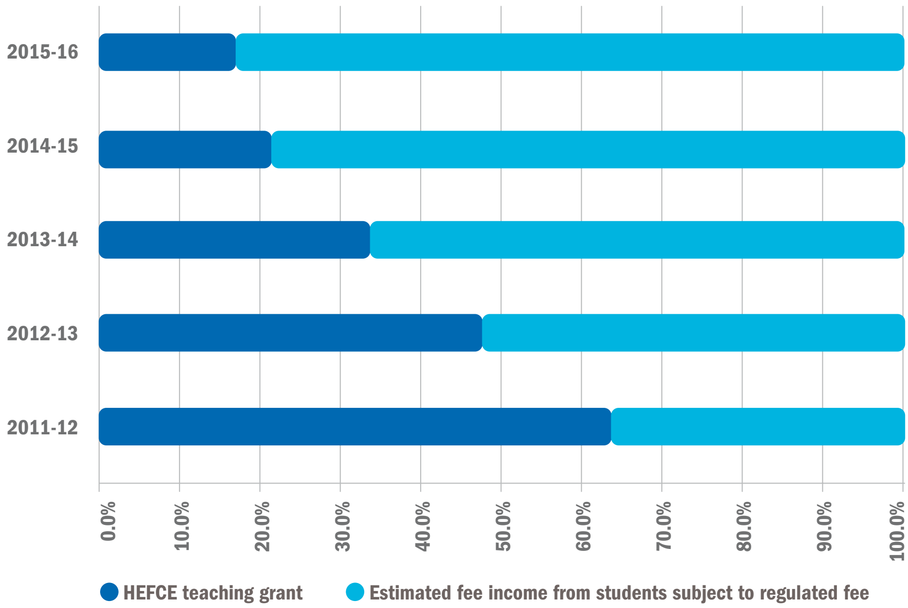
Source: Higher Education Statistics Agency

As a result of reforms in 2012/13, the university sector has experienced significant shifts in the profile of its income streams. A key characteristic of the 2012 reforms to student funding was a significant reduction in the level of teaching funding that universities received from government grants, and an increase in the level of funding from tuition fees, which were raised from £3,375 to £9,000 (in 2012 prices).[889] In response to increasing tuition fees, UK HEIs are obligated to increase expenditure on widening access and financial aid.[890]

Figure 11.23 shows that, since the implementation of the new funding system, the proportion of teaching income the sector receives from grants has decreased from 66% in 2011/12 to an estimated 17% in 2015/16. At an aggregate level, therefore, under the current system, universities are more reliant on income from tuition fees in the funding of undergraduate teaching.

The reforms have resulted in a significant increase in funding for widening participation, with a total of £1.08 billion allocated in 2014/15 from funding council grants and institutional funding. This constitutes an increase of 33% compared with 2011/12.[891]

Figure 11.23: Change in higher education institution balance income from teaching grants and tuition fees (2011/12-2015/16)



Source: Universities UK

889 Universities UK: Student Funding Panel: an analysis of the design, impact and options for reform of the student fees and loans system in England, June 2015, p36 890 *Ibid*, p5 891 *Ibid*, p43

11.17.1 Sustainability of funding

According to the Institute for Fiscal Studies (IFS), students will graduate with an average of £44,035 of student debt, compared to £24,754 of debt if the reforms had not been introduced (Figure 11.24). However, the increased repayment threshold means that all students graduating under the new system pay less per month than those under the old system. Under 2015/16 thresholds, a graduate earning £30,000 a year before tax would pay £94 a month under the old system, compared with £67 a month under the current one.[892]

However, the IFS cautions that 73% of graduates will not repay their debt in full, compared to just 25% under the old system.[893] Furthermore, the IFS state that under the new system the student loan subsidy resource accounting and budgeting charge (RAB) has increased to 45%. This means that, for every £1 lent by the government to students for HE, 45p will not be repaid.[894]

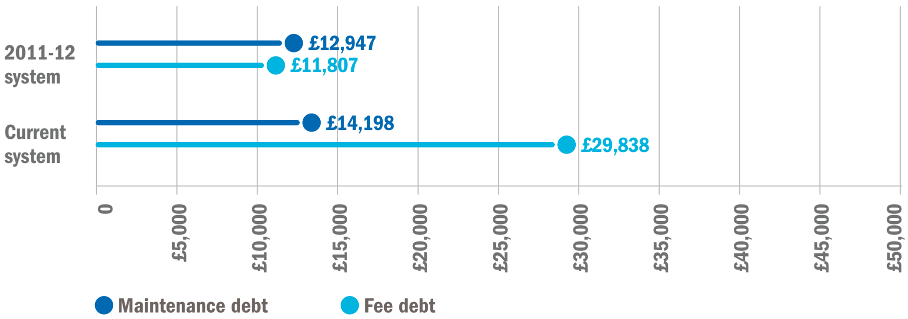
11.17.2 Effect of funding student participation

As previously mentioned, the 2012 reforms to student funding for HE did not appear to exert any considerable negative effect on student participation. This is the case across all socio-economic demographics where, in actuality, the disparity in HE participation between the least and most disadvantaged populations has narrowed slightly.

However, a survey commissioned by the Sutton Trust asked 14- to 18-year-olds whether the increase in university tuition fees in 2012 had influenced their decision to apply to a university in the UK. 22% responded ‘to a great extent’ and 37% responded ‘to some extent’, whilst 29% reported that it had not influenced their decision at all and 11% were unsure.[895] According to research conducted by Universities UK, students are more concerned about the level of maintenance support they receive while studying than they are about the long-term debt arising from the increase in student loans, with 58% expressing concerns about living costs, compared to only 42% who were worried about fee levels.[896]

Although the lower repayment terms in the post-reform system may make higher education more attractive to many pupils, especially those of lower socio-economic status, Universities UK notes that “the long-run level of debt incurred by graduates will inhibit their future economic choices, including the likelihood that graduates will undertake postgraduate study.”[897] The increase in student debt and shift in attitudes to job-related study has implications for student careers advice with around engineering. This is particularly true in light of the employment and earnings premium provided by engineering occupations, which are discussed in the following chapters on graduate destinations and earnings.

Figure 11.24: Average real student debt at graduation under the old and new system (2014 prices)



Note: These figures apply to young full-time English-domiciled students studying at the 90 largest universities in England. It is assumed that all students take out the full fee and maintenance loans to which they are entitled and that there is no ‘dropout’ from university.

Source: Universities UK

892 *Ibid*, p29 893 Higher Education Commission: Too Good to Fail – The Financial Sustainability of Higher Education in England: November 2014, p11 894 Institute for Fiscal Studies: Estimating the public cost of student loans, 24th April 2014, p6. 895 Sutton Trust: NFER Pupil Voice Survey April 2012, August 2012, p7 896 Universities UK: Student Funding Panel: an analysis of the design, impact and options for reform of the student fees and loans system in England, June 2015, p5 897 *Ibid*, p11

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Part 3 - Engineering in Employment
12.0 Graduate destinations

Engineering and technology graduates are very employable: our analysis shows that 65% were in full-time employment within six months of graduating from their course. However, it is not only those with a degree in engineering who contribute to the supply of future engineers. Our analysis shows that over 70% of graduates in architecture, building and planning were working in an engineering-related role in 2013/14, as well as 54.1% of computer science graduates.

As the economy continues to recover, the prospects for newly graduated students are becoming increasingly promising. The number of jobs recorded in the labour market increased by 2.4% in 2014, which marks the fastest growth since 1989.[898] Furthermore, data suggests that the quality – rather than simply the quantity – of jobs is improving. The Office for National Statistics (ONS) notes that the number of full-time jobs is increasing at a faster rate than part-time jobs, and growth in employee jobs is outstripping those in self-employment.[899]

Graduates enjoy higher employment rates and are more likely to work in highly-skilled jobs than their non-graduate counterparts.

In the second quarter of 2015, the Department for Business, Innovation and Skills (BIS) estimated that the employment rate among the working age population of graduates was 87.0%, compared with only 69.1% for non-graduates. Moreover, the unemployment rate for both graduates and non-graduates is now below pre-recession levels.[900]

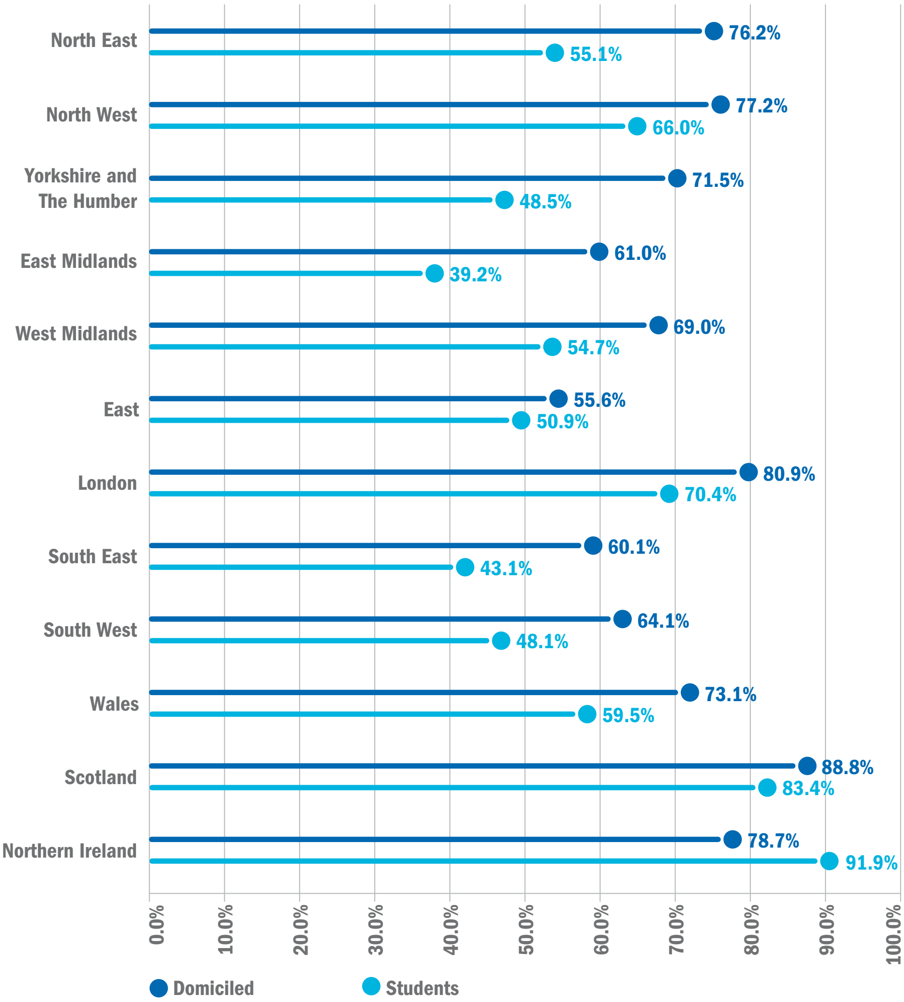
However, the Centre for Economics and Business Research (Cebr) notes that falling unemployment can present a double edged sword for the economy. This is because previously, businesses have been able to rely on a pool of unemployed but skilled individuals from which to recruit new staff. But if unemployment continues to fall, this slack in the labour market will tighten and, as a result, employers may find it more difficult to fill some vacancies.[901] In 2014, over half (52%) of firms reported that they were currently either experiencing a shortfall of staff with STEM skills, or expected to do so over the next three years.[902] As such, in the coming years, it is likely that STEM degrees will continue to attract an even greater employer premium. Indeed, in a 2014 survey, nearly half of employers (48%) reported that they prefer STEM graduates over those with other degrees.

12.1 Destinations of graduates

The Higher Education Statistics Agency (HESA) runs the Destination of Leavers from Higher Education (DLHE) survey, which is administered about six months after graduation. For the bespoke data extract used in this chapter, 443,110 leavers responded to the survey from the target population of 564,205. This gives an overall response rate of 79%.

The proportion of graduates varies across different regions and home nations in the UK. Recent graduates are more likely to stay in some areas to live and find work after graduation than in others. Figure 12.1 presents data published by the Higher Education Careers Service Unit

Figure 12.1: Proportion of first degree graduates from 2012/13 originally domiciled, and proportion of first degree graduates who went to university in each region, working in the region six months after graduation.



Source: HESA/Destinations of Leavers from Higher Education 2012/13

898 ONS: Labour Productivity Q1 2015, 01 July 2015, p3 899 *Ibid.* 900 Department for Business, Innovation & Skills: Graduate labour market statistics: April to June 2015, 8 September 2015, p3 901 Centre for economics and business research: The Benefits of Apprenticeships to Businesses: A Report for the Skills Funding Agency, March 2015, p18. 902 CBI: Gateway to growth cbi/pearson education and skills survey 2014, 2014, p9

(HECSU), which illustrates the different first degree graduate retention rates across regions of the UK.[903] The green bars represent the percentage of graduates who are currently working in a region that they are originally from (returners), whilst the yellow bars represent the percentage of students who went to university in a region and are working there six months after graduation (stayers).

Of the English regions, London has the highest retention rate of graduates who came to study there, with 70.4% staying to work. The East Midlands has the lowest rate of retention, with only 39.2% employed there six months after graduation.

Across the UK as a whole, Northern Ireland has the highest retention rate, with 91.9% of students who went to university there continuing to employment six months after graduating with a first degree.

Table 12.1 displays the employment status of UK-domiciled higher education graduates by the subject that they studied. For all subjects and level of degree, 57.8% of graduates were in full-time employment, with a corresponding unemployment rate of 6.5%. A much higher proportion – 65.0% – of engineering and technology graduates were in full-time employment. However, it is worth noting that graduates with engineering and technology degrees were slightly more likely (7.7%) than the national average to report being unemployed six months after graduating. Disregarding medical degrees, those who studied architecture, building and planning where the most likely of STEM degrees graduates to be in full-time employment six months after completing their degree (71.3%). The lowest employment rate for STEM graduates was for physical sciences, with only 45.4% in employment six months after graduation. However, this could be explained by the relatively large percentage in further study which, at 26.3%, was the largest percentage of all subjects except law.

Table 12.1: Employment status of graduates from UK higher education institutions (2013/14) – UK and EU domiciled

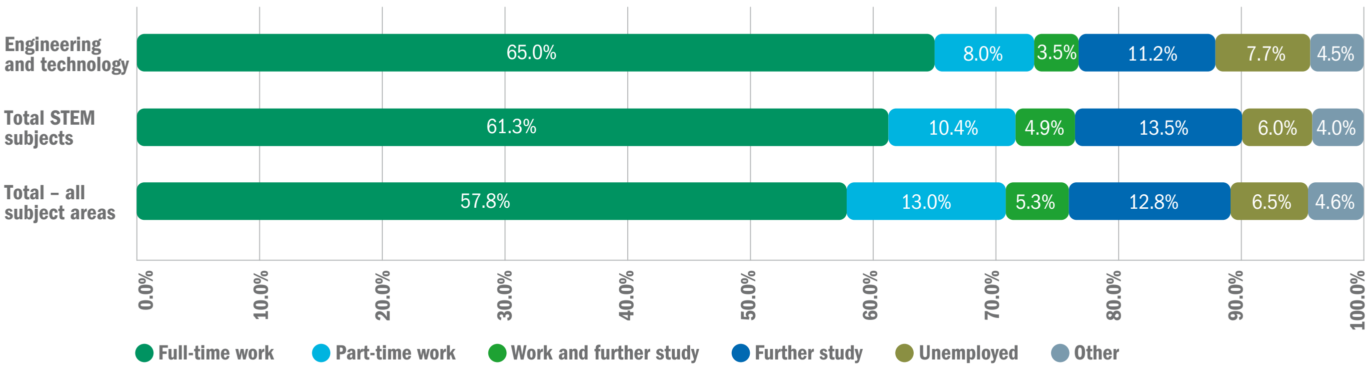
	Full-time work	Part-time work	Work and further study	Further study	Unemployed	Other
Medicine and dentistry	92.5%	0.6%	1.9%	4.5%	0.1%	0.5%
Subjects allied to medicine	74.9%	9.5%	3.5%	6.7%	3.0%	2.4%
Biological sciences	45.9%	16.0%	7.2%	19.2%	6.4%	5.2%
Veterinary science	90.9%	1.7%	0.7%	1.9%	2.8%	1.9%
Agriculture and related subjects	58.3%	12.8%	5.7%	9.6%	6.7%	6.9%
Physical sciences	45.4%	10.1%	5.1%	26.3%	7.6%	5.5%
Mathematical sciences	48.6%	7.6%	8.1%	23.1%	7.9%	4.8%
Computer science	65.5%	10.6%	2.4%	6.9%	11.3%	3.2%
Engineering and technology	65.0%	8.0%	3.5%	11.2%	7.7%	4.5%
Architecture, building and planning	71.3%	6.5%	6.2%	6.3%	5.8%	3.9%
Social studies	54.9%	12.9%	6.1%	13.2%	7.2%	5.7%
Law	42.6%	9.5%	10.7%	27.3%	5.4%	4.5%
Business and administrative studies	64.4%	10.9%	5.8%	5.6%	7.7%	5.5%
Mass communications and documentation	58.1%	20.7%	2.4%	5.1%	9.1%	4.7%
Languages	49.0%	13.4%	6.8%	18.5%	6.7%	5.7%
Historical and philosophical studies	45.3%	13.5%	7.1%	21.2%	6.8%	6.0%
Creative arts and design	52.8%	24.1%	3.8%	7.0%	7.5%	4.8%
Education	66.6%	10.7%	4.0%	12.5%	2.9%	3.3%
Combined	50.9%	12.1%	7.6%	16.9%	6.5%	6.0%
Total	**57.8%**	**13.0%**	**5.3%**	**12.8%**	**6.5%**	**4.6%**

Source: HESA/Destinations of Leavers from Higher Education

Figure 12.2 compares the employment profile of engineering and technology graduates with the STEM all-subject average. Engineering and technology graduates reported higher rates of full-time employment than not only the average for all subjects, but even for all STEM subjects. Furthermore, at 8.8%, the rates of part-time employment are lower for engineering and technology graduates than the average figure across all STEM subjects (10.4%) and for all subjects in general (13.0%).

Research has identified that part-time work is often associated with lower rates of pay and an under-use of an employee's skills, which may

Figure 12.2: Employment status of engineering and technology graduates (2013/14) – UK and EU domiciled



Source: HESA/Destinations of Leavers from Higher Education 2012/13

903 HECSU: Loyals, Stayers, Returners and Incomers: Graduate migration patterns, February 2015.

result in some graduates being trapped in low-skilled sectors. For example, ONS notes that in 2014, more than one in five part-time workers were under-employed, compared with around one in twenty of full time workers.[904]

12.2 Destinations of graduates by degree level

Table 12.2 shows that the full-time employment rate for first degree graduates is higher than for graduates of all levels, at 58.1% (compared with 57.8%). First degree graduates in engineering and technology were 67.1% likely to be in full-time employment. Furthermore, first degree engineering and technology graduates were only 7.5% likely to be in part-time work – slightly lower than the 8.0% likelihood for first degree graduates across for all degrees.

Table 12.2: Destinations of first degree graduates (2013/14) – UK domiciled

	Full-time work	Part-time work	Work and further study	Full-time study	Part-time study	Unemployed	Other
Medicine and dentistry total	92.5%	0.6%	1.9%	4.4%	0.1%	0.1%	0.5%
Subjects allied to medicine	74.4%	10.2%	4.0%	5.8%	0.4%	2.8%	2.4%
Biological sciences	46.1%	16.2%	7.3%	17.5%	1.1%	6.4%	5.4%
Veterinary science	90.4%	1.7%	0.9%	2.6%	0.0%	2.6%	1.7%
Agriculture and related subjects	58.5%	12.8%	5.7%	8.8%	0.7%	6.6%	7.1%
Physical sciences	45.8%	10.2%	5.1%	24.6%	0.9%	7.6%	5.8%
Mathematical sciences	48.7%	7.8%	8.2%	21.8%	1.0%	7.7%	5.0%
Computer science	65.2%	10.7%	2.6%	6.1%	0.6%	11.4%	3.4%
Engineering and technology	67.1%	7.5%	3.8%	9.6%	0.5%	7.3%	4.2%
Architecture, building and planning	73.8%	5.9%	6.3%	5.0%	0.4%	5.2%	3.4%
Social studies	55.4%	13.1%	6.1%	11.7%	0.8%	7.1%	5.8%
Law	43.3%	9.6%	10.8%	24.5%	1.8%	5.4%	4.6%
Business and administrative studies	65.0%	10.7%	5.9%	4.9%	0.6%	7.5%	5.5%
Mass communications and documentation	58.0%	20.7%	2.4%	4.6%	0.5%	9.1%	4.7%
Languages	48.5%	13.6%	7.0%	17.0%	1.1%	6.5%	6.3%
Historical and philosophical studies	44.8%	13.7%	7.1%	18.5%	1.4%	6.6%	7.7%
Creative arts and design	52.6%	24.2%	3.8%	6.2%	0.8%	7.5%	5.0%
Education	66.3%	11.5%	4.5%	10.7%	0.7%	2.8%	3.5%
Combined total	46.4%	14.6%	10.0%	6.9%	1.5%	4.0%	16.3%
Total – all subject areas	58.1%	13.0%	5.5%	11.4%	0.8%	6.3%	4.9%

Source: HESA/Destinations of Leavers from Higher Education

904 ONS: Underemployment and Overemployment in the UK, 25 November 2014

As Table 12.3 illustrates, postgraduates were more likely to report being in employment than undergraduates, with 87.2% of those with an 'other postgraduate' and 89.4% of those with a doctorate reporting being in some form of work six months after graduation. Furthermore, 92.4% of those with a PhD in engineering and technology reported being employed, meaning they were more likely to be in work than those who had a degree in medicine and dentistry.

Those with a PhD in computer science were the most likely to be in employment of any subject at any degree level, with 95.3% reporting that they were in some form of employment within six months of graduating.

This data accords with analysis from BIS, which showed that in the second quarter of 2015, working age postgraduates had an employment rate of 88.3%; the highest second-quarter rate recorded since before the 2008 global financial crisis.[905]

Table 12.3: Proportion of graduates going into employment by subject area and level (2013/14) – UK domiciled[906, 907]

	Other undergraduate	First degree	Foundation degree	Other postgraduate	Doctorate	Total
Medicine and dentistry	56.3%	94.9%	*	82.1%	91.4%	91.2%
Subjects allied to medicine	88.8%	88.6%	82.7%	88.6%	89.7%	88.5%
Biological sciences	60.0%	69.6%	48.9%	78.7%	90.1%	70.7%
Veterinary science	*	93.4%	*	75.4%	91.7%	91.5%
Agriculture and related subjects	58.1%	76.9%	55.1%	83.1%	86.6%	71.5%
Physical sciences	61.9%	61.1%	69.7%	73.3%	90.1%	64.6%
Mathematical sciences	66.4%	64.6%	*	66.0%	87.4%	65.4%
Computer science	57.7%	78.5%	53.7%	79.4%	95.3%	76.1%
Engineering and technology	70.9%	78.4%	77.0%	81.9%	92.4%	78.5%
Architecture, building and planning	72.5%	85.9%	77.2%	91.7%	85.6%	85.7%
Social studies	71.4%	74.7%	70.8%	84.2%	88.2%	76.1%
Law	60.5%	63.7%	54.1%	83.6%	92.8%	68.3%
Business and administrative studies	67.5%	81.5%	64.1%	88.7%	91.4%	81.3%
Mass communications and documentation	60.9%	81.1%	34.8%	88.8%	90.1%	80.7%
Languages	58.2%	69.1%	*	71.9%	82.7%	69.1%
Historical and philosophical studies	58.2%	65.7%	72.4%	70.0%	80.6%	66.5%
Creative arts and design	48.7%	80.5%	40.7%	81.5%	88.4%	78.1%
Education	92.1%	82.3%	72.3%	95.3%	90.7%	89.8%
Combined	52.5%	70.9%	*	100.0%	*	68.3%
Total – all graduates	75.5%	76.6%	65.3%	87.2%	89.4%	78.5%

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

12.3 Occupation of graduates[908]

Engineering UK commissioned a bespoke data analysis of the DLHE data set to ascertain the proportion of respondents who reported working for an engineering company and/or in an engineering-related occupation. Engineering companies and occupations were identified using our engineering SIC and SOC footprint.[909]

This set of analysis included both UK- and EU-domiciled graduates as, due to the Schengen agreement, EU citizens are eligible to freely seek employment in the UK, and thus make a vital contribution to the supply of future engineers to the British economy.

Data displayed in Figure 12.3 supports this statement, as 70.3% of EU engineering and technology graduates were working in an engineering occupation, compared with only 65.5% of those from the UK. Regrettably, female engineering and technology graduates were less likely than their male counterparts to work in an engineering occupation, with just over half reporting doing so, compared with over two thirds of male graduates.

In 2013, the Institute of Engineering and Technology noted that only 7% of the UK's engineering workforce were female.[910] The fact that – despite having a degree in engineering and technology – nearly half of women do not work in an engineering role, represents a significant leak very high up in the pipeline. Furthermore, the Institute for Public Policy Research reported that two-thirds of female engineers do not resume their engineering occupation after taking maternity leave.[911] The issue is not simply a leak in the pipeline, but in the well itself.

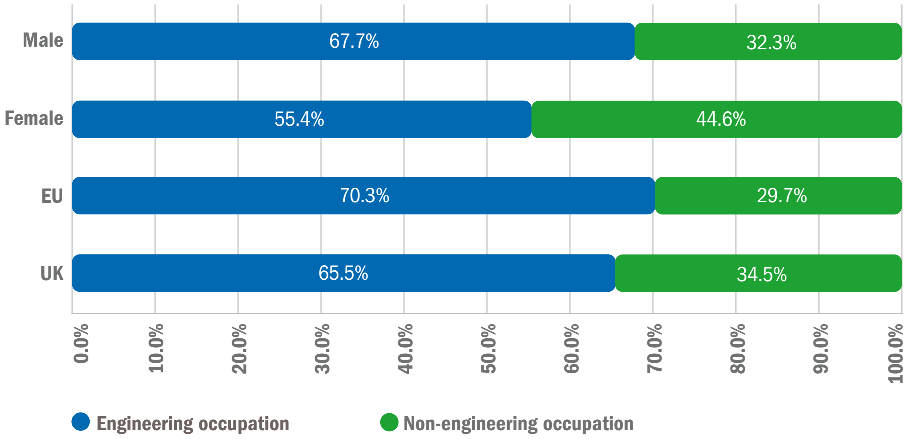
905 Department for Business, Innovation & Skills: Graduate labour market statistics: April to June 2015, 8 September 2015, p1 **906** * = Data suppressed due to HESA data rounding policy **907** Employment rate is calculated as number of graduates reporting as being in work only or work and further study. **908** Proportions of graduates going into an occupation are based on all respondents who gave their occupation, and where the occupation could be coded to SOC2010 at the four digit level **909** A full copy of the footprint is included in the appendix **910** IET: Skills and demand in industry annual survey 2013, p5. **911** Institute for public policy research: Women in engineering fixing the talent pipeline, September 2014, p7

As Table 12.4 shows, in 2013/14, one in nine employed graduates reported working in an engineering occupation soon after graduation. It is worth highlighting the significant contribution to the engineering workforce made by three subject areas, of which the majority of graduates reported working in an engineering related role. These were:

- Architecture, building and planning – 70.2%
- Engineering and technology – 65.3%
- Computer science – 54.1%

Also of note is the finding that although only 2.2% of those with a degree in medicine and dentistry reporting working in an engineer role, a substantial majority (59.5%) of those with an, 'other undergraduate' qualification did. Of all medicine and dentistry graduates who reported working in an engineering related role, 77% were working as medical, dentistry or laboratory technicians.

Figure 12.3: Proportion of engineering and technology graduates going into an engineering occupation or role by gender and domicile (2013/14)



Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Table 12.4: Proportion of graduates in engineering occupations by subject and level (2013/14) – UK and EU domiciled[912]

	Other undergraduate	First degree	Foundation degree	Other postgraduate	Doctorate	Total
Medicine and dentistry	59.5%	0.7%	*	3.6%	2.7%	2.2%
Subjects allied to medicine	1.3%	2.6%	5.9%	2.4%	2.6%	2.4%
Biological sciences	9.1%	6.4%	6.1%	5.9%	2.6%	6.2%
Veterinary science	*	0.0%	*	3.8%	6.1%	0.8%
Agriculture and related subjects	8.8%	14.0%	12.5%	20.7%	16.6%	14.2%
Physical sciences	20.6%	19.3%	7.5%	19.8%	14.9%	18.8%
Mathematical sciences	18.1%	14.1%	*	17.2%	13.6%	14.5%
Computer science	34.1%	55.3%	48.0%	61.3%	40.4%	54.1%
Engineering and technology	72.6%	66.5%	69.1%	60.3%	40.7%	65.3%
Architecture, building and planning	72.2%	71.7%	55.4%	68.5%	26.5%	70.2%
Social studies	1.8%	3.0%	0.8%	2.4%	2.6%	2.7%
Law	13.0%	2.5%	0.0%	7.1%	3.9%	4.4%
Business and administrative studies	9.2%	5.0%	15.1%	11.7%	3.1%	7.0%
Mass communications and documentation	3.7%	3.4%	4.4%	3.7%	4.0%	3.5%
Languages	7.8%	2.7%	0.0%	3.2%	1.5%	2.9%
Historical and philosophical studies	8.2%	3.9%	5.7%	3.9%	1.7%	4.0%
Creative arts and design	6.6%	11.9%	8.4%	9.0%	4.7%	11.4%
Education	1.5%	0.8%	0.3%	0.5%	0.4%	0.7%
Combined	15.6%	12.8%	*	3.7%	*	12.9%
All subjects	11.4%	12.4%	14.1%	8.9%	9.9%	11.5%

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

912 * = Data suppressed due to HESA data rounding policy.

Table 12.5 details the top engineering and non-engineering occupations entered into by engineering and technology graduates. Top engineering destinations included working as civil engineers (15.7%), and mechanical engineers. Of concern is the finding that the top non-engineering occupation for those with a degree in engineering and technology was sales and retail assistants, which suggests that such graduates were severely under-employed.

12.3.1 Occupation of graduates by ethnicity

Figure 12.4 shows that white engineering and technology graduates were the most likely of any ethnicity to working in an engineering occupation, with 67.7% reporting doing so. Chinese graduates were the second most likely. Those who identified as black or black British reported among the lowest rates of working in an engineering role, with just over half (54.0%) doing so.

12.3.2 Occupation of graduates by engineering sub-discipline

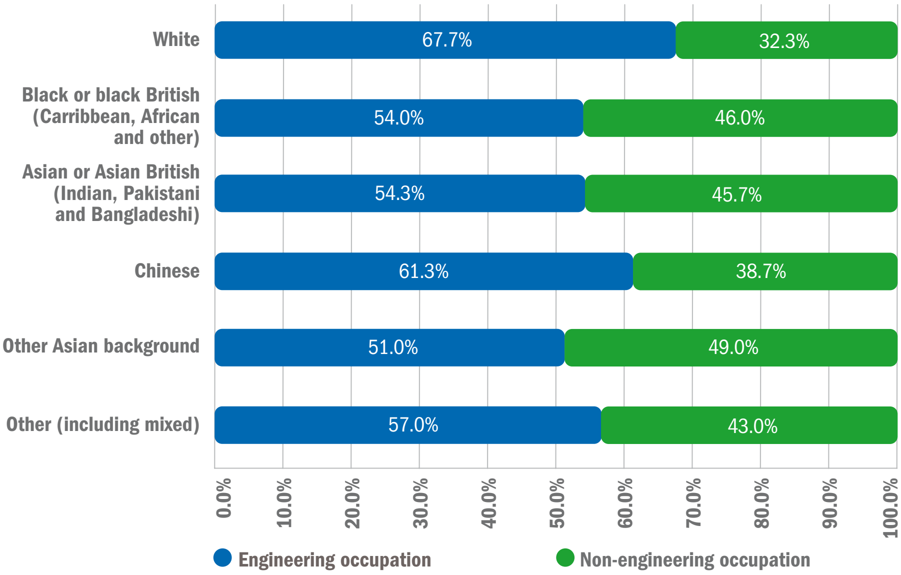
Table 12.6 shows the proportion of graduates going into an engineering occupation by the engineering sub-discipline of their degree. Overall, at 64.4%, electronic and electrical engineering graduates were the least likely to go into an engineering-related occupation. This was also the case for female graduates, only 54.1% of whom reported working in an engineering-related occupation. Graduates with a degree in mechanical engineering were the most likely to report working in an engineering occupation, at 74.8%. This was equally the case for both female and male graduates.

Table 12.5: Top ten engineering and non-engineering occupations for engineering and technology graduates (2013/14) – UK and EU domiciled

	Engineering occupations		Non-engineering occupations	
1	Civil engineers	15.7%	Sales and retail assistants	8.7%
2	Mechanical engineers	15.3%	University researchers, unspecified discipline	4.6%
3	Engineering professionals n.e.c.	14.7%	Photographers, audio-visual and broadcasting equipment operators	3.9%
4	Design and development engineers	11.7%	Business and related associate professionals n.e.c.	3.7%
5	Production and process engineers	5.7%	Business and financial project management professionals	3.0%
6	Electrical engineers	4.7%	Officers in armed forces	3.0%
7	Engineering technicians	4.0%	Management consultants and business analysts	2.9%
8	Programmers and software development professionals	3.8%	Bar staff	2.6%
9	Electronics engineers	2.2%	Ship and hovercraft officers	2.3%
10	IT business analysts, architects and systems designers	1.4%	Environment professionals	2.1%

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Figure 12.4: Proportion of employed engineering graduates going to work in an engineering occupation by ethnicity (2013/14) – UK and EU domiciled



Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Table 12.6: Proportion of employed engineering graduates, by sub-discipline and gender, going into an engineering occupation (2013/14) – UK and EU domiciled

General engineering	Male	66.3%
	Female	55.9%
	All	64.5%
Civil engineering	Male	74.5%
	Female	75.1%
	All	74.6%
Mechanical engineering	Male	74.8%
	Female	74.8%
	All	74.8%
Aerospace engineering	Male	66.7%
	Female	64.7%
	All	66.5%
Electronic and electrical engineering	Male	65.4%
	Female	54.1%
	All	64.4%
Production and manufacturing engineering	Male	68.3%
	Female	61.5%
	All	67.2%
Chemical, process and energy engineering	Male	74.3%
	Female	68.1%
	All	72.7%

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

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12.4 Types of industry[913]

Standard Industrial Classification (SIC) codes allow us to identify the primary occupation of an employer, and thus the industry that graduates have entered. It is worth nothing that the actual role of an employee within a company can be different from the primary activity of the employer.

Table 12.7 shows the proportion of graduates in employment who reported working for an engineering company.

Overall, 16% of graduates from all subjects reported working for an engineering employer. Two thirds of graduates with degrees in architecture building and planning, and engineering and technology, reported being employed in the engineering sector, followed by 45% of computer science graduates and over a third of physical sciences graduates (34.1%).

It is worth noting that over a fifth of mass communication and documentation graduates reported working in the engineering sector, which highlights the important of non-STEM graduates in supporting the engineering sector as a whole.

Table 12.7: Proportion of graduates going into employment who work for an engineering company, by subject area and level (2013/14) – UK and EU domiciled[914]

Subject area	Other undergraduate	Foundation degree	First degree	Other postgraduate	Doctorate	Postgraduate PGCE	Undergraduate PGCE	Total
Medicine and dentistry	2.4%	*	0.3%	2.8%	7.0%	*	*	1.3%
Subjects allied to medicine	1.6%	3.0%	2.2%	3.1%	9.9%	*	*	2.4%
Biological sciences	9.6%	4.0%	8.9%	9.8%	9.2%	*	*	9.0%
Veterinary science	*	*	0.5%	6.6%	14.3%	*	*	2.0%
Agriculture and related subjects	11.0%	16.0%	16.8%	28.3%	27.7%	*	*	17.8%
Physical sciences	21.2%	12.3%	32.7%	48.3%	33.1%	*	*	34.1%
Mathematical sciences	16.6%	*	18.7%	23.5%	20.6%	*	*	19.2%
Computer science	30.3%	40.6%	46.1%	50.5%	36.6%	*	*	45.4%
Engineering and technology	65.6%	63.4%	66.9%	72.2%	45.1%	*	*	66.5%
Architecture, building and planning	67.2%	59.2%	66.3%	67.0%	26.1%	*	*	66.2%
Social studies	4.8%	1.4%	8.5%	9.8%	3.8%	*	*	8.2%
Law	11.7%	4.3%	7.8%	8.8%	0.9%	*	*	8.2%
Business and administrative studies	17.3%	19.6%	17.2%	25.4%	6.6%	*	*	19.3%
Mass communications and documentation	14.0%	14.9%	21.3%	28.0%	8.6%	*	*	22.3%
Languages	11.4%	*	12.6%	11.4%	6.5%	*	*	12.3%
Historical and philosophical studies	9.5%	6.3%	11.7%	11.1%	6.8%	*	*	11.3%
Creative arts and design	9.1%	10.3%	15.1%	15.5%	6.7%	*	*	14.9%
Education	2.9%	0.2%	1.0%	1.4%	1.0%	0.0%	0.0%	0.9%
Combined	15.7%	*	16.1%	3.6%	*	*	*	15.8%
All subjects	13.4%	16.9%	14.2%	19.1%	16.7%	1.2%	0.4%	16.0%

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

913 Only those graduates whose industry type could be identified at the 4 digit SIC code level in SIC2007 have been included in this analysis. 914 * = Data suppressed due to HESA rounding policy

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Table 12.8 shows the proportion of graduates who work for an engineering company, either as an engineer, or in another occupation, by degree subject. Of the mass communications and documentation graduates working with an engineering employer, 93.3% were not working in an engineering role. However, such graduates can be vital in furthering the aims of the engineering sector, by helping to communicate its needs, and also by communicating the opportunities that an engineering career offers to young people. In fact, a large proportion of graduates from several other non-STEM subjects support the engineering sector without actually working in an engineer role. These include law (81.0%), business and administrative studies (79.8%), languages (80.8%) and social studies (83.5%).

Table 12.8: Proportion of graduates who work for an engineering company, by subject area and whether they work as an engineer (2013/14) – UK and EU domiciled

	Engineering occupation	Non-engineering occupation
Medicine and dentistry	20.6%	79.4%
Subjects allied to medicine	37.3%	62.7%
Biological sciences	29.0%	71.0%
Veterinary science	*	*
Agriculture and related subjects	47.5%	52.5%
Physical sciences	39.1%	60.9%
Mathematical sciences	48.7%	51.3%
Computer science	78.1%	21.9%
Engineering and technology	85.4%	14.6%
Architecture, building and planning	89.1%	10.9%
Social studies	16.5%	83.5%
Law	19.0%	81.0%
Business and administrative studies	20.2%	79.8%
Mass communications and documentation	6.7%	93.3%
Languages	11.7%	88.3%
Historical and philosophical studies	19.2%	80.8%
Creative arts and design	28.8%	71.2%
Education	26.2%	73.8%
Combined	45.2%	54.8%
All subjects	50.5%	49.5%

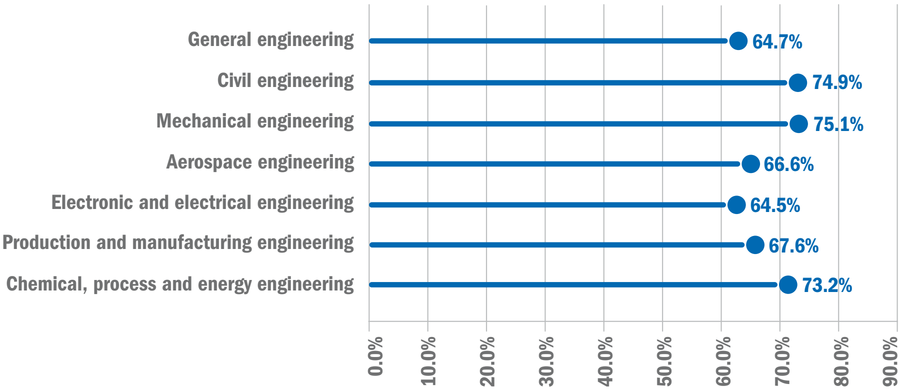
Source: HESA/Destinations of Leavers from higher education bespoke data request
* = Data suppressed due to HESA rounding policy

12.4.1 Industry type by selected sub-discipline

Figure 12.5 looks at the likelihood of graduates from specific engineering sub-disciplines working for an engineering employer. Mechanical engineering graduates were most likely to follow this path, with 75% working for an engineering employer. Electronic and electrical engineering graduates were the least likely to work in the engineering sector after graduation, with just under two thirds making this choice.

Table 12.9 shows the top ten employer destinations for graduates with a degree in engineering and technology. Overall, the manufacturing sector attracted the largest proportion of engineering and technology graduates, at 27.6%. Of the specific engineering sub-disciplines, nearly half (49.1%) of production and manufacturing engineering graduates reported working in the manufacturing sector, whereas nearly two fifths (37.7%) of civil engineering graduates were working in the construction industry.

Figure 12.5: Proportion of graduates going into employment who work for an engineering company, by engineering sub-discipline (2013/14) – UK and EU domiciled



Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Table 12.9: Top ten employer destinations for engineering and technology graduates (2013/14) – UK and EU domiciled

	General engineering	Civil engineering	Mechanical engineering	Aerospace engineering	Electronic and electrical engineering	Production and manufacturing engineering	Chemical, process and energy engineering	Total
Manufacturing	28.1%	3.7%	42.2%	38.2%	25.1%	49.1%	26.0%	27.6%
Professional, scientific and technical activities	18.5%	27.9%	15.4%	10.0%	12.0%	14.5%	17.9%	17.5%
Construction	6.9%	37.7%	4.7%	1.5%	4.0%	3.9%	3.8%	11.5%
Wholesale and retail trade; repair of motor vehicles and motorcycles	3.5%	3.8%	7.4%	7.9%	6.7%	7.5%	4.8%	5.8%
Mining and quarrying	4.7%	3.5%	7.2%	1.2%	3.2%	1.1%	18.6%	5.3%
Education	7.4%	3.4%	3.9%	4.6%	7.1%	4.7%	5.7%	5.2%
Information and communication	5.5%	1.3%	2.5%	3.5%	12.5%	3.5%	2.0%	4.8%
Public administration and defence; compulsory social security	4.9%	5.5%	2.2%	13.8%	5.1%	1.3%	1.2%	4.7%
Transportation and storage	6.0%	3.1%	1.7%	8.9%	3.0%	1.8%	0.8%	3.4%
Electricity, gas, steam and air conditioning supply	2.4%	1.2%	2.4%	0.7%	6.0%	0.8%	3.9%	2.7%

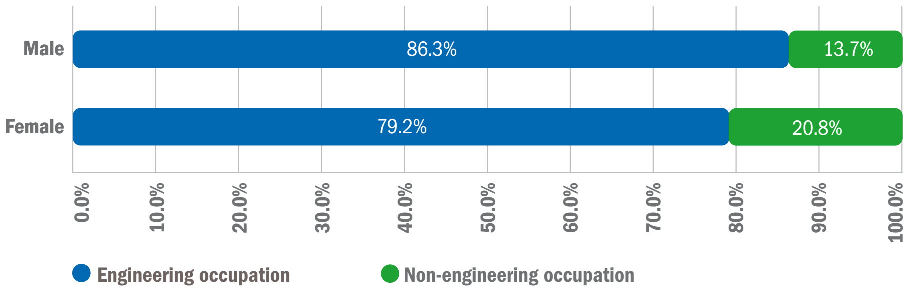
Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Figure 12.6 shows the proportion of engineering and technology graduates who reporting working in an engineering company by their type of role. It is interesting to note that female engineering and technology graduates working in an engineering company were less likely to be working in an engineering-related role than their male counterparts. Over a fifth of females (20.85%) with a degree in engineering and technology reported working in a non-engineering role, despite working for an engineering employer, compared with only 13.7% of males.

12.4.2 Industry type by ethnicity

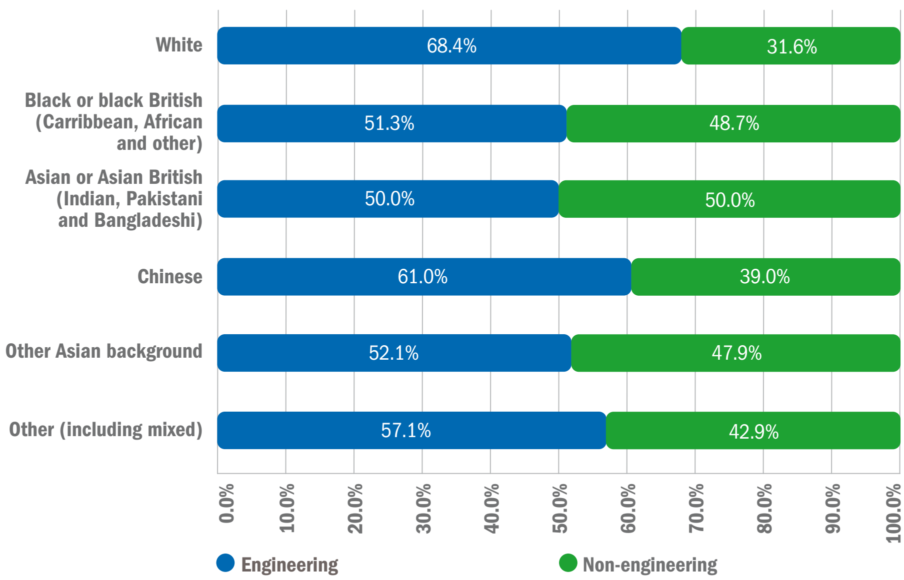
Figure 12.7 shows that just over two thirds of white engineering graduates reported working for an engineering company. This proportion is much larger than for graduates of other ethnicities. For example, only just half of engineering and technology graduates identifying as black or black British were working in the engineering sector after graduation, and for Asian or Asian British graduates this proportion falls to 50%.

Figure 12.6: Proportion of engineering and technology graduates who worked for an engineering company in an engineering role (2013/14) – UK and EU domiciled



Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Figure 12.7: Proportion of employed engineering and technology graduates, all qualifications, going to work for an engineering company, by ethnicity (2013/14) – UK and EU domiciled

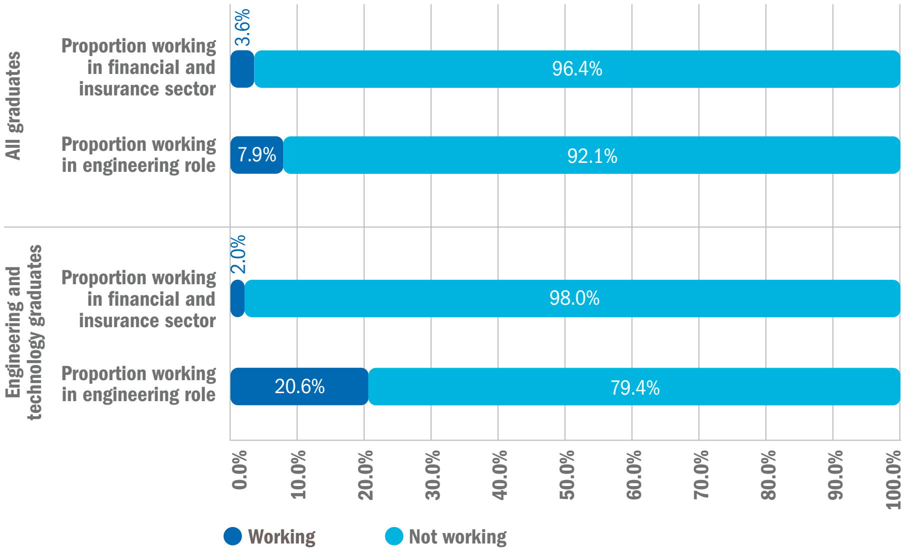


Source: HESA/Destinations of Leavers from Higher Education bespoke data request

12.4.3 Engineering and technology graduates going into finance

Because engineering graduates are highly numeral and analytical, it is widely believed that a large proportion find employment in the financial sector, and that this in turn leads to a depletion in the supply of potential engineers. However, our analysis of the HESA Destinations of Leavers from Higher Education challenges this conventional wisdom. As Figure 12.8 shows, only 2.0% of engineering and technology graduates were working in the financial and insurance sector. This compares with 3.6% of graduates from all subjects. Furthermore, one fifth of engineering and technology graduates who were working in the financial and insurance sector were employed in an engineering-related role. This data definitively lays to rest the myth that the financial sector contributes to a brain drain of talented engineering graduates from the engineering sector.

Figure 12.8: Graduates who went to work in the financial and insurance sector, by whether or not they worked in an engineering occupation and whether they graduated with an engineering and technology degree (2013/14) – UK and EU domiciled



Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Part 3 – Engineering in Employment
13.0 Graduate recruitment and starting salaries

Within six months of graduating, those with a degree in engineering and technology can expect to earn the second-highest starting salary of all graduates and almost equal to the UK average salary of £27,271. At a time when student debt is increasing, the earnings premium associated with a degree in engineering and technology is difficult to overstate. However, females still earn less than their male counterparts (£25,959 vs £27,260). If the sector is serious in addressing the dismal number of female engineers, establishing a gender parity must be a top priority.

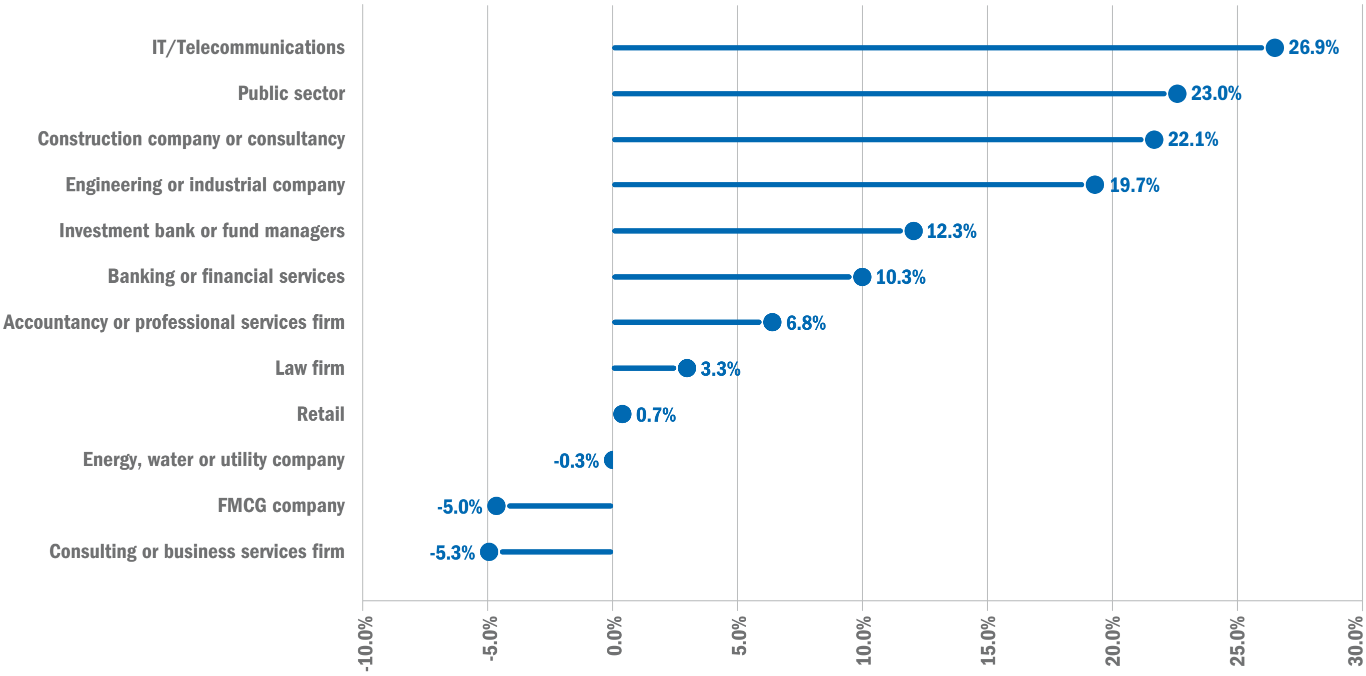
At a time when the average student graduates from higher education with around £44,000 of debt,[915] the recruitment and earnings prospect of degrees are becoming an ever greater factor in students' decision to pursue certain subjects. For example, in a 2015 interview, the director of the Higher Education Policy Institute noted that, as the cost of university education increases, students are tending to choose subjects "more obviously linked to jobs".[916]

A survey conducted by the Association of Graduate Recruiters found that, on average, employers are predicting an increase of 11.9% in graduate vacancies from 2013/14 to 2014/15. However, the increase in vacancies expected was not equal across all industries (Figure 13.1).

Employers from several engineering-related sectors reported a greater expected increase in vacancies than average. This included the IT/telecommunications sector (26.9%), construction companies or consultancies (22.1%) and the engineering sector (19.7%).[917]

915 The Sutton Trust: Earning by Degrees – Differences in the career outcomes of UK graduates, 2014, p4 **916** BBC news: Four in 10 students say university not good value – survey, 22 June 2015 – available at: http://www.bbc.co.uk/news/education-33204691 **917** Association of Graduate Recruiters: The AGR Graduate Recruitment Survey 2015 Winter Review, 2015, p14

Figure 13.1: Predicted percentage change in vacancies by sector (2013/14-2014/15)



Source: Association of Graduate Recruiters

Worth highlighting is the significant increase in graduates who turned down job offers in 2015. According to the same AGR survey, engineering and industrial companies reported an average offer acceptance rate of only 6.9%, which was higher than anticipated. The report noted that the decrease in offers accepted seemed to be due to greater discretion on the part of graduates, who were more likely to hold several offers and decide later in the cycle.

Before considering graduate starting salaries in greater detail, it is worth exploring the social benefits that a university degree can offer. Research commissioned by the Sutton Trust showed that university degrees hold the capacity to reduce inequity in society. The research found that, when factors such as university type is controlled for, graduates from disadvantaged social backgrounds tended to do equally as well after graduation as their more socially advantaged counterparts.[918] This poses implications for wider society because, as previously noted, low social mobility has the potential to curb economic growth and constrain productivity.[919]

13.1 Graduate starting salaries[920, 921, 922]

Table 13.1 displays the average salaries reported by graduates six months after graduation. The data is sourced from the Higher Statistics Agency Destinations of Leavers from Higher Education survey, which looks at graduates six months after their graduation. In previous years, we reported the starting salaries of graduates from the UK only. However, this year we have expanded our analysis to show comparisons between UK-domiciled graduates and those from the EU who graduated from a UK higher education institute.

The average starting salary reported by UK-domiciled graduates of all subjects was £22,205. It is interesting to note that graduates who were originally from the EU enjoyed a higher starting salary: at £24,166, an 8.8% difference. The increased earnings reported by EU-domiciled graduates were found across the majority of subjects, with the largest earnings premium being for agriculture and related subjects, at 23.0%.

UK-domiciled engineering and technology graduates enjoyed the second highest average starting salaries of all subjects, with a mean value of £27,079. It is worth noting that this is almost equal to the average annual salary in the UK across all ages and all occupations – £27,271. Only graduates of medicine and dentistry reported a higher starting salary (£32,040 on average). EU-domiciled engineering and technology graduates benefited from a slightly higher starting salary of £27,742 – 2.4% higher than their UK counterparts.

Of all STEM subjects, graduates with a biological sciences degree reported the lowest starting salaries, at only £18,287 for UK-domiciled graduates and £21,824 for EU-domiciled graduates. In both cases, these salaries were below the all-subject averages.

The higher starting salaries reported by EU-domiciled graduates may be due to the fact that such students are more likely to be studying at postgraduate level. As Figure 13.2 shows, over half of EU-domiciled graduates who responded to the DLHE survey had a postgraduate degree, in comparison with only one fifth of UK-domiciled respondents.

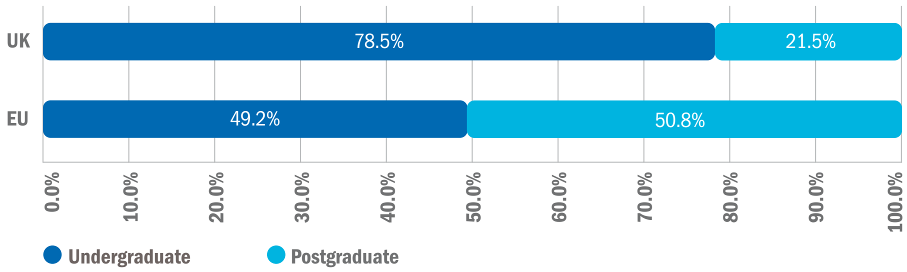
918 The Sutton Trust: Earning by Degrees - Differences in the career outcomes of UK graduates, 2014, p46 919 OECD: Intergenerational Social Mobility: a family affair?, 2010: Available at: http://www.oecd.org/economy/obstaclestosocialmobilityweakenequalopportunitiesandeconomicgrowth saysoecdstudy.htm 920 Starting salary is defined as reported salary six months after graduation. However, it is acknowledged that in some instances, graduates may have received a pay rise during this period. 921 Not all graduates who completed the destinations of leavers form higher education provided salary information. 922 HESA DLHE data is provided in salary brackets: £0-£5,000 then rising by £1,000 increments until £69,000 and then all salaries that are £70,000 or over.

Table 13.1: Average starting salary for graduates by subject area and domicile (2013/14)

	Mean			Median		
Subject area	**UK domiciled**	**EU domiciled**	**Percentage difference**	**UK domiciled**	**EU domiciled**	**Percentage difference**
Medicine and dentistry	£32,040	£28,755	-10.3%	£30,000	£28,000	-6.7%
Subjects allied to medicine	£23,718	£24,095	1.6%	£21,000	£22,000	4.8%
Biological sciences	£18,287	£21,824	19.3%	£16,000	£19,000	18.8%
Veterinary science	£26,504	£28,053	5.8%	£26,000	£25,000	-3.8%
Agriculture and related subjects	£18,468	£22,708	23.0%	£17,000	£21,000	23.5%
Physical sciences	£21,556	£25,596	18.7%	£20,000	£25,000	25.0%
Mathematical sciences	£23,306	£27,779	19.2%	£22,000	£25,000	13.6%
Computer science	£22,991	£26,747	16.3%	£21,000	£24,000	14.3%
Engineering and technology	£27,079	£27,742	2.4%	£25,000	£26,000	4.0%
Architecture, building and planning	£24,655	£22,092	-10.4%	£23,000	£21,000	-8.7%
Social studies	£22,232	£23,198	4.3%	£20,000	£21,000	5.0%
Law	£21,266	£25,093	18.0%	£17,000	£19,000	11.8%
Business and administrative studies	£24,997	£27,185	8.8%	£20,000	£23,000	15.0%
Mass communications and documentation	£17,103	£18,160	6.2%	£16,000	£17,000	6.3%
Languages	£17,662	£17,257	-2.3%	£16,000	£16,000	0.0%
Historical and philosophical studies	£18,585	£21,085	13.5%	£17,000	£19,000	11.8%
Creative arts and design	£15,249	£16,463	8.0%	£14,000	£14,000	0.0%
Education	£23,202	£22,894	-1.3%	£22,000	£22,000	0.0%
Combined	£22,492	£14,167	-37.0%	£20,000	£12,000	-40.0%
Total	£22,205	£24,166	8.8%	£21,000	£22,000	4.8%

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Figure 13.2: Proportion of graduates surveyed by level of degree and domicile (2013/14)



Source: HESA/Destinations of Leavers from Higher Education bespoke data request

However, on closer analysis, a more complicated pattern can be discerned. As Table 13.2 shows, across all subjects, graduates originally from the EU with an 'other postgraduate' degree actually earn 14.6% less than their UK-domiciled counterparts. Furthermore, EU-domiciled graduates with a doctorate earn on average 2.7% less than an equivalent qualified graduate from the UK. However, EU-domiciled graduates with a foundation degree can expect to earn 25.7% more than their UK counterparts (£25,083 vs £19,949).

Looking at engineering and technology graduates specifically, EU-domiciled graduates with an 'other postgraduate' degree earn nearly 20% less than those from UK. However, for all other degree levels, those originally from the EU reported higher starting salaries.

Table 13.2: Mean starting salary of graduates by level of degree and domicile (2013/14)

		UK	EU	Percentage difference
All subjects	Foundation degree	£19,949	£25,083	25.7%
	Other undergraduate	£23,237	£22,988	-1.1%
	First degree	£19,661	£19,838	0.9%
	Other postgraduate	£30,464	£26,020	-14.6%
	Doctorate	£33,399	£32,512	-2.7%
Engineering and technology	Foundation degree	£29,112	£30,500	4.8%
	Other undergraduate	£27,569	£28,556	3.6%
	First degree	£25,151	£25,435	1.1%
	Other postgraduate	£34,789	£27,859	-19.9%
	Doctorate	£33,712	£34,770	3.1%

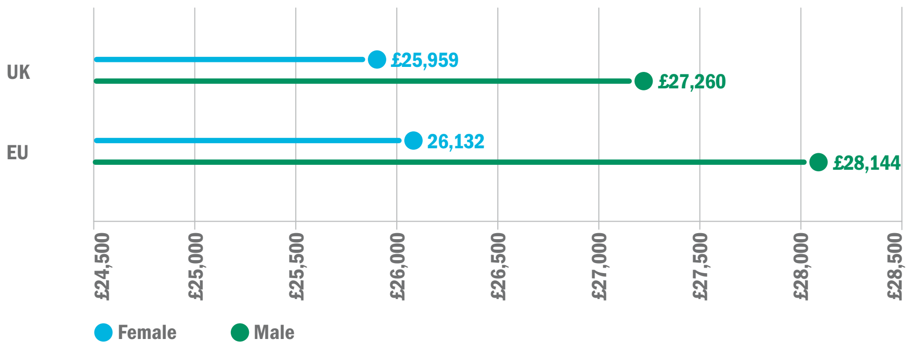
Source: HESA/Destinations of Leavers from Higher Education bespoke data request

13.1.1 Graduate starting salaries by gender

Considering the difference in starting salary by gender, it is regrettable to note that female graduates with an engineering and technology degree can expect to earn substantially less than their male counterparts (£25,959 vs £27,260) (Figure 13.3). This is the case for both UK- and EU-domiciled graduates, with a larger pro-male bias seen for those originally from the EU.

Table 13.3 displays the difference in starting salary reported by male and female graduates for selected engineering sub-disciplines and engineering in total (minus technology subjects). For several sub-disciplines, female graduates actually reported higher starting salaries than males. For example, for chemical, process and energy engineering, female graduates reported an average starting salary of £28,929: £237 higher than the £28,692 reported by males. Though small, this is equivalent to a £4.55 weekly earnings premium. General engineering was the sub-discipline with the largest discrepancy between male and female starting salaries, with female graduates reporting an average annual salary of £27,664: only 88.0% of that reported by males (£31,442).

Figure 13.3: Mean salary for engineering and technology graduates by domicile and gender (2013/14)



Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Table 13.3: Average starting salary for graduates in engineering, by selected sub-discipline, gender and domicile (2013/14)

		Mean	Median
General engineering	UK	£30,811	£28,000
	Female	£27,664	£27,000
	Male	£31,442	£28,000
	EU	£29,361	£28,000
	% Female of male	88.0%	96.4%
Civil engineering	UK	£25,739	£24,000
	Female	£25,510	£24,000
	Male	£25,783	£24,000
	EU	£25,846	£24,000
	% Female of male	98.9%	100.0%
Mechanical engineering	UK	£26,690	£25,000
	Female	£26,776	£26,000
	Male	£26,683	£25,000
	EU	£27,513	£27,000
	% Female of male	100.3%	104.0%
Aerospace engineering	UK	£26,069	£25,000
	Female	£24,570	£25,000
	Male	£26,208	£25,000
	EU	£31,609	£28,000
	% Female of male	93.8%	100.0%
Electronic and electrical engineering	UK	£26,644	£25,000
	Female	£23,845	£23,500
	Male	£26,885	£25,000
	EU	£29,064	£27,000
	% Female of male	88.7%	94.0%
Production and manufacturing engineering	UK	£28,883	£25,000
	Female	£26,991	£25,000
	Male	£29,164	£26,000
	EU	£24,720	£25,000
	% Female of male	92.5%	96.2%
Chemical, process and energy engineering	UK	£28,749	£28,000
	Female	£28,929	£29,000
	Male	£28,692	£27,000
	EU	£28,807	£27,000
	% Female of male	100.8%	107.4%
All engineering graduates	UK	£27,428	£25,000
	Female	£26,537	£25,000
	Male	£27,553	£25,000
	EU	£27,923	£26,000
	% Female of male	96.3%	100.0%

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

13.1.2 Graduate starting salaries by ethnicity

Examining graduate starting salaries by ethnicity (Table 13.4) shows that white engineering and technology graduates enjoyed the highest starting salary, at £27,611. The lowest-earning ethnic group six months after graduation was those who identify as being from an 'other Asian background': this group reported an average starting salary of £23,287.

Table 13.4: Average starting salary for graduates in engineering and technology, by ethnicity (2013/14) – UK and EU domiciled

	Mean salary	Median salary
White	£27,611	£25,000
Black or black British (Caribbean, African and other)	£24,494	£23,000
Asian or Asian British (Indian, Pakistani and Bangladeshi)	£23,818	£23,000
Chinese	£25,338	£25,000
Other Asian background	£23,287	£23,000
Other (including mixed)	£25,301	£24,000

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

13.1.3 Graduate starting salaries by university mission group

Somewhat surprisingly, those who held an engineering and technology degree from a Russell group university reported an average annual salary that was lower than those from non-Russell group institutions (£26,952 vs £27,225). However, this is may be due to the fact that a higher proportion of those from Russell group universities reported being solely in further study. When just those graduates who reported being solely in work were considered, Russell group graduates were found to earn very slightly more than their non-Russell group counterparts (£27,356 vs £27,266). However, this difference was so small as to be negligible.

Table 13.5: Average starting salary for graduates in engineering and technology, by university mission group (2013/14) – UK and EU domiciled

		Mean salary	Median salary
All	Russell Group	£26,952	£26,000
	Non- Russell Group	£27,225	£25,000
Work only	Russell Group	£27,356	£26,000
	Non- Russell Group	£27,266	£25,000

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

13.1.4 Graduate starting salaries by level of qualification obtained

As Table 13.6 illustrates, in general higher level study is rewarded with a higher starting salary, with those who have a doctorate in engineering and technology earning £8,773 a year more than those with only a first degree (£33,938 vs £25,165). However, the extra cost of further study, in addition to the time spent not being in employment, must be considered.

Table 13.6: Average starting salary for graduates in engineering and technology, by qualification obtained (2013/14) – UK and EU domiciled

	Mean	Median
Doctorate	£33,938	£31,000
Other postgraduate	£32,609	£29,000
First degree	£25,165	£24,000
Foundation degree	£29,123	£29,000
Other undergraduate	£27,579	£25,000

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

13.1.5 Graduate starting salaries by industry and occupation

Table 13.7 shows that the mean starting salary for an engineering and technology graduate employed in an engineering occupation was £28,800: interestingly, those working in an engineering role earn more than the average salary of those with an engineering and technology degree who do not take up work as an engineer. A similar magnitude of difference was observed between those working for an engineering company and those not working for an engineering company.

Table 13.7: Average starting salary for graduates in engineering, by whether they work as an engineer or for an engineering company or not (2013/14) – UK and EU domiciled

	Mean	Median
Engineering role	£28,800	£26,000
Non-engineering role	£23,279	£21,000
Engineering company	£28,688	£26,000
Non-engineering company	£23,567	£21,000

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Working in an engineering role – regardless of subject studied – can also lead to increased earnings. For example, Table 13.8 shows that those with a degree in business and administrative studies employed in an engineering role reported a starting salary of £33,401. This is significantly more than the average starting salary of £24,997 (UK domiciled) and £27,185 (EU domiciled) for graduates of these subjects in all roles.

Table 13.8: Starting salary for graduates employed in an engineering role by subject studied (2013/14) – UK and EU domiciled

Subject area	Mean salary
Combined	£33,947
Business and administrative studies	£33,401
Law	£33,066
Medicine and dentistry	£28,948
Engineering and technology	£28,688
Mathematical sciences	£27,769
Computer science	£25,653
Education	£25,496
Architecture, building and planning	£24,723
Historical and philosophical studies	£24,407
Social studies	£24,217
Physical sciences	£24,188
Languages	£23,550
Agriculture and related subjects	£22,783
Subjects allied to medicine	£22,644
Mass communications and documentation	£21,262
Veterinary science	£20,833
Biological sciences	£20,423
Creative arts and design	£18,379

Source: HESA/Destinations of Leavers from Higher Education bespoke data request

Part 3 - Engineering in Employment
14.0 Earnings in STEM Careers

This chapter shows that, from a set of selected STEM professions, aircraft pilots and flight engineers had the highest mean salary in 2013/14, at £90,146. This is substantially more than medical practitioners, who earned £69,463. Within STEM technician and craft careers, the highest salary was for financial and accounting technicians (£44,080), whilst pipe fitters took home the second highest annual salary (£37,982). Males in STEM careers still earn more than their female counterparts. However, the gender pay gap is highest for those aged 40 or above.

If Britain were to match US levels of productivity, every household in the country would be the equivalent of £21,000 better off per year. This statement, expressed by the director of the Enterprise & Growth Unit at the Treasury, highlights the synergy between productivity and earnings.[923] Indeed, every OECD country that has higher productivity levels than Britain also has higher average wages.[924]

Statistically, graduates are far more productive than the general population. The National Institute for Social and Economic research estimates that approximately one third of the increase in UK labour productivity between 1994 and 2005 is a result of an increase of graduate skills in the labour force.[925]

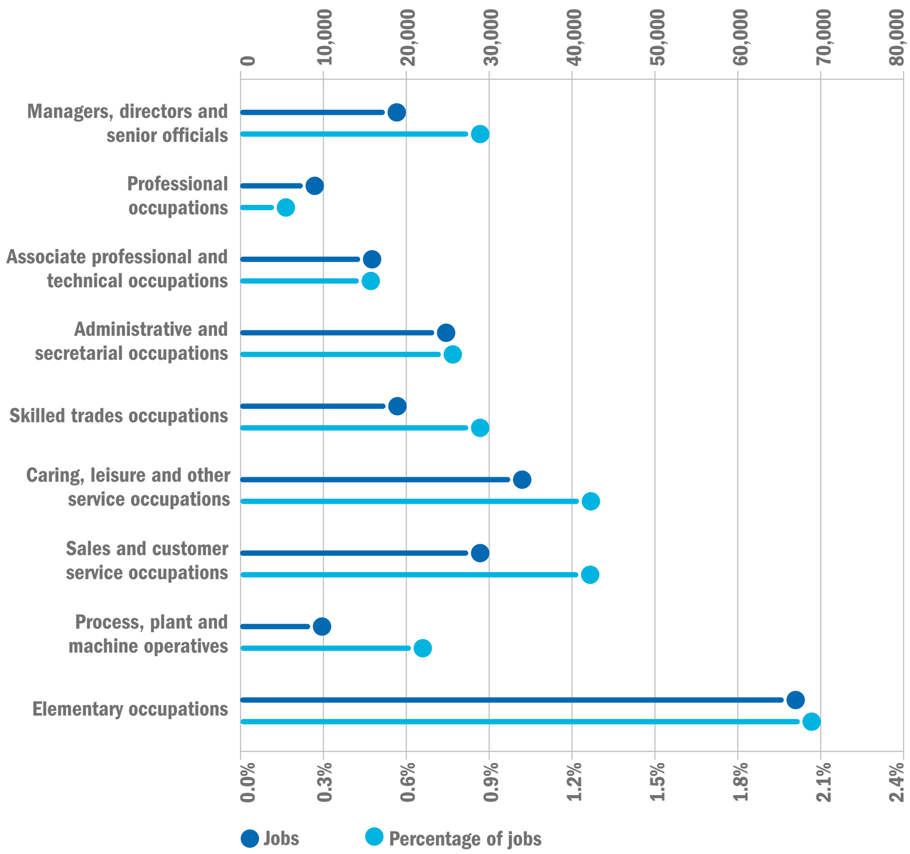
Graduate earnings are frequently used as an indicator for productivity, as employers are willing to pay more to employ more productive workers. Indeed, women with a first degree can expect a lifetime earnings premium of £250,000, whilst the corresponding premium for male first degree graduates is £165,000.

Furthermore, the accumulation of higher skills is crucial in avoiding the problem of low pay. As Figure 4.1 shows, the percentage of those earning less than the minimum wage fall considerably as the skill level of a profession increases. In April 2014, 2.1% of those employed in elementary occupations earned a salary less than the minimum wage, compared with less than 0.3% of those working in professional occupations, which are the most likely to require a university degree.

Thus, it is important to note that graduates with an engineering and technology degree were the fifth most likely of all subjects to be working in a professional or managerial occupation[926] (Figure 14.2). In total, 66.8% of engineering and technology graduates were working in a professional or managerial occupation, compared with an all-subject average of 50.0%.

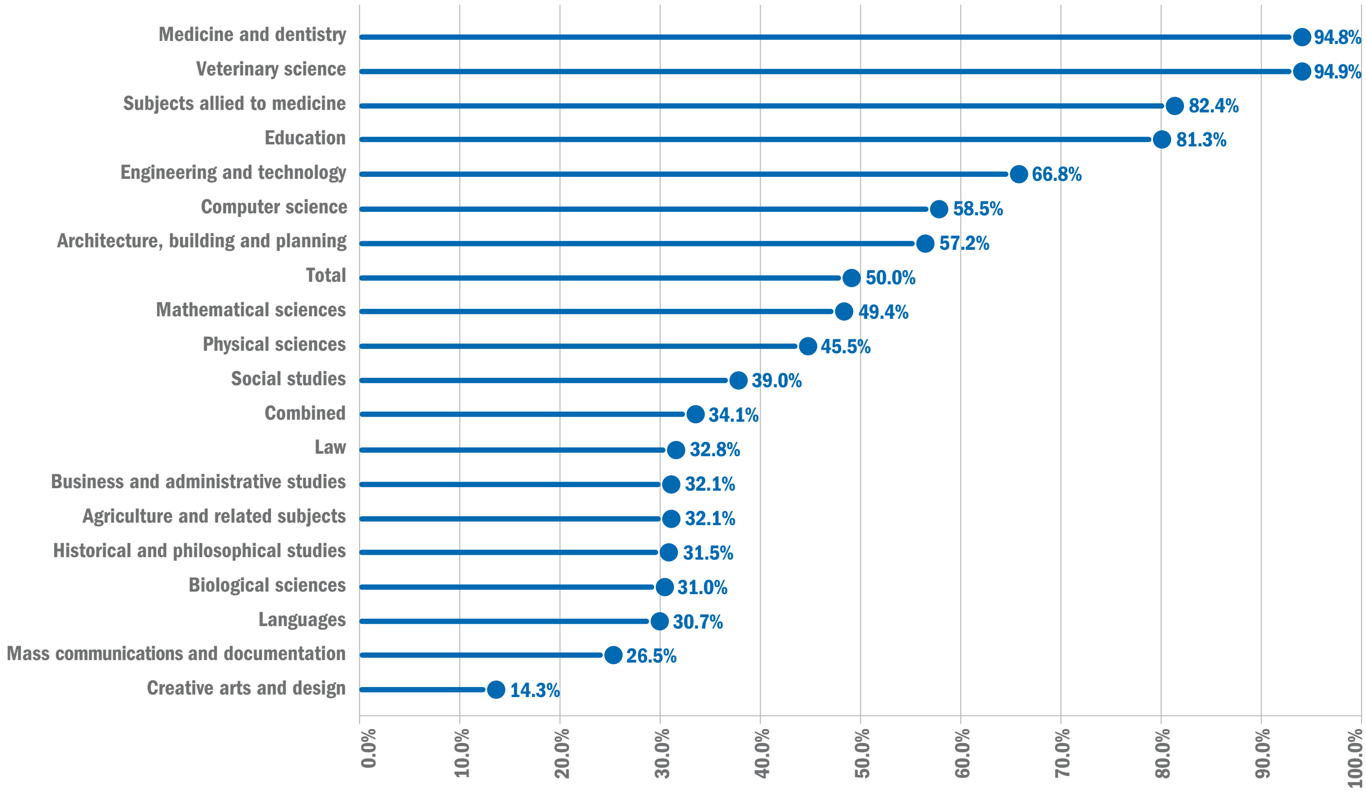
923 Cabinet Office: Civil Service Quarterly – The Productivity Plan: a route map to a more prosperous nation, 10th September 2015 **924** *Ibid.* **925** Department for Business, Innovation and Skills: Graduates and economic growth across countries, 15th August, 2013 **926** As defined by SOC 2010 two digit codes 11 to 24.

Figure 14.1: Number and percentage of jobs paid below the national minimum wage by major occupation group (2014) – UK



Source: Office for National Statistics: Annual Survey of Hours and Earnings

Figure 14.2: Percentage of graduates employed in a professional or managerial occupation (2013/14) – UK and EU



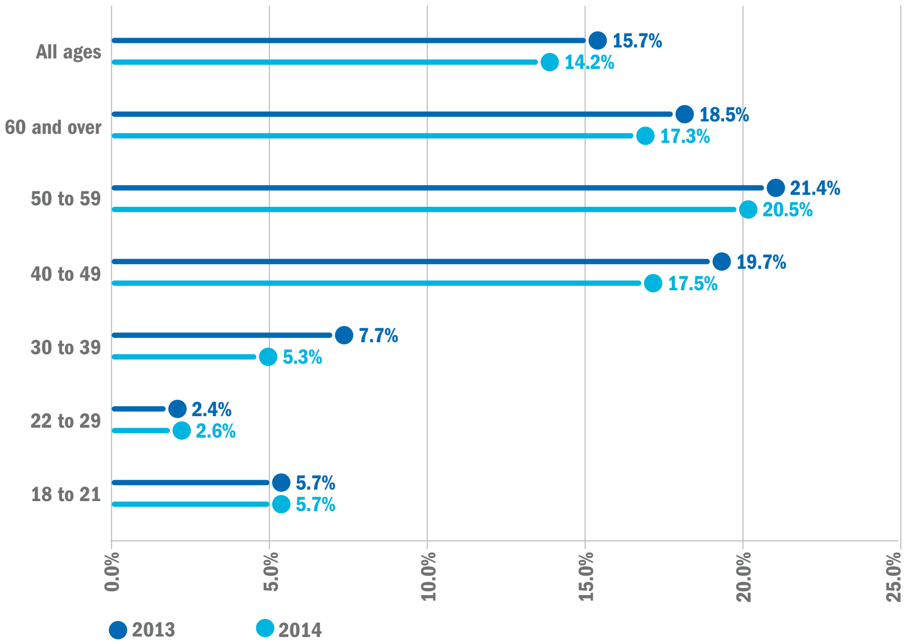
Source: Higher Education Statistics Agency

14.1 Earnings by gender

Figure 14.3 shows the gender pay gap for mean full-time hourly earnings by age. A positive value indicates a higher male wage. Between 2013 and 2014, the gender pay gap across all ages has decreased from 15.7% to 14.2%. It is worth noting that the pay gap is significantly smaller for young adults than for those in more senior age brackets. For example, for those aged 22-29, the pay gap between men and women was only 2.6% in 2014. This is lower than the gap for 50- to 59-year-olds, where males can expect to earn a fifth more per hour than females of a similar age. Interestingly, there is a larger pay gap (5.7%) for 18- to 21-year-olds than there is for 22- to 29-year-olds. This may be because the younger demographic are not likely to hold university degrees, which attests to the capacity of a degree to reduce gender inequality.

Furthermore, the Department for Culture, Media and Sport highlights that the gender pay gap is consistently lower for those employed in professional and associate professional occupations: careers associated with having a university degree.[927]

Figure 14.3: Gender pay gap for mean full-time gross hourly earnings (excluding overtime) by age group (April 2014) – UK



Source: Office for National Statistics – Annual Survey of Hours and Earnings

14.2 Annual mean and median gross pay for selected STEM professions

Since the recession of 2008 and 2009, a puzzling characteristic of the UK labour market has been the healthy rise in employment, coupled by stubbornly weak growth in earnings. For example, the Institute for Fiscal Studies reports that whilst the employment rate for 16- to 64-year-olds has already rebounded to its pre-crisis level, average earnings remain stagnated well below their pre-crisis level.[928] However, data from the Office for National Statistics Annual Survey of Hours and Earnings shows that those going into STEM professions have generally enjoyed increases in earnings between April 2013 and April 2014.

Table 14.1 displays the average gross annual pay for selected STEM professions compared with all occupations, and shows that the average annual pay for all occupations was £27,271. Whilst annual pay across all occupations only grew by 0.6%, growth was much greater for several engineering-related occupations. For example, on average, electrical engineers earned £46,984 – up 5.7% from the previous year – whilst production managers and directors in construction received an average earnings increase of 5.0% to £49,668.

However, despite these increases, some engineering occupations did experience a decline in earnings. For example, mechanical engineers saw average annual pay drop by 3% to £43,029, whilst production managers and directors in manufacturing saw their annual salary fall by 3.5% to £49,690.

927 Department for Culture, Media and Sport: Secondary Analysis of the Gender Pay Gap: changes in the gender pay gap over time, March 2014, p22 **928** Institute for Fiscal Studies: Earnings since the recession, 30th January 2015 – available online at: http://www.ifs.org.uk/publications/7543

Table 14.1: Annual mean and median gross pay for selected STEM professions by gender (2014) – UK[929, 930, 931]

Occupation	Gender	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Aircraft pilots and flight engineers	All	8,000	£90,146	12.5%	£90,534	15.1%
	Male	8,000	£91,598	14.3%	£91,692	16.6%
	Female	*	£0	0.0%	*	0.0%
Medical practitioners	All	171,000	£69,463	-1.7%	£61,516	-3.4%
	Male	94,000	£81,953	-0.8%	£78,025	-2.3%
	Female	77,000	£54,082	0.6%	£44,955	2.9%
Information technology and telecommunications directors	All	23,000	£80,215	23.7%	£61,423	10.8%
	Male	20,000	*	0.0%	£60,215	8.6%
	Female	*	£64,626	2.5%	£63,328	0.0%
Research and development managers	All	39,000	£52,882	6.7%	£43,648	0.6%
	Male	*	£59,489	9.5%	*	0.0%
	Female	13,000	£39,284	0.6%	£35,274	1.3%
Health services and public health managers and directors	All	40,000	£47,894	-2.8%	£42,633	-2.0%
	Male	16,000	£50,899	-6.7%	£46,929	-0.2%
	Female	24,000	£45,919	0.5%	£40,345	1.1%
IT specialist managers	All	142,000	£49,194	2.0%	£43,762	1.0%
	Male	115,000	£51,427	3.1%	£45,775	1.8%
	Female	26,000	£39,433	-2.9%	£34,347	-4.7%
Electrical engineers	All	21,000	£46,984	5.7%	£43,061	1.1%
	Male	20,000	£47,163	5.6%	£43,382	1.6%
	Female	*	£44,200	6.7%	£42,599	2.0%
Production managers and directors in manufacturing	All	416,000	£49,690	-3.5%	£40,477	-0.2%
	Male	338,000	£52,104	-3.9%	£42,169	-0.9%
	Female	78,000	£39,291	0.8%	£32,906	1.8%
Mechanical engineers	All	32,000	£43,029	-3.0%	£40,158	-0.8%
	Male	28,000	£44,432	-1.3%	£40,824	-0.6%
	Female	*	*	0.0%	*	0.0%
IT business analysts, architects and systems designers	All	93,000	£46,197	3.9%	£41,407	2.0%
	Male	80,000	£46,383	1.7%	£42,053	1.6%
	Female	13,000	£45,028	19.6%	£35,935	4.6%
Production managers and directors in construction	All	79,000	£49,668	5.0%	£38,364	-2.3%
	Male	73,000	£49,962	4.7%	£38,742	-2.6%
	Female	*	*	0.0%	*	0.0%
Engineering professionals n.e.c.	All	126,000	£41,453	0.0%	£38,580	-0.9%
	Male	109,000	£42,433	-0.3%	£38,968	-2.2%
	Female	17,000	£35,029	2.3%	£33,271	6.8%
Programmers and software development professionals	All	158,000	£40,748	1.1%	£39,298	1.8%
	Male	137,000	£41,504	1.9%	£40,145	2.8%
	Female	20,000	£35,607	-4.3%	£33,973	0.2%
Design and development engineers	All	66,000	£40,245	0.7%	£37,949	0.2%
	Male	59,000	£41,201	1.9%	£38,419	1.1%
	Female	7,000	£32,365	-5.6%	£29,415	-17.3%
Waste disposal and environmental services managers	All	7,000	£40,857	-3.7%	£34,367	-7.6%
	Male	*	£43,601	2.4%	£37,669	0.0%
	Female	*	£31,799	-23.6%	£32,581	0.0%
Information technology and telecommunications professionals n.e.c.	All	75,000	£40,957	1.6%	£38,891	4.9%
	Male	65,000	£41,852	0.9%	£39,830	3.4%
	Female	10,000	£35,123	0.0%	£33,532	0.0%
Quality assurance and regulatory professionals	All	62,000	£45,458	6.0%	£37,779	2.7%
	Male	39,000	£49,905	6.1%	£38,820	-3.0%
	Female	24,000	£38,213	4.1%	£35,054	7.1%
Production and process engineers	All	38,000	£38,223	-0.8%	£36,713	0.5%
	Male	33,000	£39,213	0.2%	£37,164	0.5%
	Female	*	£31,339	0.0%	£31,767	0.0%

929 Employees on adult rates who have been in the same job for more than a year. 930 Figures for number of jobs are for indicative purposes only and should not be considered an accurate estimate of employee job counts. 931 * = data omitted due to disclosive or unreliable nature

Table 14.1: Annual mean and median gross pay for selected STEM professions by gender (2014) – UK – continued

Occupation	Gender	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Civil engineers	All	41,000	£40,200	4.3%	£37,961	5.1%
	Male	38,000	£40,845	4.3%	£38,906	7.0%
	Female	*	£32,527	2.6%	£30,472	-6.7%
Managers and directors in transport and distribution	All	58,000	£41,998	2.8%	£36,776	4.0%
	Male	51,000	£42,149	3.2%	£37,075	4.3%
	Female	*	*	0.0%	*	0.0%
Pharmacists	All	35,000	£37,439	0.5%	£37,679	4.7%
	Male	12,000	£44,366	0.0%	£44,554	0.0%
	Female	22,000	£33,564	-3.1%	£34,039	2.5%
Construction project managers and related professionals	All	15,000	£40,519	-3.4%	£34,118	-3.2%
	Male	13,000	£42,042	-3.6%	£34,799	-3.6%
	Female	*	£26,712	-9.5%	£23,216	0.0%
Architects	All	29,000	£43,307	-1.9%	£36,158	2.6%
	Male	23,000	£46,448	-1.1%	*	0.0%
	Female	6,000	£31,703	0.2%	£31,432	10.8%
Chartered and certified accountants	All	76,000	£38,692	3.2%	£34,934	0.9%
	Male	40,000	£44,690	10.1%	£40,427	5.1%
	Female	37,000	£32,210	-4.8%	£30,122	-2.5%
Natural and social science professionals n.e.c.	All	42,000	£36,594	0.3%	£34,837	1.9%
	Male	24,000	£38,411	0.7%	£36,367	2.5%
	Female	18,000	£34,185	-0.1%	£31,500	-0.8%
Biological scientists and biochemists	All	55,000	£38,108	1.0%	£34,530	0.9%
	Male	27,000	£42,069	4.3%	£38,102	3.6%
	Female	28,000	£34,225	-2.7%	£32,039	0.9%
Quality control and planning engineers	All	30,000	£36,454	5.1%	£35,322	4.2%
	Male	26,000	£37,055	6.3%	£35,577	4.9%
	Female	*	£33,353	-0.7%	£31,974	-0.5%
Business, research and administrative professionals n.e.c.	All	61,000	£35,545	-1.2%	£33,036	0.7%
	Male	34,000	£38,390	-0.1%	£34,986	2.7%
	Female	27,000	£31,865	-1.9%	£31,261	0.9%
Chartered surveyors	All	50,000	£36,470	2.7%	£33,799	2.9%
	Male	43,000	£37,569	1.7%	£34,534	2.3%
	Female	7,000	£29,398	13.9%	£28,293	13.1%
Chemical scientists	All	12,000	£34,099	-4.0%	£31,001	-4.5%
	Male	8,000	£37,385	-3.6%	£32,884	-4.9%
	Female	*	£26,568	-6.9%	*	0.0%
Ophthalmic opticians	All	6,000	£30,834	-0.4%	£31,478	-2.5%
	Male	*	*	0.0%	*	0.0%
	Female	*	£28,926	-12.3%	*	0.0%
Environment professionals	All	32,000	£32,036	-3.6%	£29,028	-6.6%
	Male	23,000	£33,528	-3.6%	£30,093	-6.9%
	Female	9,000	£28,217	-2.5%	£27,779	0.1%
Medical radiographers	All	32,000	£31,520	0.6%	£30,694	1.0%
	Male	10,000	£35,034	4.2%	£32,519	-3.0%
	Female	22,000	£29,964	-1.3%	£29,027	-2.1%
Conservation professionals	All	*	£26,023	-10.0%	*	0.0%
	Male	*	*	0.0%	*	0.0%
	Female	*	£20,529	-16.3%	*	0.0%
Web design and development professionals	All	33,000	£29,856	0.4%	£28,671	-0.9%
	Male	26,000	£30,426	-0.1%	£28,990	-3.4%
	Female	7,000	£27,572	4.1%	£26,180	1.6%
Managers and proprietors in other services n.e.c.	All	66,000	£36,035	0.0%	£28,460	0.6%
	Male	38,000	£38,816	-4.6%	£30,292	0.1%
	Female	28,000	£32,206	9.1%	£24,322	2.3%
All employees	All	21,563,000	£27,271	0.6%	£22,044	0.9%
	Male	10,797,000	£33,802	0.2%	£27,162	0.0%
	Female	10,766,000	£20,720	1.3%	£17,103	0.8%

Source: Office for National Statistics – Annual Survey of Hours and Earnings

14.2.1 Annual mean and median pay for selected full-time STEM professions by gender

Table 14.2 considers the average annual pay for those in full-time work. Overall, aircraft pilots and flight engineers had far and away the highest mean salary, at £94.179 per year. Furthermore, this increased by 15.3% over the previous year. In contrast, the annual earnings of conservation professionals fell by the largest amount, down 7.1% to £30,275. Considering staple engineering professions, full-time civil engineers earned £40,765, an increase of 4.0% over the previous year. However, males earned substantially more than their female counterparts (£41,373 vs £33,394). This was also the case for electrical engineers – albeit to a lesser extent – with males earning on average £47,934, compared with £44,390 for females.

It is worth pointing out that females earned more than males for some engineering-related occupations. For example, the mean annual pay for female IT business analysts, architects and systems designers was £48,539: higher than the male average earnings of £46,827. This was driven by a substantial increase of 15.7% for females, whilst males only saw their pay rise by 1.6%.

Table 14.2: Annual mean and median gross pay for full-time selected STEM professions by gender (2014) – UK[932, 933, 934]

Occupation	All full-time					Male					Female					Female mean pay greater?
	Number of jobs (thousands)	Mean	Annual percentage change	Median	Annual percentage change	Number of jobs (thousands)	Mean	Annual percentage change	Median	Annual percentage change	Number of jobs (thousands)	Mean	Annual percentage change	Median	Annual percentage change	
Aircraft pilots and flight engineers	7,000	£94,179	15.3%	£90,420	14.9%	7,000	£94,179	15.3%	£90,420	14.9%	*	£0	0.0%	£0	0.0%	No
Medical practitioners	132,000	£78,755	-1.3%	£71,141	-5.9%	79,000	£89,183	0.5%	£85,517	-1.7%	53,000	£63,258	-1.6%	£54,147	-0.1%	No
Information technology and telecommunications directors	21,000	£86,546	24.9%	£64,511	12.1%	18,000	*	0.0%	£64,576	12.9%	*	£64,329	-3.4%	*	0.0%	No
Research and development managers	36,000	£55,305	6.4%	£45,191	0.4%	*	£60,591	8.8%	*	0.0%	10,000	£42,596	0.6%	£39,080	4.9%	No
Health services and public health managers and directors	34,000	£51,793	0.5%	£44,919	-2.3%	14,000	£53,894	-0.7%	£47,239	-2.7%	20,000	£50,330	1.7%	£41,531	-3.5%	No
IT specialist managers	135,000	£50,200	2.0%	£44,906	1.6%	113,000	£51,841	3.2%	£46,076	2.2%	22,000	£41,684	-4.5%	£36,034	-6.8%	No
Electrical engineers	20,000	£47,761	5.6%	£43,711	1.9%	19,000	£47,934	5.5%	£43,915	2.0%	*	£44,390	8.4%	£42,174	28.7%	No
Production managers and directors in manufacturing	361,000	£54,917	-0.2%	£44,567	3.7%	302,000	£56,466	-1.0%	£45,374	2.0%	59,000	£47,000	6.4%	£39,373	7.7%	No
Mechanical engineers	31,000	£43,650	-4.6%	£40,558	-1.1%	27,000	£44,436	-3.9%	£40,764	-2.3%	*	*	0.0%	*	0.0%	Yes
IT business analysts, architects and systems designers	90,000	£47,034	3.1%	£41,983	2.2%	79,000	£46,827	1.6%	£42,849	2.6%	11,000	£48,539	15.7%	£37,945	4.6%	Yes
Production managers and directors in construction	73,000	£52,335	5.7%	£39,855	-1.0%	68,000	£52,418	5.8%	£40,000	-1.1%	*	*	0.0%	*	0.0%	Yes
Engineering professionals n.e.c.	120,000	£42,230	0.3%	£38,974	-1.0%	105,000	£43,147	0.2%	£39,365	-1.5%	15,000	£35,698	0.5%	£33,840	5.0%	No
Programmers and software development professionals	149,000	£41,811	1.6%	£40,007	2.1%	133,000	£42,224	2.2%	£40,558	2.7%	16,000	£38,436	-3.1%	£35,879	-0.3%	No
Design and development engineers	62,000	£41,466	0.8%	£38,549	-0.5%	57,000	£42,074	1.6%	£38,698	-0.3%	*	£34,929	-6.3%	£32,177	-11.0%	No

932 Employees on adult rates who have been in the same job for more than a year. 933 Figures for number of jobs are for indicative purposes only and should not be considered an accurate estimate of employee job counts. 934 * = data omitted due to disclosive or unreliable nature

Table 14.2: Annual mean and median gross pay for full-time selected STEM professions by gender (2014) – UK – continued

	All full-time					Male					Female					
Occupation	Number of jobs (thousands)	Mean	Annual percentage change	Median	Annual percentage change	Number of jobs (thousands)	Mean	Annual percentage change	Median	Annual percentage change	Number of jobs (thousands)	Mean	Annual percentage change	Median	Annual percentage change	Female mean pay greater?
Waste disposal and environmental services managers	7,000	£40,857	-5.7%	£34,367	-7.8%	*	£43,601	-0.2%	£37,669	0.0%	*	£31,799	-23.6%	£32,581	0.0%	No
Information technology and telecommunications professionals n.e.c.	70,000	£42,655	1.0%	£39,759	2.8%	62,000	£43,317	0.6%	£40,387	2.6%	9,000	£37,965	0.0%	£34,961	0.0%	No
Quality assurance and regulatory professionals	58,000	£47,105	6.0%	£38,563	1.8%	38,000	£50,535	5.9%	£39,475	-1.9%	20,000	£40,707	4.7%	£36,180	5.2%	No
Production and process engineers	37,000	£38,386	-1.0%	£36,861	0.0%	33,000	£39,285	-0.2%	£37,166	0.5%	*	£31,556	0.0%	£31,904	0.0%	No
Civil engineers	40,000	£40,765	4.1%	£38,508	6.0%	37,000	£41,373	4.1%	£39,256	7.8%	*	£33,394	4.0%	£30,729	-5.9%	No
Managers and directors in transport and distribution	56,000	£42,871	2.8%	£37,054	3.9%	50,000	£42,840	3.5%	£37,416	4.8%	*	*	0.0%	*	0.0%	Yes
Pharmacists	25,000	£42,300	0.3%	£41,500	2.7%	11,000	£46,764	0.7%	£45,904	1.5%	14,000	£38,818	-1.1%	£39,023	3.4%	No
Construction project managers and related professionals	14,000	£41,351	-3.0%	£34,479	-2.5%	13,000	£42,977	-2.2%	£35,517	-1.9%	*	£25,491	-18.9%	£22,201	0.0%	No
Architects	26,000	£46,297	-0.6%	£38,000	0.6%	21,000	£49,379	0.8%	*	0.0%	*	£33,553	-0.5%	£32,318	6.8%	No
Chartered and certified accountants	65,000	£42,244	3.0%	£37,680	0.6%	37,000	£47,130	7.0%	£41,651	4.6%	29,000	£36,008	-2.8%	£32,844	-3.1%	No
Natural and social science professionals n.e.c.	36,000	£38,911	2.7%	£35,860	2.1%	23,000	£39,683	1.9%	£36,556	1.0%	14,000	£37,653	3.9%	£33,459	0.6%	No
Biological scientists and biochemists	46,000	£41,809	2.6%	£38,103	1.0%	24,000	£45,089	6.6%	£40,502	2.5%	22,000	£38,165	-2.2%	£35,901	-2.9%	No
Quality control and planning engineers	29,000	£37,273	5.8%	£35,809	5.5%	25,000	£37,318	6.5%	£35,656	5.0%	*	£37,002	1.0%	£37,602	10.7%	No
Business, research and administrative professionals n.e.c.	50,000	£38,254	0.6%	£34,635	3.3%	31,000	£39,984	1.5%	£35,494	2.0%	19,000	£35,407	-0.7%	£33,064	3.1%	No
Chartered surveyors	45,000	£38,314	2.6%	£34,953	1.4%	40,000	£39,117	2.3%	£35,900	2.6%	6,000	£32,605	9.8%	£31,101	5.0%	No
Chemical scientists	11,000	£35,191	-4.8%	£31,642	-6.5%	8,000	£37,385	-4.6%	£32,884	-5.6%	*	£28,827	-5.4%	£24,432	0.0%	No
Ophthalmic opticians	*	£41,468	11.0%	£38,484	4.8%	*	£48,530	42.9%	*	0.0%	*	£36,302	-8.6%	£37,047	1.9%	No
Environment professionals	29,000	£32,992	-4.0%	£29,749	-5.5%	22,000	£33,687	-3.7%	£30,193	-6.6%	7,000	£30,671	-4.1%	£28,310	-1.3%	No
Medical radiographers	23,000	£35,857	-0.3%	£34,352	-1.4%	8,000	£38,393	4.6%	£35,354	1.1%	15,000	£34,465	-3.1%	£33,355	-3.8%	No
Conservation professionals	8,000	£30,275	-7.1%	£30,208	-3.5%	*	£31,826	-7.3%	£32,964	-6.0%	*	£26,711	-9.5%	*	0.0%	No
Web design and development professionals	29,000	£30,731	-0.5%	£29,171	-2.8%	25,000	£31,252	-0.3%	£29,739	-1.3%	*	£28,060	-2.0%	£28,287	6.6%	No
Managers and proprietors in other services n.e.c.	58,000	£38,279	-0.6%	£29,886	-0.4%	36,000	£40,541	-3.9%	£32,022	3.6%	22,000	£34,678	7.0%	£27,194	1.1%	No
All employees	15,480,000	£33,475	0.6%	£27,195	0.7%	9,394,000	£37,028	0.5%	£29,441	0.6%	6,086,000	£27,991	0.9%	£23,889	1.3%	No

Source: Office for National Statistics – Annual Survey of Hours and Earnings

14.2.2 Annual mean and median pay for selected part-time professions by gender

As expected, average part-time annual pay was lower than full-time pay, at £11,480 vs £33,475. However, medical practitioners who worked part-time still earned £38,159 a year on average, higher than the full-time average. Furthermore, across all occupations, there were substantially more occupations being worked in by females than males on a part-time basis (4,680,000 vs 1,403,000).

Table 14.3: Annual mean and median gross pay for part-time selected STEM professions by gender (2014) – UK[935, 936, 937]

	All part-time					Male					Female				
Occupation	**Number of jobs**	**Mean**	**Annual percentage change**	**Median**	**Annual percentage change**	**Number of jobs**	**Mean**	**Annual percentage change**	**Median**	**Annual percentage change**	**Number of jobs**	**Mean**	**Annual percentage change**	**Median**	**Annual percentage change**
Medical practitioners	39,000	£38,159	2.0%	£27,662	0.0%	16,000	£45,301	-6.0%	*	0.0%	24,000	£33,452	11.6%	£27,731	2.7%
Health services and public health managers and directors	6,000	£24,674	0.0%	*	0.0%	*	*	0.0%	*	0.0%	*	£23,307	0.8%	*	0.0%
Production managers and directors in manufacturing	55,000	£15,265	-14.4%	£9,000	-21.4%	36,000	£15,065	-12.7%	£8,384	-11.0%	19,000	£15,633	-16.6%	*	0.0%
Programmers and software development professionals	9,000	£22,753	1.0%	£20,105	0.0%	*	£21,545	9.0%	*	0.0%	-	£24,192	-5.8%	*	0.0%
Pharmacists	9,000	£24,080	0.0%	£23,990	0.0%	*	*	0.0%	*	0.0%	8,000	£24,127	-0.4%	£24,184	3.3%
Chartered and certified accountants	11,000	£18,152	2.3%	£15,828	0.0%	*	*	0.0%	*	0.0%	8,000	£18,799	-8.9%	£16,448	-20.2%
Biological scientists and biochemists	8,000	£17,038	-12.8%	£16,609	-16.8%	*	£13,556	-22.6%	*	0.0%	6,000	£18,657	-8.0%	*	0.0%
Business, research and administrative professionals n.e.c.	11,000	£23,224	-3.7%	£22,193	10.3%	*	£23,367	0.0%	*	0.0%	8,000	£23,162	2.6%	£22,210	5.3%
Medical radiographers	10,000	£21,148	0.0%	£20,602	0.0%	*	£20,334	0.0%	*	0.0%	8,000	£21,343	0.0%	£22,259	0.0%
Managers and proprietors in other services n.e.c.	8,000	£19,315	2.1%	£13,887	-2.4%	*	£14,084	-27.0%	£12,083	0.0%	5,000	£21,767	16.1%	*	0.0%
All employees	60,830,000	£11,480	1.8%	£9,000	1.6%	1,403,000	£12,200	0.9%	£8,676	3.1%	4,680,000	£11,264	2.0%	£9,089	1.3%

Source: Office for National Statistics – Annual Survey of Hours and Earnings

935 Employees on adult rates who have been in the same job for more than a year. **936** Figures for number of jobs are for indicative purposes only and should not be considered an accurate estimate of employee job counts. **937** * = data omitted due to disclosive or unreliable nature

14.3 Annual mean and median gross pay for selected STEM technician and craft careers

In 2014, the UK STEM workforce comprised over 4.9 million people: 16.9% of the total UK workforce of 29.1 million people. Of the 4.9 million STEM workers, around 40% (2.1 million) were employed in STEM technician occupations, which equates to 7.3% of the total UK workforce. Of these, 1.4 million were employed in skilled worker roles (e.g. telecommunications engineers, IT engineers, electricians and electrical fitters), whilst 748,000 were employed in associate professional occupations, such as laboratory technicians, engineering technicians and draughtspersons.[938]

The Royal Society notes that, traditionally, most technicians have been poorly paid, employed on insecure short-term contracts which reduces their scope for career development.[939]

As Table 14.4 shows, the highest mean salary was for financial and accounting technicians, at £44,080. This was followed by pipe fitters, who earned £37,982 a year on average. The lowest mean salary was for industrial cleaning and process occupations, at £15,376. Furthermore, females engaged in this occupation earned a meagre £12,120 a year.

Table 14.4: Annual mean and median gross pay for selected STEM technician and craft careers by gender (2014) – UK[940, 941, 942]

Occupation	Gender	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Pipe fitters	All	*	£37,982	3.7%	£36,873	-1.4%
	Male	*	£37,982	3.7%	£36,873	-1.4%
	Female	*	£0	0.0%	£0	0.0%
Financial and accounting technicians	All	27,000	£44,080	1.2%	£35,103	-5.4%
	Male	12,000	£56,641	4.8%	£46,664	0.2%
	Female	15,000	£34,135	2.3%	£28,115	3.6%
Aircraft maintenance and related trades	All	15,000	£34,088	-1.1%	£34,225	-1.9%
	Male	*	£34,490	-2.0%	£34,575	-2.7%
	Female	*	£27,127	27.4%	£25,705	32.7%
Skilled metal, electrical and electronic trades supervisors	All	46,000	£35,709	1.5%	£32,769	0.5%
	Male	43,000	£36,243	3.0%	£33,642	2.8%
	Female	*	£27,190	0.0%	£27,448	0.0%
Engineering technicians	All	79,000	£34,355	5.2%	£33,150	3.7%
	Male	69,000	£35,213	4.6%	£33,725	3.0%
	Female	10,000	£28,479	6.7%	£26,751	0.0%
Telecommunications engineers	All	36,000	£32,320	0.1%	£31,324	0.3%
	Male	34,000	£32,633	-0.6%	£31,524	-1.0%
	Female	*	£24,321	8.0%	*	0.0%
Electrical and electronics technicians	All	12,000	£29,926	3.6%	£30,406	0.2%
	Male	12,000	£30,401	0.9%	£30,683	-1.3%
	Female	*	£17,105	-8.1%	*	0.0%
Electrical and electronic trades n.e.c.	All	102,000	£31,241	1.7%	£29,430	-0.3%
	Male	97,000	£31,440	1.9%	£29,489	-0.4%
	Female	*	*	0.0%	*	0.0%
Electricians and electrical fitters	All	113,000	£30,345	1.0%	£29,555	0.8%
	Male	111,000	£30,408	1.1%	£29,666	1.0%
	Female	*	£26,188	0.3%	£24,102	0.0%
Water and sewerage plant operatives	All	9,000	£29,872	2.7%	£29,652	1.4%
	Male	9,000	£30,144	2.6%	£29,648	0.9%
	Female	*	*	0.0%	*	0.0%
Metal plate workers, and riveters	All	7,000	£30,215	2.7%	£30,549	7.3%
	Male	7,000	£30,215	2.7%	£30,549	7.3%
	Female	*	£0	0.0%	£0	0.0%
Precision instrument makers and repairers	All	12,000	£28,703	-1.4%	£29,606	3.9%
	Male	10,000	£30,000	3.2%	£30,006	5.8%
	Female	*	*	0.0%	*	0.0%
Assemblers (vehicles and metal goods)	All	53,000	£30,097	0.9%	£29,225	3.2%
	Male	49,000	£30,923	1.3%	£29,650	2.3%
	Female	*	£21,119	0.4%	*	0.0%
Metal working production and maintenance fitters	All	286,000	£30,010	3.1%	£28,611	3.4%
	Male	279,000	£30,157	2.9%	£28,673	3.0%
	Female	8,000	£24,589	6.5%	*	0.0%
Product, clothing and related designers	All	23,000	£28,346	-3.7%	£27,361	-1.1%
	Male	11,000	£30,859	-4.2%	£30,506	2.3%
	Female	*	£26,054	-1.7%	£25,025	1.7%

938 TBR: Understanding the UK STEM technician workforce, September 2014, p4 939 Royal Society: Vision for Science and Mathematics Education, June 2014, p48 940 Employees on adult rates who have been in the same job for more than a year. 941 Figures for number of jobs are for indicative purposes only and should not be considered an accurate estimate of employee job counts. 942 * = data omitted due to disclosive or unreliable nature

Table 14.4: Annual mean and median gross pay for selected STEM technician and craft careers by gender (2014) – UK – continued

Occupation	Gender	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Draughtspersons	All	28,000	£29,438	-1.3%	£27,206	-1.4%
	Male	24,000	£30,678	-0.5%	£28,050	0.2%
	Female	*	*	0.0%	*	0.0%
Plumbers and heating and ventilating engineers	All	52,000	£27,330	-1.9%	£27,621	0.4%
	Male	51,000	£27,356	-1.8%	£27,745	0.9%
	Female	*	£25,987	-4.6%	*	0.0%
IT operations technicians	All	93,000	£30,026	0.5%	£26,637	-2.2%
	Male	64,000	£31,867	-0.7%	£27,896	-1.9%
	Female	29,000	£26,032	3.5%	£24,263	0.5%
IT user support technicians	All	114,000	£29,449	0.6%	£27,918	3.2%
	Male	85,000	£31,164	-0.9%	£28,922	1.4%
	Female	30,000	£24,532	2.2%	£23,316	1.2%
Planning, process and production technicians	All	34,000	£31,505	5.3%	£29,086	7.9%
	Male	27,000	£33,604	4.6%	£30,934	6.7%
	Female	7,000	£24,019	1.8%	£22,168	-0.5%
Architectural and town planning technicians	All	*	£29,427	5.6%	£28,000	4.6%
	Male	*	£29,268	3.3%	£27,725	2.9%
	Female	*	£30,053	14.0%	£29,183	23.4%
TV, video and audio engineers	All	9,000	£27,361	5.1%	£27,322	4.9%
	Male	9,000	£27,361	5.1%	£27,322	4.9%
	Female	*	£0	0.0%	£0	0.0%
Tool makers, tool fitters and markers-out	All	11,000	£26,230	-0.6%	£24,767	-5.5%
	Male	11,000	£26,497	-0.5%	£25,308	-3.9%
	Female	*	£0	0.0%	£0	0.0%
Energy plant operatives	All	6,000	£27,160	3.0%	*	0.0%
	Male	5,000	£28,817	3.0%	£28,269	0.0%
	Female	*	*	0.0%	*	0.0%
Quality assurance technicians	All	26,000	£27,651	1.2%	£26,169	1.0%
	Male	17,000	£29,599	1.0%	£28,217	3.6%
	Female	9,000	£23,921	-1.0%	£22,773	-3.9%
IT engineers	All	*	£25,934	-4.3%	£23,268	-8.6%
	Male	12,000	£25,512	-3.2%	£23,179	-8.9%
	Female	*	*	0.0%	*	0.0%
Printers	All	*	£27,026	0.7%	£25,383	-1.5%
	Male	*	£27,241	0.4%	£25,890	-0.1%
	Female	*	£0	0.0%	£0	0.0%
Medical and dental technicians	All	24,000	£26,440	-1.1%	£26,582	4.0%
	Male	12,000	£30,243	-2.3%	£28,853	-1.7%
	Female	12,000	£22,599	-2.5%	£20,201	-10.0%
Vehicle paint technicians	All	9,000	£24,756	-3.3%	£24,669	-2.1%
	Male	8,000	£24,731	-3.1%	£24,484	-1.9%
	Female	*	£0	0.0%	£0	0.0%
Metal machining setters and setter-operators	All	60,000	£26,976	-0.2%	£25,120	0.4%
	Male	57,000	£27,477	-0.2%	£25,535	-0.2%
	Female	*	£16,930	0.8%	*	0.0%
Rubber process operatives	All	*	£26,053	4.9%	£28,499	13.9%
	Male	*	£26,664	4.3%	£28,624	10.8%
	Female	*	£0	0.0%	£0	0.0%
Science, engineering and production technicians n.e.c.	All	118,000	£26,820	0.3%	£25,518	2.3%
	Male	99,000	£28,245	-0.2%	£26,752	2.4%
	Female	19,000	£19,314	4.1%	£17,726	5.8%
Welding trades	All	43,000	£26,597	-0.9%	£24,521	-1.2%
	Male	43,000	£26,705	-0.8%	£24,545	-1.1%
	Female	*	£0	0.0%	£0	0.0%
Sheet metal workers	All	11,000	£27,284	5.0%	£25,946	7.6%
	Male	11,000	£27,656	5.1%	£26,392	9.0%
	Female	*	£0	0.0%	£0	0.0%
Metal making and treating process operatives	All	11,000	£25,411	1.1%	£24,107	-1.0%
	Male	10,000	£25,317	1.0%	£24,050	-1.2%
	Female	*	£0	0.0%	£0	0.0%
Vehicle technicians, mechanics and electricians	All	106,000	£25,145	0.1%	£24,607	2.7%
	Male	105,000	£25,214	0.0%	£24,638	2.7%
	Female	*	£19,792	8.2%	*	0.0%

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Table 14.4: Annual mean and median gross pay for selected STEM technician and craft careers by gender (2014) – UK – continued

Occupation	Gender	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Process operatives n.e.c.	All	10,000	£24,496	-0.5%	£23,218	-2.9%
	Male	8,000	£25,830	1.8%	£25,161	0.6%
	Female	*	£15,008	-4.4%	*	0.0%
Vehicle body builders and repairers	All	23,000	£24,644	3.6%	£24,196	3.5%
	Male	23,000	£24,683	3.7%	£24,377	4.2%
	Female	*	£0	0.0%	£0	0.0%
Chemical and related process operatives	All	25,000	£26,456	4.9%	£23,664	3.4%
	Male	21,000	£28,464	5.0%	£25,768	1.4%
	Female	*	£17,312	8.5%	£15,840	4.6%
Routine inspectors and testers	All	44,000	£24,169	-2.0%	£22,374	-2.0%
	Male	31,000	£26,268	-1.7%	£25,031	0.2%
	Female	13,000	£19,078	0.6%	£18,033	2.6%
Plant and machine operatives n.e.c.	All	16,000	£24,248	1.0%	£21,708	-2.6%
	Male	14,000	£25,460	1.6%	£23,443	1.0%
	Female	*	£16,183	-2.3%	*	0.0%
Electroplaters	All	6,000	£22,302	2.4%	£20,924	-2.3%
	Male	5,000	£22,598	2.6%	£20,983	-2.5%
	Female	*	£0	0.0%	£0	0.0%
Metal working machine operatives	All	24,000	£21,719	-1.5%	£20,229	-3.4%
	Male	20,000	£22,530	-2.0%	£20,943	-7.2%
	Female	*	£17,171	4.3%	£16,285	6.7%
Elementary construction occupations	All	43,000	£21,051	0.9%	£20,417	-1.2%
	Male	43,000	£21,062	0.5%	£20,442	-1.4%
	Female	*	£20,334	20.5%	£18,696	0.0%
Pharmaceutical technicians	All	16,000	£20,144	-2.8%	£19,202	0.4%
	Male	*	£26,897	12.5%	£25,958	21.2%
	Female	14,000	£19,129	-4.8%	£19,017	0.8%
Printing machine assistants	All	17,000	£21,250	1.4%	£20,032	4.2%
	Male	12,000	£23,121	4.2%	£23,547	11.4%
	Female	*	£16,381	-3.2%	£16,120	4.8%
Assemblers (electrical and electronic products)	All	15,000	£20,229	3.7%	£19,195	0.2%
	Male	9,000	£21,755	1.3%	£21,370	3.7%
	Female	6,000	£17,790	10.7%	£17,144	8.5%
Paper and wood machine operatives	All	22,000	£20,517	1.1%	£19,211	1.0%
	Male	20,000	£21,025	1.7%	£19,731	1.7%
	Female	*	£15,937	-1.2%	*	0.0%
Laboratory technicians	All	57,000	£21,533	1.9%	£19,439	2.3%
	Male	26,000	£25,547	1.6%	£24,094	3.4%
	Female	31,000	£18,167	3.1%	£16,471	1.1%
Textile process operatives	All	11,000	£20,520	3.1%	£19,174	1.0%
	Male	8,000	£22,479	2.9%	£21,586	-0.1%
	Female	*	£15,427	1.0%	£15,487	0.0%
Elementary process plant occupations n.e.c.	All	82,000	£19,855	2.4%	£18,808	1.0%
	Male	66,000	£21,030	3.3%	£19,674	1.1%
	Female	15,000	£14,698	-4.4%	£14,209	-3.6%
Glass and ceramics process operatives	All	6,000	£20,741	4.1%	£18,691	4.2%
	Male	5,000	£21,611	0.8%	£19,193	3.5%
	Female	*	*	0.0%	*	0.0%
Tyre, exhaust and windscreen fitters	All	11,000	£20,298	7.5%	£19,769	13.5%
	Male	11,000	£20,298	7.6%	£19,769	13.7%
	Female	*	£0	0.0%	£0	0.0%
Food, drink and tobacco process operatives	All	129,000	£18,030	-0.5%	£16,897	-0.9%
	Male	85,000	£19,674	0.7%	£18,480	0.9%
	Female	44,000	£14,884	-1.2%	£14,526	-3.0%
Industrial cleaning process occupations	All	14,000	£15,376	1.0%	£15,372	0.6%
	Male	9,000	£17,271	2.3%	£16,602	3.1%
	Female	5,000	£12,120	4.6%	*	0.0%
All employees	All	21,563,000	£27,271	0.6%	£22,044	0.9%
	Male	10,797,000	£33,802	0.2%	£27,162	0.0%
	Female	10,766,000	£20,720	1.3%	£17,103	0.8%

Source: Office for National Statistics – Annual Survey of Hours and Earnings

14.3.1 Annual mean and median gross pay for selected full time STEM technician and craft careers by gender

Table 14.5 shows the annual mean and median salary for selected full time STEM technician and craft careers by gender. Those employed in aircraft maintenance and related trades earned £34,793 on average, whilst telecommunications engineers took home an average annual wage of £35,208.

The largest percentage difference in male and female pay was for those employed as process operatives, where males earned £26,242, compared with the average female pay of £15,008: a difference of 74.9%. The smallest pay gap (based on reliable data) was seen for engineering technicians, where males earned on average 9% more than females (£35,517 vs £32,536).

Table 14.5: Annual mean and median pay for selected full-time STEM technician and craft careers by gender (2014) – UK

	All full-time					Male					Female				
	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Financial and accounting technicians	21,000	£50,259	2.8%	£40,096	-1.6%	12,000	£58,401	4.8%	£47,243	-2.7%	10,000	£40,523	2.4%	£30,273	0.0%
Aircraft maintenance and related trades	14,000	£34,793	-0.4%	£34,527	-1.5%	-	£35,259	-1.3%	£36,204	1.8%	-	£27,127	27.4%	£25,705	32.7%
Skilled metal, electrical and electronic trades supervisors	45,000	£35,964	1.6%	£32,844	0.7%	43,000	£36,248	2.8%	£33,567	2.7%	-	£30,404	0.0%	£29,643	0.0%
Engineering technicians	75,000	£35,208	4.0%	£33,645	3.0%	67,000	£35,517	4.2%	£34,006	3.5%	8,000	£32,536	2.1%	£29,209	1.0%
Telecommunications engineers	35,000	£32,418	-1.1%	£31,363	-1.1%	34,000	£32,741	-1.5%	£31,565	-2.4%	-	£24,321	1.6%	-	0.0%
Electrical and electronics technicians	12,000	£30,204	0.9%	£30,561	-1.1%	12,000	£30,449	0.1%	£31,011	-0.3%	-	£0	0.0%	£0	0.0%
Electrical and electronic trades n.e.c.	99,000	£31,660	2.1%	£29,716	0.2%	94,000	£31,767	2.2%	£29,796	0.6%	-	-	0.0%	-	0.0%
Electricians and electrical fitters	106,000	£31,150	2.4%	£30,172	2.2%	104,000	£31,221	2.5%	£30,195	2.2%	-	£26,246	-1.5%	£23,345	0.0%
Water and sewerage plant operatives	9,000	£30,372	3.4%	£30,112	1.8%	8,000	£30,392	3.2%	£29,684	0.3%	-	£29,949	6.4%	-	0.0%
Metal plate workers, and riveters	7,000	£30,254	3.1%	£30,543	7.4%	7,000	£30,254	3.1%	£30,543	7.4%	-	£0	0.0%	£0	0.0%
Precision instrument makers and repairers	11,000	£30,209	1.8%	£30,034	4.7%	10,000	£30,611	3.2%	£30,202	5.8%	-	£25,958	-13.6%	-	0.0%
Assemblers (vehicles and metal goods)	50,000	£30,192	0.4%	£29,224	2.7%	47,000	£30,775	0.8%	£29,580	2.1%	-	£23,027	2.3%	£20,506	0.0%

Table 14.5: Annual mean and median pay for selected full-time STEM technician and craft careers by gender (2014) – UK – continued

	All full-time					Male					Female				
	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Metal working production and maintenance fitters	275,000	£30,556	3.2%	£28,846	2.3%	268,000	£30,649	3.0%	£28,888	2.1%	7,000	£26,731	7.5%	-	0.0%
Product, clothing and related designers	20,000	£30,181	-2.4%	£28,336	-2.6%	10,000	£31,798	-3.3%	£31,111	3.8%	-	£28,432	0.2%	£25,901	-0.6%
Draughtspersons	26,000	£30,488	-0.8%	£27,856	-0.5%	23,000	£31,129	-0.7%	£28,120	-1.4%	-	-	0.0%	-	0.0%
Plumbers and heating and ventilating engineers	48,000	£28,270	-0.4%	£28,253	2.3%	47,000	£28,317	-0.3%	£28,309	2.5%	-	£25,987	-4.6%	-	0.0%
IT operations technicians	84,000	£31,651	-1.1%	£27,840	-2.1%	61,000	£32,804	-1.7%	£28,299	-3.9%	23,000	£28,591	0.8%	£26,186	-1.4%
IT user support technicians	106,000	£30,538	0.1%	£28,519	2.5%	82,000	£31,519	-1.5%	£29,006	0.4%	23,000	£27,050	2.9%	£25,769	2.9%
Planning, process and production technicians	32,000	£32,612	6.8%	£29,643	8.2%	26,000	£33,756	5.0%	£31,030	7.0%	-	£26,987	7.2%	£24,274	5.7%
Architectural and town planning technicians	9,000	£29,841	4.0%	£28,799	5.9%	7,000	£29,781	1.8%	£28,154	2.7%	-	£30,053	11.6%	£29,183	15.7%
TV, video and audio engineers	8,000	£28,045	5.5%	£27,397	3.5%	8,000	£28,045	5.5%	£27,397	3.5%	-	£0	0.0%	£0	0.0%
Tool makers, tool fitters and markers-out	10,000	£27,469	-0.9%	£25,539	-3.8%	10,000	£27,604	-1.7%	£25,591	-4.3%	-	£0	0.0%	£0	0.0%
Energy plant operatives	5,000	£29,957	6.3%	£28,756	6.6%	5,000	£30,654	3.8%	£29,176	5.6%	-	-	0.0%	-	0.0%
Quality assurance technicians	25,000	£28,580	1.5%	£27,170	1.9%	17,000	£29,813	0.6%	£28,324	3.5%	8,000	£25,885	1.8%	£24,048	-0.5%
IT engineers	-	£27,067	-6.5%	-	0.0%	11,000	£26,711	-5.6%	£24,365	-9.6%	-	-	0.0%	-	0.0%
Medical and dental technicians	19,000	£29,560	-1.7%	£27,901	1.3%	11,000	£31,704	0.2%	£30,002	1.4%	8,000	£26,378	-5.9%	£23,665	-6.0%
Vehicle paint technicians	8,000	£25,069	-2.7%	£24,707	-2.3%	8,000	£25,051	-2.5%	£24,652	-2.1%	-	£0	0.0%	£0	0.0%
Metal machining setters and setter-operators	57,000	£27,482	0.0%	£25,351	-0.6%	56,000	£27,721	-0.1%	£26,061	1.1%	-	£20,349	4.0%	-	0.0%
Science, engineering and production technicians n.e.c.	107,000	£28,112	-0.3%	£26,521	3.1%	95,000	£28,855	-0.5%	£26,990	1.4%	12,000	£22,355	1.9%	£20,917	7.9%
Welding trades	42,000	£26,923	-1.1%	£24,676	-1.7%	41,000	£26,989	-1.1%	£24,703	-1.9%	-	£0	0.0%	£0	0.0%
Sheet metal workers	11,000	£27,736	4.4%	£26,383	9.2%	10,000	£28,137	4.4%	£27,540	12.4%	-	£0	0.0%	£0	0.0%
Metal making and treating process operatives	10,000	£25,509	-1.5%	£23,913	-8.1%	10,000	£25,411	-1.7%	£23,888	-8.2%	-	£0	0.0%	£0	0.0%
Vehicle technicians, mechanics and electricians	101,000	£25,729	0.3%	£24,783	2.7%	100,000	£25,793	0.1%	£24,797	2.2%	-	£20,288	11.0%	-	0.0%
Process operatives n.e.c.	9,000	£24,817	0.0%	£23,829	-0.3%	8,000	£26,242	2.4%	£25,858	3.4%	-	£15,008	-4.4%	-	0.0%

Table 14.5: Annual mean and median pay for selected full-time STEM technician and craft careers by gender (2014) – UK – continued

	All full-time					Male					Female				
	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Vehicle body builders and repairers	22,000	£25,256	3.5%	£24,821	4.9%	22,000	£25,303	3.7%	£24,853	5.0%	-	£0	0.0%	£0	0.0%
Chemical and related process operatives	23,000	£27,427	4.5%	£25,080	1.4%	20,000	£28,965	5.1%	£26,230	1.4%	-	£18,869	8.5%	£18,261	5.8%
Routine inspectors and testers	41,000	£24,905	-3.3%	£22,910	-3.9%	30,000	£26,542	-2.6%	£25,124	0.2%	11,000	£20,377	-1.6%	£18,860	1.1%
Plant and machine operatives n.e.c.	15,000	£25,003	3.0%	£22,919	0.6%	13,000	£25,870	3.2%	£24,132	3.3%	-	£17,903	0.2%	-	0.0%
Electroplaters	5,000	£22,767	3.2%	£21,027	-2.5%	5,000	£23,093	3.4%	£22,003	1.0%	-	£0	0.0%	£0	0.0%
Metal working machine operatives	23,000	£22,098	-2.0%	£20,454	-6.0%	19,000	£22,931	-1.8%	£21,437	-5.4%	-	£17,478	1.5%	£16,298	6.5%
Elementary construction occupations	39,000	£22,139	0.5%	£20,904	-2.1%	38,000	£22,171	0.4%	£20,937	-2.0%	-	£20,334	6.0%	£18,696	2.7%
Pharmaceutical technicians	11,000	£23,277	2.9%	£21,134	-0.9%	-	£26,897	12.5%	£25,958	21.2%	9,000	£22,420	0.7%	£20,066	-1.8%
Printing machine assistants	15,000	£22,314	1.7%	£20,630	1.6%	12,000	£23,380	2.3%	£23,713	7.8%	-	£18,661	1.9%	£16,833	4.9%
Assemblers (electrical and electronic products)	13,000	£20,784	2.8%	£20,199	4.1%	9,000	£22,406	3.0%	£22,046	4.0%	-	£17,945	4.4%	£17,779	4.7%
Paper and wood machine operatives	19,000	£21,580	2.1%	£19,709	1.6%	18,000	£21,914	2.7%	£20,293	3.2%	-	£17,802	-2.4%	-	0.0%
Laboratory technicians	43,000	£24,539	1.8%	£21,941	2.1%	24,000	£27,100	2.3%	£24,995	4.9%	20,000	£21,494	1.8%	£19,336	4.0%
Textile process operatives	9,000	£22,184	1.3%	£19,921	-2.6%	7,000	£23,881	3.8%	£21,968	-0.6%	-	£16,699	-9.2%	£17,982	-3.3%
Elementary process plant occupations n.e.c.	75,000	£20,634	2.1%	£19,137	-0.1%	63,000	£21,507	2.2%	£20,033	0.5%	12,000	£16,188	-2.1%	£15,057	-2.8%
Glass and ceramics process operatives	5,000	£21,507	0.9%	£18,876	3.5%	5,000	£21,611	-2.9%	£19,193	2.3%	-	£0	0.0%	£0	0.0%
Tyre, exhaust and windscreen fitters	10,000	£21,519	7.2%	£20,442	7.8%	10,000	£21,519	7.2%	£20,442	8.1%	-	£0	0.0%	£0	0.0%
Food, drink and tobacco process operatives	109,000	£19,259	0.3%	£17,846	1.1%	75,000	£20,487	1.7%	£18,968	1.4%	33,000	£16,486	-1.2%	£15,554	-3.3%
Industrial cleaning process occupations	9,000	£18,780	-3.1%	£18,154	-0.8%	-	£19,379	-2.8%	£18,060	-3.9%	-	£17,012	-1.7%	£17,735	-2.2%
All employees	15,480,000	£33,475	0.6%	£27,195	0.7%	9,394,000	£37,028	0.5%	£29,441	0.6%	6,086,000	£27,991	0.9%	£23,889	1.3%

Source: Office for National Statistics – Annual Survey of Hours and Earnings

14.3.2 Annual mean and median gross pay for selected part time STEM technician and craft careers by gender

Table 14.6 displays the mean pay for selected part time STEM technicians and craft careers by gender. Financial and accounting technicians earned most per year at £19,047, whilst those employed in elementary process plant occupations earned the least, taking home £9,742 a year on average. IT user support technicians saw the largest increase in salary over a year, with their annual pay rising by 18.8% to £13,939.

Table 14.6: Annual mean and median pay for selected part-time STEM technician and craft careers by gender (2014) – UK

	All part-time					Male					Female				
	Number of jobs	Median	Annual percentage change	Mean	Annual percentage change	Number of jobs	Median	Annual percentage change	Mean	Annual percentage change	Number of jobs	Median	Annual percentage change	Mean	Annual percentage change
Financial and accounting technicians	6,000	£19,047	0.0%	£22,432	16.0%	-	-	0.0%	£15,720	0.0%	-	£19,200	0.0%	£23,032	16.0%
IT operations technicians	10,000	£13,840	0.0%	£15,911	4.5%	-	-	0.0%	£13,402	-0.7%	7,000	£14,116	0.0%	£17,092	6.0%
IT user support technicians	9,000	£13,639	18.8%	£16,072	21.5%	-	-	0.0%	-	0.0%	6,000	£12,983	8.6%	£15,352	13.6%
Medical and dental technicians	6,000	-	0.0%	£16,314	2.5%	-	-	0.0%	£15,643	-18.4%	-	-	0.0%	£16,475	6.1%
Science, engineering and production technicians n.e.c.	11,000	£13,022	11.3%	£14,063	15.1%	-	-	0.0%	£14,690	22.2%	7,000	£13,251	16.9%	£13,656	10.6%
Elementary construction occupations	5,000	-	0.0%	£11,860	7.1%	5,000	-	0.0%	£11,860	4.8%	-	£0	0.0%	£0	0.0%
Laboratory technicians	13,000	£10,810	7.8%	£11,822	7.9%	-	-	0.0%	£9,941	27.1%	11,000	£10,866	5.5%	£12,220	6.4%
Elementary process plant occupations n.e.c.	7,000	£9,742	0.0%	£11,116	-1.7%	-	-	0.0%	£13,244	0.0%	-	-	0.0%	£8,238	-7.4%
Food, drink and tobacco process operatives	21,000	£10,755	8.1%	£11,529	4.2%	10,000	£12,953	12.3%	£13,260	6.7%	11,000	£9,734	4.6%	£10,026	-1.0%
Industrial cleaning process occupations	4,000	£6,284	0.0%	£7,765	10.9%	-	-	0.0%	£7,891	11.3%	-	-	0.0%	£7,689	11.1%
All employees	6,083,000	£9,000	1.6%	£11,480	1.8%	1,403,000	£8,676	3.1%	£12,200	0.9%	4,680,000	£9,089	1.3%	£11,264	2.0%

Source: Office for National Statistics – Annual Survey of Hours and Earnings

14.4 Engineering salaries across the UK

Average salaries for STEM occupations vary across different devolved nations and regions of the UK. As Table 14.7 shows, all occupations in London saw the highest annual earnings at an average figure of £41,095. However, this was not the best region for earnings for several engineering occupations. For example, civil engineers earned more a year in the South East (£42,541 vs £40,992). Furthermore, electrical engineers commanded an average salary of £52,216 a year in the North West, compared with their counterpart in the capital, who took home £46,984. Taking into account the higher living costs associated with living in London, an engineering degree can lead to substantially higher standards of living in other parts of the country.

The lowest mean salary (£21,616) was recorded for Northern Ireland – a decline of 3.8% from the previous year.

Table 14.7: Annual mean salaries for engineering occupations by region (2013-2014) – UK

	Year	North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland	Northern Ireland	United Kingdom
Civil engineers	2014	£32,837	£40,410	£34,749	£41,894	£40,364	-	£40,992	£42,541	£33,626	£33,300	£41,188	-	£40,200
	2013	£42,497	£33,186	£31,770	£33,940	£34,352	£34,408	£38,856	£43,867	£34,144	£34,186	£44,623	-	£38,236
Mechanical engineers	2014	£43,029	£44,222	£34,386	£43,029	£43,029	£43,029	£43,029	£43,029	£43,029	£43,029	£43,029	-	£43,029
	2013	-	£38,096	£39,972	£40,980	-	£40,043	£48,131	£46,851	£42,177	£48,635	£49,837	-	£44,176
Electrical engineers	2014	£46,984	£52,216	£40,651	£46,984	£46,984	£46,984	£46,984	£46,984	£46,984	£46,984	£46,984	-	£46,984
	2013	-	£47,938	£36,187	£51,765	£36,987	£48,268	£43,156	£45,838	£33,018	-	-	-	£44,439
Electronics engineers	2014	£41,685	-	£39,753	£41,685	£41,685	£41,685	£41,685	£41,685	£41,685	£41,685	£41,685	-	£41,685
	2013	-	-	-	-	-	£29,935	£32,189	£50,410	£39,807	-	-	-	£36,751
Design and development engineers	2014	£40,245	£34,941	-	£40,245	£40,245	£40,245	£40,245	£40,245	£40,245	£40,245	£40,245	-	£40,245
	2013	£45,897	£34,541	£32,438	£37,883	£37,558	£42,383	£47,412	£41,779	£41,632	£33,242	£40,392	-	£39,890
Production and process engineers	2014	£38,223	£38,800	£34,604	£38,223	£38,223	£38,223	£38,223	£38,223	£38,223	£38,223	£38,223	-	£38,223
	2013	-	£45,580	£33,405	£39,231	£34,149	£34,752	-	£40,068	£34,130	£39,679	£39,790	-	£38,475
Engineering professionals n.e.c.	2014	£41,453	£41,833	£31,949	£41,453	£41,453	£41,453	£41,453	£41,453	£41,453	£41,453	£41,453	-	£41,453
	2013	£36,217	£41,519	£37,641	£38,215	£45,697	£41,879	£52,302	£40,642	£37,847	£36,167	£43,271	-	£41,421
Quality control and planning engineers	2014	£36,454	£35,601	£35,181	£36,454	£36,454	£36,454	£36,454	£36,454	£36,454	£36,454	£36,454	-	£36,454
	2013	£36,240	£34,338	£34,772	£37,261	£33,628	£33,953	£35,252	£35,280	£32,729	£33,045	£36,828	-	£34,868
Engineering technicians	2014	£34,355	£33,262	£32,828	£34,355	£34,355	£34,355	£34,355	£34,355	£34,355	£34,355	£34,355	-	£34,355
	2013	£34,034	£31,810	£30,726	£32,337	£28,157	£31,145	-	£35,043	£30,739	£33,238	£33,189	-	£32,528
Building and civil engineering technicians	2014	£30,610	-	£32,019	£30,610	£30,610	£30,610	£30,610	£30,610	£30,610	£30,610	£30,610	-	£30,610
	2013	-	£33,553	£29,382	-	-	-	-	£30,168	£28,344	£21,961	-	-	£30,300
Science, engineering and production technicians n.e.c.	2014	£26,820	£24,512	£28,425	£26,820	£26,820	£26,820	£26,820	£26,820	£26,820	£26,820	£26,820	-	£26,820
	2013	£24,854	£26,352	£23,755	£28,113	£24,573	£26,998	£28,977	£29,084	£26,428	£22,341	£27,593	-	£26,710
Aircraft pilots and flight engineers	2014	£90,146	-	-	£90,146	£90,146	£90,146	£90,146	£90,146	£90,146	£90,146	£90,146	-	£90,146
	2013	-			£66,765		£78,973	£103,225	-	£60,413	-	£53,470	-	£78,482
Air-conditioning and refrigeration engineers	2014	£30,652	£29,851	-	£30,652	£30,652	£30,652	£30,652	£30,652	£30,652	£30,652	£30,652	-	£30,652
	2013	-	£26,490	£31,073	£27,676	£26,275	£26,645	-	£38,872	-	-	-	-	£28,770
Telecommunications engineers	2014	£32,320	£29,924	£32,151	£32,320	£32,320	£32,320	£32,320	£32,320	£32,320	£32,320	£32,320	-	£32,320
	2013	£27,777	£29,511	£31,603	£30,778	£28,207	£32,421	£36,057	£33,980	£33,350	£32,531	£31,351	-	£32,253
TV, video and audio engineers	2014	£27,361	-	£31,889	£27,361	£27,361	£27,361	£27,361	£27,361	£27,361	£27,361	£27,361	-	£27,361
	2013	-	-	-	-	-	£23,839	-	£22,136	-	-	£27,937	-	£26,164
IT engineers	2014	£25,934	-	-	£25,934	£25,934	£25,934	£25,934	£25,934	£25,934	£25,934	£25,934	-	£25,934
	2013	-	-	£21,465	-	£21,855	£31,012	£31,306	£29,458	£27,945	-	£27,323	-	£27,064
Plumbers and heating and ventilating engineers	2014	£27,330	£24,716	£23,294	£27,330	£27,330	£27,330	£27,330	£27,330	£27,330	£27,330	£27,330	-	£27,330
	2013	£28,358	£27,230	£29,233	£29,932	£27,778	£27,844	£31,971	£27,094	£27,791	£27,108	£26,167	-	£27,832
All employees	**2014**	**£23,644**	**£24,608**	**£23,564**	**£24,172**	**£24,102**	**£25,704**	**£41,095**	**£28,198**	**£23,913**	**£22,877**	**£25,584**	**£21,616**	**£27,271**
	2013	**£23,367**	**£24,401**	**£23,672**	**£24,257**	**£24,746**	**£25,194**	**£41,143**	**£27,740**	**£23,773**	**£22,707**	**£25,729**	**£22,463**	**£27,174**

Source: Office for National Statistics – Annual Survey of Hours and Earnings

14.5 2013 survey of professionally-registered engineers and technicians

Salaries of professionally-registered engineers and technicians

Table 14.8 shows the mean and median salaries for Chartered Engineers, Incorporated Engineers, Engineering Technicians and ICT Technicians from the 2013 survey of professionally-registered engineers and technicians. Included in the table are comparisons of male and female salaries, which have been calculated using all respondents. The next survey will be in 2016 and will be fully reported in next year's report.

Table 14.8: Mean and median basic salaries for Chartered Engineers, Incorporated Engineers, Engineering Technicians and ICT Technicians (2013)

	Mean salary	Median salary
Chartered engineers	£68,539	£60,000
Incorporated engineers	£51,227	£45,000
Engineering technicians	£52,349	£37,000
ICT technicians	£36,423	£35,500
Male	£64,828	£55,000
Female	£53,471	£45,941

Source: Engineering Council 2013 Survey of Professionally Registered Engineers and Technicians

14.6 Working it out: what does the changing face of the jobs market mean for the engineering sector?

Authored by Hannah Feiner, Policy Advisor, Recruitment and Employment Confederation (REC)

The UK's diverse workforce continues to challenge employers in new ways, and businesses are having to use different recruitment methods to attract and retain talent in a market increasingly driven by the candidate. Sectors suffering from skills shortages, such as the engineering sector, need to address a lack of engagement with both female and older workers in order to counteract the current skills drought.

The market – the temporary and permanent landscape

The UK jobs market is continuing to perform well but REC research has indicated that more must be done to facilitate growth. Although confidence amongst hirers has improved, productivity is being restrained by a lack of suitable candidates. Eighty percent of respondents to the REC's JobsOutlook survey stated that economic conditions are getting better but a substantial majority of businesses continue to report that they have 'no' or only 'a little' surplus capacity to accommodate any further increase in demand.[943] Employers have indicated that, overall, growth of staff appointments has been frustrated by skills shortages;[944] the engineering sector in particular continues to report a lack of candidates, with one in ten employers concerned that they expect to see shortages of candidates for engineering roles within the next year.[945]

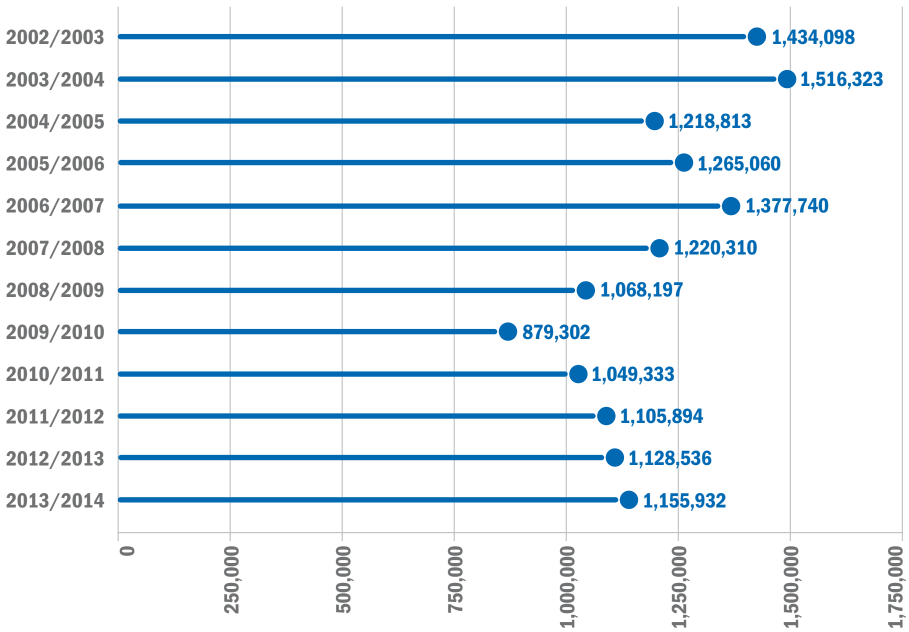
In summer 2015, the rate of permanent placements increased for the 34th month in a row but growth eased to the slowest it's been for over two years. Whilst 74% of employers are intending to take on permanent staff,[946] indicating an improvement in levels of confidence amongst businesses, many sectors still report candidate shortages for permanent roles. Engineering employees were one of the most sought-after types of permanent staff, with engineering ranking within the top five in-demand sectors for permanent placements for the majority of 2015.

As well as the growth of permanent placements, increasing numbers of people, especially in the engineering sector, want and need to work more flexibly. On any given day last year, there were 1.16 million people out on a temporary or contract assignment secured via a recruiter (Figure 14.4). This is an increase of 2.4% on 2012/2013. Of these, 13% were in engineering and technical roles.[947] Notably, nearly all respondents to the *JobsOutlook* survey (99%) stated that agency workers are paid the same or more than they would be as a permanent worker.[948] Eighty-four percent of respondents also said that the use of agency workers to provide short-term access to key strategic skills is now also significantly more important than any other benefits (Figure 14.5). The use of agencies to cover leave – the key benefit to hirers two years ago – now ranks sixth in importance. With one in seven people stating that they have used temporary work to gain experience,[949] and businesses continuously reporting that they are unable to source candidates, temporary placements can act as a stepping stone in upskilling workers and helping organisations secure the skillset of their future workforce.

Emerging workforce trends: the balance of power

There has been a shift in the way job-seekers view the balance of power between applicant and hirer: the labour market is becoming increasingly candidate driven. The REC's report,

Figure 14.4: Average daily temporary/contract recruitment volumes (2002/03-2013/14)



Source: REC Recruitment Industry Trends Survey 2013/2014

943 JobsOutlook, REC, July 2015. JobsOutlook surveys a representative sample of employers every month about their short and medium-term plans for hiring permanent and temporary staff. **944** Report on Jobs, REC and KPMG, August 2015. Report on Jobs is a monthly publication produced by Markit on behalf of the REC and KPMG. The report features original survey data which provide the most up-to-date monthly picture of recruitment, staff availability and employee earnings trends. **945** JobsOutlook, REC, July 2015. **946** *ibid.* **947** Recruitment Industry Trends Survey 2013/2014, REC, October 2014. **948** JobsOutlook, REC, July 2015. **949** Flex appeal: why freelancers, contractors and agency workers choose to work this way, REC, July 2014.

The candidate strikes back,[950] outlined the shift in influence between hirers and job-seekers. The REC found that businesses must do more to compete for candidates and that those looking for new jobs have increased bargaining power due to a higher number of vacancies. Furthermore, 51% of people who had a negative experience during an organisation's recruitment process discussed it with friends and family, and 38% shared their experience with people in their professional network. Additionally, 93% of workers who described their last candidate experience as 'bad' were not asked for feedback from the employer. These statistics are significant for industries such as engineering; organisations operating in sectors suffering from skills shortages need to be aware of the business implications if their recruitment process leaves a negative impression on a candidate. One in three workers stated that providing feedback to unsuccessful candidates is the single most important improvement employers could make (Figure 14.6), proving that simple but effective changes can be made by businesses in order to continue attracting the best talent in the UK.

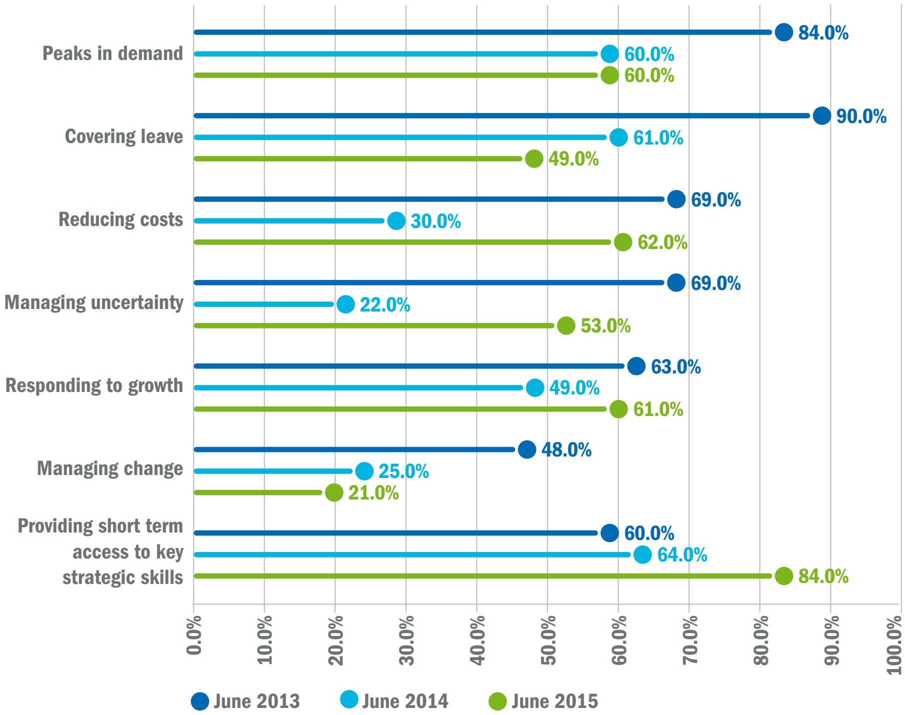
Gender in the engineering sector

The engineering workforce continues to lack gender diversity. The UK has one of the lowest numbers of female engineers in Europe[951] and this will need addressing in the coming years if the sector is to counteract skills shortages. Evidence shows that the choices students make at 16 are based on the perception that engineering is still a 'career for brainy boys' and it is at this critical age that women abandon engineering as a potential choice of career.[952] Although organisations such as WISE (the campaign to promote Women in Science, Technology and Engineering) and WES (Women's Engineering Society) are working to raise awareness of gender disparity in the industry, the long-term solution to improving the female take-up of engineering roles also lies with improved careers advice for young people as a whole. Work experience schemes and careers guidance must be more mindfully designed to encourage women to consider roles they feel aren't normally accessible. Teachers and families must also impress upon students – young women in particular – the opportunities available, and attitudes must change to curtail archaic and deep-rooted misconceptions about the engineering sector.

Engaging the older worker

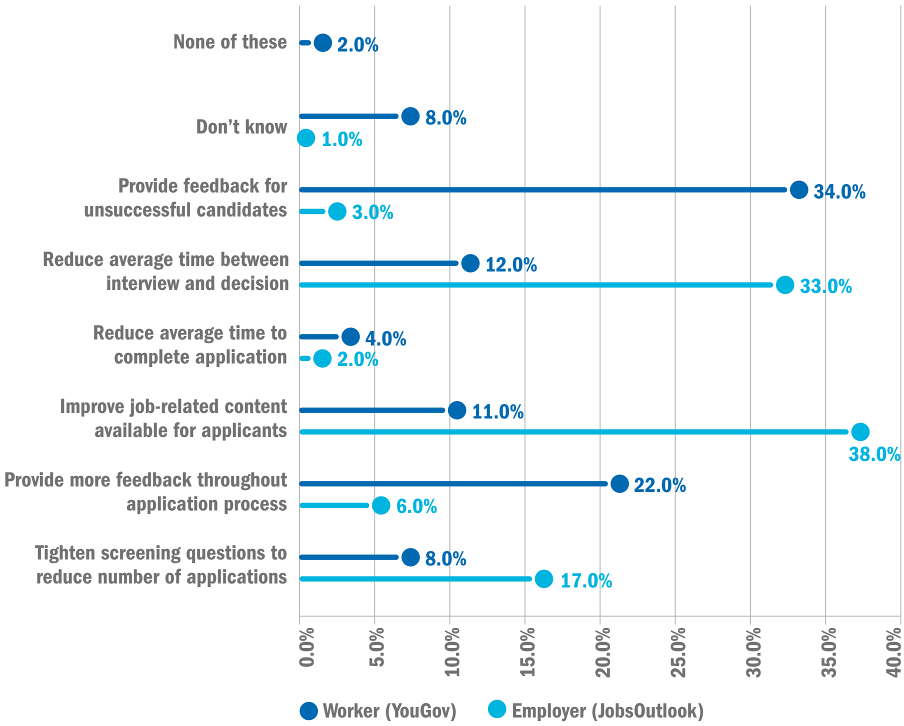
Despite the removal of the default retirement age, businesses need to do more to get the best out of the older part of the workforce. With four in ten unemployed older workers out of work for more than a year,[953] many need to be given a

Figure 14.5: Reasons why agencies are so important to employers (2013-2015)



Source: REC JobsOutlook July 2015

Figure 14.6: Most important change an organisation can make to enable a good application experience



Source: The candidate strikes back, REC, June 2015

950 The candidate strikes back, REC, June 2015. 951 Analysis of the European Labour Force Survey 2007, conducted by the UK Resource Centre for Women in Science, Engineering and Technology. 952 Women in Engineering: Fixing the Talent Pipeline, Institute for Public Policy Research, September 2014. 953 Labour Force Survey, ONS, May 2015.

better chance of finding employment. Previous research[954] has suggested that, of the 3.3 million people aged 50-64 who are economically inactive in the UK, approximately one million have been made 'involuntarily workless' due to redundancy, ill health or early retirement. Reintegrating this demographic back into the workforce could boost the UK's GDP by up to £88 billion. Results from an REC survey of employers released in January 2015 found that a third of respondents indicated that they should be providing more opportunities for older workers to upskill or reskill. A further 20% said that businesses needed to be more careful with language used in job adverts to avoid discouraging older workers. Older workers offer experience, skills and knowledge. But to enthuse this part of the workforce back into the labour market, organisations must give higher levels of consideration to attracting them, and be open to structuring work patterns differently. Whilst the abolition of the default retirement age may have completed the legislative necessities, it is clear that businesses still need to act more effectively to attract the older worker.

14.7 The state of UK engineering recruitment – demand outstrips supply as skills gaps bite

Authored by Chris Moore, Managing Director, Roevin Engineering

The first half of 2015 has been extremely positive for the UK economy: we've enjoyed the lowest unemployment rate since early 2008 (5.5%), recorded the highest wage growth since August 2011 (2.6%), and been dubbed the fastest growing economy in the G7 this year by the OECD. And the upward turn hasn't escaped the engineering sector.

Healthy economy bolsters demand for engineering professionals

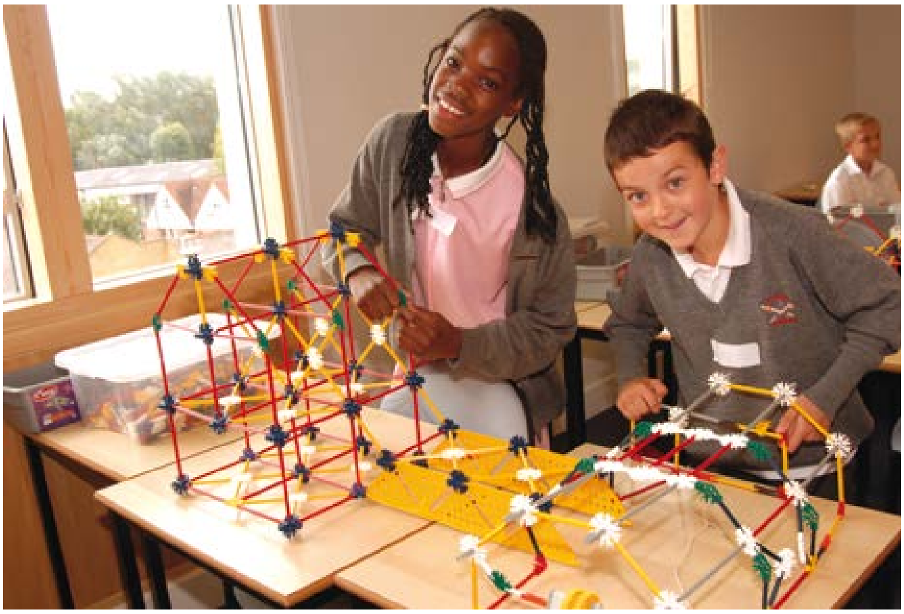
According to the Markit/CIPS Purchasing Managers' Index, confidence in the construction sector is at its highest for 11 years; construction firms are hiring at their fastest pace for six months, leading to a growth of 18% year on year.

We've also seen an astonishing rise in the demand for nuclear engineers (up 40% year on year), with the confirmation of a new plant at Sellafield, Cumbria. There's been a similar jump of 33% year on year within the automotive industry, which has sped up on the back of domestic demand. In fact, 2014 saw a ten-year high in the number of new cars sold (2.47 million), and the highest number of cars made (1.528 million) since 2007.

And while control systems and mechanicals enjoyed rises of 18% and 15% respectively (year on year), the most impressive hike in demand can be traced back to the renewables sector, with a hearty increase of 138%. This more than doubled in the 12 months to May, and we expect it to continue as a major force for the next ten years.

However, it's not all plain sailing

Demand for pipeline and drilling professionals dropped by 79% in the 12 months to May 2015. This sharp decline is in direct correlation to the Middle East ramping up production – flooding the market with cheap crude oil, and preventing other oil producing countries from stabilising or raising prices in order to carry out further (expensive) exploration.



Burgeoning skills shortages threaten to stunt engineering growth

In December 2014, the REC recorded skills gaps in every area of engineering – making the shortage of skilled candidates the single biggest issue facing the UK engineering industry today.

According to EngineeringUK, the industry needs 107,000 new engineers with level 4+ skills each year in order to function and compete effectively. However, only 66,000 are being produced each year. Figure 14.7 makes it very obvious that demand is far outstripping supply. And that figure doesn't even take into account a recent report issued by the House of Lords Science and Technology Committee, in which it states that almost half of all STEM graduates take up employment in non-STEM areas.

In response to the skills deficit presently threatening organisational performance, we've seen a rise in engineering, construction, automotive and aerospace salaries (increasing by 7.3%, 5.4%, 5.2% and 9.7% respectively – Figure 14.8) as companies vie for available talent. But it's not increased salaries alone that are being used to plug the skills gap; we're also looking further afield.

UK employers turning to foreign talent

The extent to which we rely on immigration for engineering skills is reflected in the Tier 2 shortage occupation list, which details those occupations without sufficient resident workers to fill available jobs.

The ongoing increase in demand for specialist engineering skills is far outstripping the potential short term supply, as reflected in the occupation list. Engineering jobs dominate the list, accounting for half of the 119 job titles, with a further 20% in closely-related scientific and technical areas.

But what can we do about it?

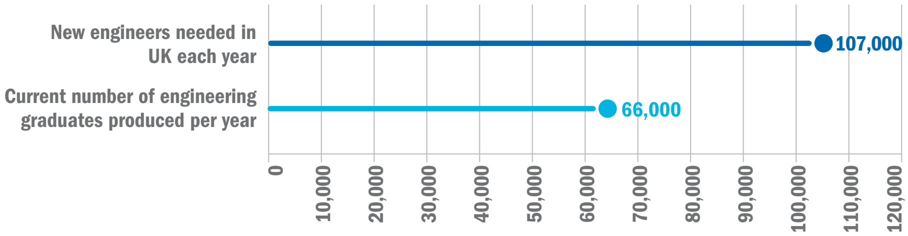
Changing perceptions

There are more women in work than at any other point in British history, and yet women make up just 6% of the UK's engineering workforce.

Parent company Adecco Group's recent 'Gender Agenda' report found that a surprising 70% of girls aged 14-16 would be interested in a career in STEM; clearly then, these girls are getting lost somewhere along the way. And it's little wonder when many still view engineering as a 'subject for boys'.

954 The missing million: illuminating the employment challenges of the over 50s, Business in the Community, October 2014.

Figure 14.7: UK engineering – demand and supply (2013/14)



Source: EngineeringUK[955]

The IET believes the skills shortage could be plugged if outdated perceptions about engineering and STEM subjects were changed. IET Chief Executive Nigel Fine said the current situation meant there was a need to "promote engineering as an appealing career choice to young people." And we couldn't agree more.

For Britain's engineering industry to thrive in the face of global competition, we need to communicate a modern vision of the sector. Rhys Morgan, Director of Engineering and Education at the Royal Academy of Engineering, recently said: "The perception persists that engineering is part of the old economy – a relic of dirty manual trades like working on the railways."

But there is help from popular culture. In today's tech-savvy society, geeks rule the world. One of our most popular TV shows – The Big Bang Theory – celebrates and challenges what it means to be a 'geek' in a world so reliant on technology, while Google has been named, for the sixth time, as the number one company to work for by Fortune.

The industry is changing; jobs are becoming more exciting, and the people who occupy them, more influential. Engineering of the future will be about renewable energy and the future of our planet. It will be about carbon neutral houses and recycling water. To give one example, the Sydney Desalination Plant in Australia is vital to maintain the water supply for the Greater Metropolitan area. Not only is the plant a masterstroke of engineering, pumping 250 cubic mega-litres of water each day, but it has been powered entirely through wind farm technology.

The possibilities are endless, but if the UK hopes to influence the future of engineering – and enjoy everything the industry has to offer – more needs to be done to acquire the right skills to make it happen.

Capturing scarce talent in a competitive market

Chris Moore, Managing Director of Roevin Engineering, sums it up well. *"STEM recruitment is already a highly competitive playing field, and it's likely to get even tougher for employers in the foreseeable future. As a result, companies are going to have to use every tool in their arsenal if they want to attract the skills necessary to drive their businesses forward. And it's not just about salaries: flexible working, work/life balance options, career development, upskilling, and office environment are all becoming increasingly important to today's job seekers. As such, those hoping to attract the most talented candidates would do well to start promoting these benefits in their employment packages."*

"We know the next generation is motivated by the future low carbon environment and flexible workplaces. Employers need to help them make the link between these interests and a career in engineering, designing the structures that make this future possible," says Keith Gallagher, business director at Roevin.

Recent research from EY (formerly Ernst & Young) suggests that non-fiscal benefits are even more important for new graduates. For the 'millennial' generation, salary is not always the overriding factor when deciding on which employer to pledge allegiance to. In fact, quality of training is now the most influential factor.

In a nod to the direction the industry is heading in – with a particular focus on the future of our planet – Corporate Social Responsibility is also gaining traction with the job seekers of today. In fact, a survey by our sister company Spring Technology found that one in ten technology candidates based in London considered CSR a deal breaker when making employment choices.

As markets become more congested, engineering candidates will be forced to take far more factors into account than ever before to simply aid in their decision making. And increasingly, technology professionals want to work for companies that do some good.

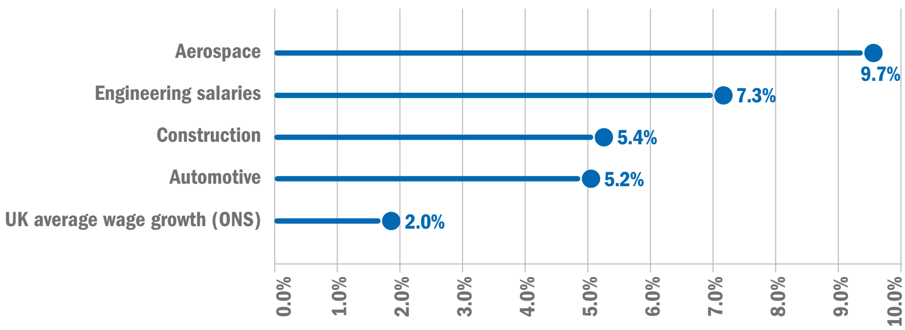
Engineering: the new world

The future of engineering is exciting, but we need Millennials to really get involved and drive it. What's more, we need to encourage more women into the industry if we are to stand any chance of plugging the skills gaps that threaten to bar us from global innovation.

Employers will need to get far more involved in shaping perceptions of the engineering sector and the exciting range of careers it has to offer, starting from a young age, before potential talent is lost to other avenues.

Fundamentally, the UK's engineering industry must play a bigger part in encouraging innovation and new thinking: a low carbon economy will change the way that we work and live, but if we want to be at the forefront of these exciting changes, we need to nurture and encourage the talent that will secure our place in this global race.

Figure 14.8: Rise in advertised salaries by sector (April 2013 – April 2014)



Source: APSCo/Broadbean[956]

955 Engineering UK 2015: The state of engineering, EngineeringUK, January 2015, p151 956 Professional Recruitment Trends Report June/July 2015, July 2015

Part 3 - Engineering in Employment
15.0 Skills Shortage Vacancies and employment projections

The extension to Working Futures 2012-2022 for engineering enterprises shows that demand for occupations most likely to require intermediate or higher engineering skills is approximately 162,000 per year. Of this figure, around 56,000 vacancies will be at level 3, and 107,000 occupations will require expertise at level 4 or above. However, as discussed in this chapter, our analysis of the supply data shows an annual shortfall of individuals with these skills of 69,000: approximately 28,000 at level 3 and 40,000 at level 4+. Compounding this issue is a projected decline in the population of young people over the next 10 years, a fall in employer training in the workforce, and the fact that engineering enterprises are more likely than average to have Hard-to-Fill vacancies.

As the development of new technology continues to accelerate, whole new industries will open up that did not exist even a few years ago. From artificial intelligence and Big Data to driverless cars and commercial spaceflight, an exciting and promising future of engineering is ripe for the taking. Therefore, it is essential that the UK retains its competitive edge and continues to train its population to the highest levels of technical and vocational knowledge, lest we bequeath the future of engineering to other, hungrier nations.

China produces 20-times more engineers than the UK every year. What's more, a third of them are women.[957] Women account for only 7% of the professional engineering workforce in the UK, and less than 4% of engineering technicians.[958]

The UK currently has over one million people working in the science, engineering and technology sectors. While this accounts for 3.7% of the workforce, it still compares unfavourably to the European average of 5.3%.[959]

As Figure 15.1 illustrates, the profile of the UK labour force is changing. A reduction in traditionally middle-level jobs has been met by a bi-polar expansion of low- and high-skilled roles. This trend has been dubbed the 'hour glass economy'[960] and attests to the increasing importance that higher level training will play in ensuring the UK's future economic prosperity.

957 James Dyson quoted in the Huffington Post: Getting Women Into Engineering Is Vital, 23rd June, 2015 **958** IET: Engineering and Technology, Skills and Demand in Industry, 2013, p5 **959** Association of Colleges: Breaking the Mould – creating higher education fit for the future, 2014, p29 **960** UKCES: The Labour Market Story: An Overview, July 2014, p10

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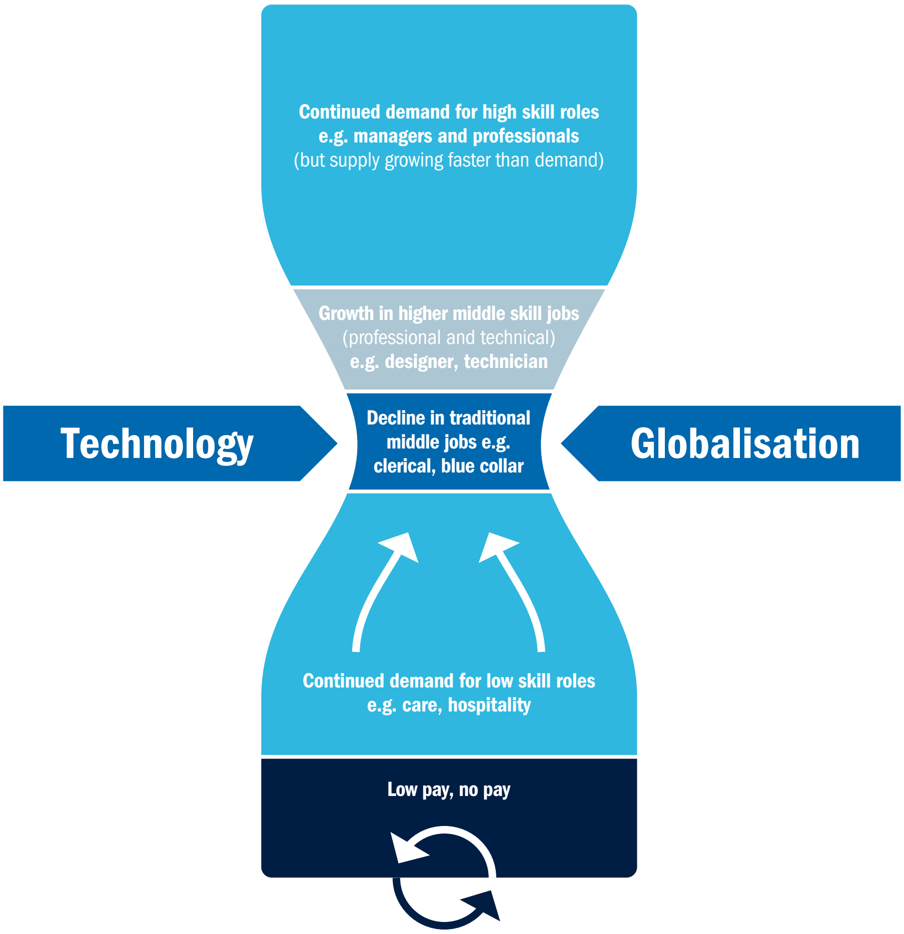
Figure 15.1: Future shape of the labour market[961]



Source: UK Commission for Employment and Skills

Businesses are continuing to report major skill shortages in sectors such as manufacturing, engineering, construction and digital. According to a survey conducted by the Confederation of British Industry, close to half of all businesses (42%) said that they would like to see an increase in the number of science, technology, engineering and maths graduates.[965] Furthermore, in research conducted by the Institution of Engineering and Technology, 59% of engineering employers expressed concern that a shortage of engineers posed a threat to their business.[966]

The European Commission notes that – in contrast to most of the EU, where labour shortages fell sharply after the global financial crisis – the UK was unique in experiencing shortages in the industrial sector.[967]

According to the UK Commission's Employer Skills Survey, 43% of vacancies in 2013 for professionals working in science, research, engineering and technology were Hard-to-Fill due to skills shortages. This figure is almost twice as large as the all-occupations average, making STEM sectors the worst affected of all 25 occupational groups.[968]

Table 15.2 shows the profile of Hard-to-Fill vacancies by occupation for both all enterprises and all engineering enterprises. Engineering enterprises were less likely than average to have skills shortages for professional occupations (Table 15.2). However, they have nearly double the proportion of Hard-to-Fill vacancies amongst professionals (31.7% compared to 17.6%). For

However, the demand for higher skills is currently outpacing supply. By 2022, the UK commission on Employment and Skills (UKCES) estimates that two million more jobs will require higher level skills. Furthermore, UKCES notes that more than one in five of all vacancies are Skills Shortage Vacancies.[962]

15.1 Skills shortages and Hard-to-Fill vacancies

Table 15.1 shows the profile of Skills Shortage Vacancies by occupation for all enterprises, and also for all engineering enterprises. For most occupations, the proportion of vacancies that are classed as Skills Shortage Vacancies is similar for all enterprises and all engineering enterprises. However, one in five (19.7%) vacancies in the professional occupations were classed as Skills Shortage Vacancies, compared with 14.3% for engineering enterprises. Also, the incidence of Skills Shortage Vacancies in skilled trades occupations was almost double for engineering enterprises (23.9%) than it was for all enterprises (13.6%).

Table 15.1: Profile of Skills Shortage Vacancies, by occupation, for all enterprises and engineering enterprises (2013) – UK[963, 964]

	All enterprises		All engineering enterprises	
	Count	Percentage	Count	Percentage
Managers	4,706	3.2%	839	2.4%
Professionals	28,780	19.7%	5,040	14.3%
Associate professionals	25,357	17.4%	6,271	17.7%
Administrative/clerical staff	8,931	6.1%	1,058	3.0%
Skilled trades occupations	19,825	13.6%	8,457	23.9%
Caring, leisure and other services staff	27,001	18.5%	*	*
Sales and customer services staff	10,077	6.9%	1,026**	2.9%**
Machine operatives	7,408	5.1%	2,848	8.1%
Elementary staff	10,700	7.3%	922**	2.6%**
Unclassified staff	3,402	2.3%	*	*
Unweighted row	10,817		2,920	
Weighted	146,187		35,340	

Source: Bespoke analysis of UK Commission Employer Skills Survey
* Data suppressed as the unweighted base size is too small to be reliable
** Figures are indicative only due to small base size

961 *ibid*, p10 962 UKCES: Forging futures: building higher level skills through university and employer collaboration, 22nd of September 2014, p4 963 *=Data suppressed as unweighted base size is too small to be reliable. 964 **=Figures are indicative only due to small base size 965 CBI: Gateway to growth: CBI/Pearson education and skills survey 2014, 2014 966 Institution of Engineering and Technology: Skills and Demands in Industry, 2014, p4 967 European Commission: Labour market shortages in the European Union, 30th April, 2015, p40 968 UKCES: Reviewing the requirement for high level STEM skills, July 2015, p6

skilled trades occupations, the proportion of Hard-to-Fill vacancies is almost double for engineering enterprises (24.8%) than it is for all enterprises (12.6%).

Figure 15.2 displays the results of a survey conducted by the Association of Graduate Recruiters, which shows that businesses in several engineering-related sectors reported amongst the largest proportion of unfilled vacancies in 2013/14. For example, in the IT and telecommunications sectors, employers reported than on average over one in ten (11.8%) vacancies were unfilled, and around 7.7% of vacancies in construction companies were not filled. This compares to an average figure of 5.4%.

What is a Skills Shortage Vacancy and how does it differ from a Hard-to-Fill vacancy?

A Skills Shortage Vacancy (SSV), is a type of vacancy that occurs when an employer is unable to find workers with the skills or experience they require. A Hard-to-Fill vacancy, on the other hand, may not be due to an absolute shortage of skills in the labour force, but as a result of not being able to recruit the skilled workers that do exist due to factors such as competition from other employers, and the geographical location of the business.[971]

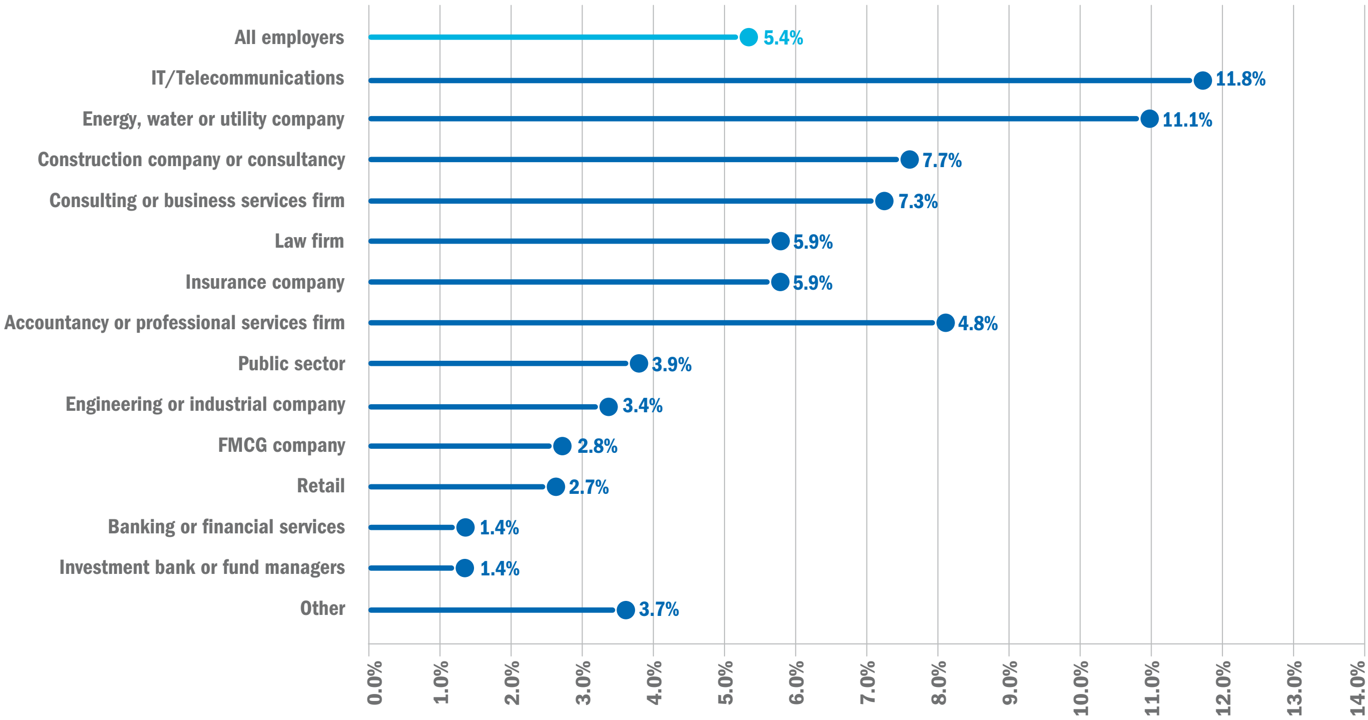
Table 15.2: Profile of Hard-to-Fill vacancies, by occupation, for all enterprises and engineering enterprises (up to six vacancies) (2013) – UK[969, 970]

	All enterprises		All engineering enterprises	
	Count	Percentage	Count	Percentage
Managers	5,883	3.1%	973	2.4%
Professionals	33,375	17.6%	12,872	31.7%
Associate professionals	30,649	16.2%	6,951	17.1%
Administrative/clerical staff	11,154	5.9%	1,266	3.1%
Skilled trades occupations	23,820	12.6%	10,051	24.8%
Caring, leisure and other services staff	36,118	19.1%	*	*
Sales and customer services staff	14,291	7.5%	1,631	4.0%
Machine operatives	10,694	5.6%	3,347	8.3%
Elementary staff	18,622	9.8%	830**	2%**
Unclassified staff	4,722	2.5%	1,739	4.3%
Unweighted row	14,050		3,324	
Weighted	189,328		40,552	

Source: Bespoke analysis of UK Commission Employer Skills Survey

Figure 15.3 shows the barriers that employers are experiencing in recruiting STEM staff. Almost half (48%) of businesses reported that the quality of STEM graduates was a key factor in being unable to recruit appropriate staff, whereas a similar proportion responded that there was an absolute shortage of STEM graduates (at 46%). It is interesting to note that around a third of employers noted that a lack of general workplace experience and the appropriate attitude for working life were issues they experienced when trying to recruit STEM

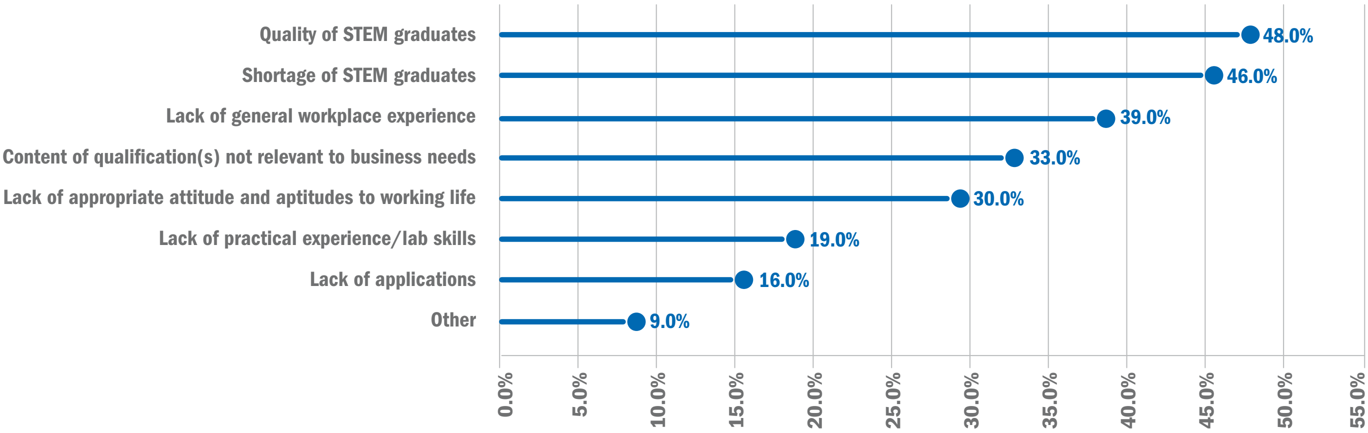
Figure 15.2: Average proportion of unfilled vacancies by sector (2013/14)[972]



Source: Association of Graduate Recruiters

969 *=Data suppressed as unweighted base size is too small to be reliable. 970 **=Figures are indicative only due to small base size 971 UKCES: Skills Shortage Vacancies: UKCES explains, 4th June 2014 972 Association of Graduate Recruiters: Graduate Recruitment Survey 2015 Winter Review, 2015, p20

Figure 15.3: Barriers experienced by business in recruiting STEM staff[974]



Source: Confederation of Business and Industry

staff. This issue may be compounded by findings from UKCES, which revealed that the number of 16- and 17-year-olds combining part-time work with their studies has halved, from just over two-fifths (42%) in 1996 to only 18% in 2014.[973] As a result, graduates in the future may be less prepared for working life than has been the case traditionally.

Table 15.3 reveals that, for engineering enterprises, Hard-to-Fill vacancies resulted in an increased workload for staff (87.0%) and made it difficult for them to meet customer needs (56.1%).

As well as looking at the main implications overall, it is worth noting where the implications of Hard-to-Fill vacancies are greater for engineering enterprises than they are for other enterprises. These include:

- Difficulties meeting customer services objectives (56.1% compared with 47.0%)
- Delay developing new products or services (48.3% compared with 41.0%)
- Lose business or orders to competitors (45.4% compared with 40.4%)
- Outsource work (35.2% compared to 27.5%)
- Have difficulties introducing technological change (25.8% compared to 19.9%)

STEM skills shortages are also affected by geography. UKCES has noted that London appears to be a magnet for inward commuters with high-level STEM skills, which leads to employers in neighbouring regions finding it difficult to attract the necessary workforce needed to run their business.[977] This dynamic is corroborated by data discussed in Section 2.0 (Table 2.7) of this report. This showed that in 2014, the East of England was the only English region to see a decline in the number of

Table 15.3: Implications of hard-to-fill vacancies for all enterprises and engineering enterprises (2013) – UK[975, 976]

	All enterprises		All engineering enterprises	
	Count	**Percentage**	**Count**	**Percentage**
Increase workload for other staff	74,817	83.4%	16,153	87.0%
Have difficulties meeting customer services objectives	42,139	47.0%	10,414	56.1%
Delay developing new products or services	36,763	41.0%	8,963	48.3%
Lose business or orders to competitors	36,251	40.4%	8,421	45.4%
Experience increased operating costs	36,003	40.1%	8,309	44.8%
Have difficulties introducing new working practices	31,720	35.3%	5,712	30.8%
Have difficulties meeting quality standards	29,826	33.2%	5,578	30.1%
Outsource work	24,707	27.5%	6,538	35.2%
Withdraw from offering certain products or services altogether	20,860	23.2%	4,377	23.6%
Have difficulties introducing technological change	17,862	19.9%	4,789	25.8%
None	5,204	5.8%	893	4.8%
Don't know	198	*	*	*
Unweighted row	6,133		1,449	
Weighted	89,732		18,561	

Source: Bespoke analysis of UK Commission Employer Skills Survey

employees – down 11.9% from the 2013 level. London saw the largest growth in the number of employees, up 15.5% on 2013. Furthermore, the National Assembly for Wales has noted that the nation experiences a catch-22 situation when it comes to securing a skilled workforce. The desire to attract high-value industry to Wales is limited by a shortage of skilled graduates to support it, which is a result of there not being a high-value industry present to retain such skilled potential employees.[978]

The construction sector in particular has experienced a sudden skills shortage, brought about by the recent slump in house building, which led to a migration of labour from the industry. In London, it has been estimated that a third of the largest construction companies have had to turn down bidding opportunities due to a shortage of skilled labour.[979]

According to research carried out by the Construction Industry Training Board (CITB), one

973 UK Commission for Employment and Skills: Students “can't see the jobs for the grades” as the number of teenagers combining study and work plummets, 16 June 2015 974 CBI: Gateway to growth: CBI/Pearson education and skills survey 2014, p21 975 *=Data suppressed as unweighted base size is too small to be reliable. 976 **=Figures are indicative only due to small base size 977 UKCES: Reviewing the requirement for high level STEM skills, July 2015, p7 978 National Assembly for Wales: Enterprise and Business Committee, Science, Technology, Engineering and Mathematics Skills, September 2014 979 The Guardian: UK needs plumbers, builders and engineers as skill crisis hits economy, Tuesday 10th February

in eight construction businesses face a skills shortfall, with 182,000 new workers required over the next five years to meet projected demand. To achieve this, the CITB estimates that the number of apprenticeships in construction needs to more than double. However, the CITB notes that negative perceptions of construction still act as a barrier that prevents young people from pursuing a career in the industry, with over a third of careers advisers believing that a career in construction is unattractive.[980]

15.2 New industries

The many new industries that are forecast to develop over the coming decades pose serious implications for the future requirement of STEM skills. For example, the UK Commission for Employment and Skills (UKCES) notes that the advance of robotics and 3D printing is leading to an increase in demand for highly-skilled, IT literate workers to work in the UK's advanced manufacturing sector which, in turn, is leading to a decrease in low-skilled and machine operative roles.[981] The global advanced manufacturing market is forecast to total £750 billion in 2020, almost double its current size.

The demand for higher level IT skills will also be driven by the increasing adoption of robotics in areas traditionally served by human labour. This includes service industries such as health care (supporting or conducting surgery as well as attending to patient care), palliative care (in particular in ageing societies) and the transportation of passengers and goods in autonomous vehicles.[982]

Another area projected to experience dramatic growth over the coming years is that of Big Data. Demand for Big Data refiners is already outstripping supply.[983] The results of a survey conducted by the Tech Partnership and SAS revealed that there has been a tenfold increase in demand for Big Data staff in the past five years, with vacancies increasing from 1,800 in 2008 to 21,400 in 2013. This equates to an average annual increase of 21%. Furthermore, it is worth noting that over the past year, there's been a 41% increase in the number of Big Data jobs advertised.

However, perhaps the technological development most likely to cause disruption in the UK and global labour markets over the coming decades is that of artificial intelligence. Over the previous decade, artificial intelligence (AI) applications have been used in several areas, most prominently in predicting financial stocks for trading, but the future will see them adopted in other fields such medical diagnosis, education and computer games.[984]

15.3 Employer training

It is worth noting that technological developments alone will not drive growth in higher level skills. UKCES notes that such technical change will have to be met by organisational change to optimise the gains from technology.[985] For this reason, people who have hybrid skillsets, such as technology and project management skills, are likely to be in great demand: employees will need to seek continued training throughout their careers to adapt to the rapidly changing landscape of the UK economy.[986] Furthermore, training the existing workforce – who, unlike graduates, are experienced and have already shown an aptitude for work – will be key to addressing skills shortages.

The Department of Business, Innovation and Skills notes that only 1.3 million businesses in the UK provide training for their workers. With an annual investment of only £43 billion, the UK compares unfavourably to other countries.[987] Furthermore, the department highlights that 900,000 UK businesses do not provide any training, whilst the amount spent on training has declined by £2.5 billion since 2011, with spending per employee decreasing by 17% during the same period. Moreover, training has become shorter, with an increase in training in lower lever skills (e.g. health & safety).[988]

However, there is evidence to suggest that some businesses are responding to the need for greater employer training. For example, the Confederation of British Industry notes that there are far more firms planning to increase their investment in employee training and development during the coming year than there are firms planning to cut back. This has resulted in a positive balance of 26%. Furthermore, this increase in training was greater for construction employers (44%), reflecting recognition of the need to tackle skill shortages in this sector.[989]

The government is investing £30 million in business for them to implement innovative approaches in tackling skills shortages in engineering. The Improving Engineering Careers scheme provides funding for training and re-skilling programmes, with an aim to increase workforce skill levels to professional status. Furthermore, the Developing Women Engineers scheme has been established to support employers in developing their female engineering workforce. A key benefit of this scheme is 'returner training', which helps women return to engineering after a break in their career, commonly caused by leaving work to raise children.[990]

15.4 Labour force projections

Working Futures 2012-2022 predicts that there will be 12 million job openings created by those who leave the labour market over this 10-year period.[991] There will also be 1.8 million new job openings created over the period. Replacement demand – i.e. replacing those who leave the labour market – occurs in all industries and all occupations, including those where the net level of employment will significantly decline.

The Working Futures report also predicts a significant increase in the size of the working population and the potential economically-active workforce, but that there will be a small decline in the participation rate in the labour

980 OFSTED: The report of Her Majesty's Chief Inspector of Education, Children's Services and Skills 2013/14 Further education and skills, 2014, p20 **981** UK Commission for Employment and Skills: Rise of the machines causing skills shortages, new report finds, 29 June 2015 **982** *Ibid*. **983** SAs and the Tech Partnership: Big Data Analytics Assessment of Demand for Labour and Skills 2013–2020, October 2014, p4 **984** UKCES: The Future of Work: Jobs and skills in 2030, February 2014, p37 **985** UKCES: The Labour Market Story: An Overview, July 2014, p10 **986** *Ibid*. **987** Department for Business, Innovation and Skills: Dual mandate for adult vocational education, a consultation paper, March 2015, Page p15 **988** *ibid*, p15 **989** CBI: Gateway to growth: CBI/Pearson education and skills survey 2014, 2014, p7 **990** Department for Business, Innovation and Skills: Engineering Skills: Perkins Review Progress Report, November 2014, p9 **991** Working Futures 2012-2022, UK Commission for Employment and Skills, March 2014, pxii

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market.[992] This is caused by the aging population and changes in statutory pension ages. They also highlighted that the manufacturing sector will see a small decline in the total share of employment, down one percentage point to 7%, but that it will maintain its share of output at about 10%.

Table 15.4 shows that eight occupations are projected to grow by at least 15% over the 10-year period. These are:

- Corporate managers and directors – up 22.5%
- Science, research, engineering and technology professionals – up 20.4%
- Health professionals – up 25.0%
- Business, media and public service professionals – up 19.8%
- Health and social care associate professionals – up 30.7%
- Business and public service associate professionals – up 17.0%
- Caring personal service occupations – up 26.9%
- Customer service occupations – up 20.8%

By comparison, three occupations are expected to decline by at least 15%. These are:

- Secretarial and related occupations – down 34.6%
- Textiles, printing and other skilled trades – down 35.5%
- Process, plant and machine operatives – down 26.1%

For process, plant and machine operatives, the job losses are concentrated amongst full-time jobs, especially amongst men.[993]

The table also shows that the following engineering-related occupations will need to recruit around half their current workforce, in ten years, to meet replacement and expansion demand:

- Science, research, engineering and technology professionals – 52.7%
- Science, engineering and technology associate professional – 40.3%
- Skilled construction and building trades – 40.1%

Table 15.4: Expansion and replacement demand by occupation (2012-2022) – all UK industries[994, 995]

	Base employment level 2012 (thousand)	Expansion demand (thousand)	Percentage of base	Replacement demand (retirements and mortality) (thousand)	Percentage of base	Net requirement (excluding occupational mobility) (thousand)	Percentage of base
Corporate managers and directors	2,189	493	22.5%	844	38.5%	1,337	61.1%
Other managers and proprietors	1,115	93	8.3%	534	47.9%	627	56.2%
Science, research, engineering and technology professionals	1,731	354	20.4%	559	32.3%	913	52.7%
Health professionals	1,330	332	25.0%	572	43.0%	905	68.0%
Teaching and educational professionals	1,507	152	10.1%	666	44.2%	818	54.2%
Business, media and public service professionals	1,701	337	19.8%	739	43.4%	1,076	63.3%
Science, engineering and technology associate professional	532	47	8.9%	167	31.4%	215	40.3%
Health and social care associate professionals	334	102	30.7%	138	41.5%	241	72.1%
Protective service occupations	450	-39	-8.7%	112	24.8%	72	16.1%
Culture, media and sports occupations	610	88	14.5%	259	42.5%	347	56.9%
Business and public service associate professionals	2,255	384	17.0%	865	38.3%	1,249	55.4%
Administrative occupations	2,811	-159	-5.7%	1,176	41.8%	1,017	36.2%
Secretarial and related occupations	945	-327	-34.6%	431	45.6%	104	11.0%
Skilled agricultural and related trades	403	-41	-10.2%	205	50.7%	164	40.6%
Skilled metal, electrical and electronic trades	1,340	-103	-7.7%	419	31.3%	316	23.6%
Skilled construction and building trades	1,116	73	6.6%	374	33.5%	447	40.1%
Textiles, printing and other skilled trades	663	-236	-35.5%	198	29.8%	-38	-5.7%
Caring personal service occupations	2,212	594	26.9%	1,015	45.9%	1,609	72.7%
Leisure, travel and related personal service occupations	647	55	8.5%	310	47.9%	364	56.3%
Sales occupations	2,032	-202	-10.0%	718	35.3%	516	25.4%
Customer service occupations	666	138	20.8%	235	35.3%	373	56.1%
Process, plant and machine operatives	810	-211	-26.1%	226	27.9%	14	1.8%
Transport and mobile machine drivers and operatives	1,179	-3	-0.2%	504	42.7%	501	42.5%
Elementary trades and related occupations	577	-23	-4.0%	194	33.7%	171	29.7%
Elementary administration and service occupations	2,771	-44	-1.6%	1,043	37.6%	998	36.0%
All occupations	31,926	1,855	5.8%	12,501	39.2%	14,356	45.0%

Source: UK Commission for Employment and Skills[996]

992 *ibid*, px 993 *ibid*, p77 994 Numbers may not sum due to rounding errors 995 Occupational and geographical mobility are assumed to be zero in these estimates 996 Working Futures 2012-2022, UK Commission for Employment and Skills, March 2014, p85

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15.5 Labour force projections for engineering enterprises

For this section of the Engineering UK Report we have worked with Warwick Institute for Employment Research to create a bespoke extension of the Working Futures 2012-2022 for engineering enterprises. The analysis shows that engineering companies are now projected to see 2.56 million job openings across a diverse range of disciplines between 2012 and 2022. This represents 17.8% of all job openings across all industries by 2022 and is equivalent to 47.2% of the workforce who currently work in engineering enterprises (5.4 million). Of these 2.56 million jobs, 2.3 million will be to replace workers who are leaving the workforce, while the remaining 257,000 will be new jobs.

However, it is important to note that not everyone working in an engineering company will be employed in an engineering role. Furthermore, not all engineering roles will require the same level of skills.

Table 15.5 provides a breakdown of the demand for jobs across the major occupation groups as identified in SOC 2010. We have then broken these major groups down by the sub-groups that we regard as most likely to require engineering skills and the level required.

We consider that those employed in engineering companies as corporate managers and directors, other managers and proprietors, and science, research and engineering technology professionals will require engineering skills at level 4 or above.

Furthermore, we calculate that a proportion of those employed as science, engineering and technology associate professionals and business and public service associate professionals, will require engineering skills at level 4 or above. The proportion of those employed in these professions was calculated from the proportion of people working in these occupations in 2012 who had a level 4+ qualification.

The demand for level 3 engineering skills was calculated as pertaining to those working in skilled trades occupations such as metal, electrical and electronic trades, construction and building trades and textiles, printing and other skilled trades. Furthermore, a proportion of those employed as science, engineering and technology associate professionals and business and public service associate professionals, we regarded as requiring engineering skills at level 3+. This was calculated from the percentage of people working in these occupations in 2012 who had a level 3 qualification.

15.5.1 Calculation of demand

As Table 15.5 shows, the overall demand by 2022 for workers in engineering companies due to new job positions (expansion) is 257,100 and the demand created by the existing workforce leaving is 2,303,900. This gives a total demand for workers in the engineering sector of 256,110 per year. Considering specific engineering occupations, expansion demand by 2022 for all skill levels is 157,600, and replacement demand is 1,658,900. This results in a total demand of 181,680 workers in engineering roles per year.

For engineers with level 3 skills, the expansion demand is actually negative, with a decline of 55,358 jobs predicted between 2012 and 2022. This is consistent with predictions that middle-level jobs will see a reduction over the coming years in favour of lower- and higher-skilled occupations. However, replacement demand at level 3 is estimated at 611,277, resulting in an annual requirement of 55,592 workers with engineering skills at level 3.

Looking at demand for level 4 skills and above, expansion demand is estimated at 360,158 between 2012 and 2022, with replacement demand calculated as 706,423. This results in an annual requirement for 106,658.

It is important to point out that the expansion demand for level 4 positions is higher than the expansion demand for engineering enterprises in general across all skill levels and occupations. This is due to the stark decline in the number of new jobs expected to be created at level 3 and below. In real terms, this can be expressed as an upskilling of the engineering sector, with the creation of new jobs for those with level 4 engineering skills or higher far outstripping those at lower skill levels.

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Table 15.5: Expansion and replacement demand in the engineering sector by occupation and skills required (2012-2022) – UK

	Major group	Engineering skills sub-group		Expansion by 2022	Replacement by 2022	Total requirement by 2022	Annual requirement
Occupations requiring skills and experience equivalent to level 4+	**Managers and senior officials**			**138,900**	**299,000**	**437,900**	**43,790**
		11. Corporate managers and directors		130,000	240,900	370,900	37,090
		12. Other managers and proprietors		8,900	58,100	67,000	6,700
	Professional occupations			**248,000**	**458,600**	**706,600**	**70,660**
		21. Science, research and engineering and technology professionals		169,700	270,500	440,200	44,020
Occupations requiring either level 4+ or level 3 skills and experience	**Associate professional occupations**			**102,600**	**311,500**	**414,100**	**41,410**
		31. Science, engineering and technology associate professionals		22,900	72,700	95,600	9,560
		31a. % working with level 4 qualifications or above	53.9%	12,335	39,159	51,494	5,149
		31b. % working with level 3 qualifications or below	46.1%	10,565	33,541	44,106	4,411
		35. Business and public service associate professionals		67,000	167,000	234,000	23,400
		35a. % working with level 4 qualifications or above	58.5%	39,223	97,764	136,987	13,699
		35b. % working with level 3 qualifications or below	41.5%	27,777	69,236	97,013	9,701
Occupations requiring level 3 skills and experience	**Administrative, clerical and secretarial occupations**			**-38,900**	**245,100**	**206,200**	**20,620**
	Skilled trades occupations			**-91,500**	**535,300**	**443,900**	**44,390**
		52. Skilled metal, electrical and electronic trades		-74,300	253,700	179,400	17,940
		53. Skilled construction and building trades		40,000	217,400	257,400	25,740
		54. Textiles, printing and other skilled trades.		-59,400	37,400	-22,000	-2,200
	Personal service occupations			**23,900**	**30,500**	**54,400**	**5,440**
	Sales and customer service occupations			**21,300**	**82,700**	**104,000**	**10,400**
Occupations requiring level 2 skills and experience	**Transport and machine operatives**			**-130,000**	**218,500**	**88,500**	**8,850**
		81. Process, plant and machine operatives		-142,900	140,800	-2,100	-210
		82. Transport and mobile machine drivers and operatives		12,900	77,700	90,600	9,060
	Elementary trades and related occupations			**-17,200**	**122,700**	**105,500**	**10,550**
		91. Elementary trades and related occupations		-11,400	57,500	46,100	4,610
		92. Elementary administration and service occupations		-5,800	65,200	59,400	5,940
Total engineering company demand				**257,100**	**2,303,900**	**2,561,100**	**256,110**
Total demand for engineering skills	**All**			**157,600**	**1,658,900**	**1,816,800**	**181,680**
	Equivalent level 4 or above	(sub groups: 11, 12, 21. 31a, 35a)		360,158	706,423	1,066,581	106,658
	Equivalent level 3	(sub groups: 31b, 35b, 52, 53, 54)		-55,358	611,277	555,919	55,592

Source: Working Futures 2012-2022 engineering extension

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In Table 15.6 we show the breakdown of the total requirement for engineering companies, and the requirement for those jobs most likely to require engineering skills, by the different nations and regions of the UK. For each nation and region, there is very little variation in the percentages for all requirement, and for the jobs most likely to require engineering skills.

At a home nation level, 85.4% of the demand for jobs most likely to require engineering skills is in England, followed by Scotland (8.1%), Wales (3.9%) and then Northern Ireland (2.5%).

Within England, the region with the highest percentage demand for jobs most likely to require engineering skills is the South East (16.1%), followed by London (13.4%). The English region with the lowest percentage demand is the North East (3.7%).

The expansion and replacement demand plus the total number of job openings for engineering companies within the main industry groups is shown in Table 15.7. The largest proportion of job openings will occur in engineering enterprises within construction, and the information and communications sectors (27.3% each). In both cases, the total requirement is a mixture of expansion demand and replacement demand. By comparison, a quarter (25.0%) of job openings will occur in engineering companies in the manufacturing sector. The workforce in this sector will contract by 225,000, but 864,000 job openings will be created as a result of replacement demand.

According to the Working Futures report,[997] construction is predicted to have particularly strong employment growth during the period 2017-22. As was noted in Section 15.1, the construction industry in particular faces significant skills shortages. The Confederation of British Industry and Pearson Education have shown that problems recruiting people with STEM skills are likely to be most severely felt in the construction industry, with companies predicting problems in the next three years with recruiting for both technician and graduate level roles.

In the manufacturing sector, Working Futures[998] shows that the contraction in the number of jobs is being driven by automation.

Table 15.6: Recruitment requirement in engineering companies by home nation and English region (2012-2022) – UK

	Total requirement in engineering companies 2012-2022	Percentage of total requirement	Total requirement for jobs most likely to require engineering skills in engineering companies 2012-2022	Percentage of total requirement for jobs most likely to require engineering skills
North East	95,200	3.7%	66,900	3.7%
North West	274,100	10.7%	192,900	10.6%
Yorkshire and The Humber	185,200	7.2%	130,300	7.2%
East Midlands	192,500	7.5%	138,000	7.6%
West Midlands	211,400	8.3%	149,700	8.2%
East	247,200	9.7%	177,700	9.8%
London	352,000	13.7%	243,000	13.4%
South East	402,200	15.7%	291,900	16.1%
South West	223,600	8.7%	161,400	8.9%
England	2,183,500	85.3%	1,551,800	85.4%
Wales	97,000	3.8%	71,400	3.9%
Scotland	215,300	8.4%	147,300	8.1%
Northern Ireland	65,200	2.5%	46,200	2.5%

Source: Working Futures 2012-2022 bespoke analysis

Table 15.7: Recruitment requirements for engineering companies within the main industry groups (2012-2022) – UK

	Expansion by 2022	Replacement demand by 2022	Total requirement by 2022	Percentage of total requirement by 2022
Manufacturing	-224,900	864,500	639,600	25.0%
Construction	202,800	496,400	699,200	27.3%
Information and communication	244,200	454,300	698,500	27.3%
Professional, scientific and technical activities	17,300	239,000	256,300	10.0%
All engineering industries	257,200	2,303,900	2,561,000	

Source: Working Futures 2012-2022 bespoke analysis

997 Working Futures 2012-2022, UK Commission for Employment and Skills, March 2014, p15 **998** *ibid*, p35

15.6 Supply analysis

The supply of those with level 3 engineering skills who are able to participate in an engineering occupation is calculated by summing the number of level 3 apprenticeship achievements from England, Scotland, Wales and Northern Ireland. This gives a figure of 27,195.

Calculating the supply of those with level 4+ skills who are able to participate in an engineering occupation is slightly more involved. Furthermore, this year we distinguish between the potential pool of those with level 4+ engineering-related skills who are able to contribute to the engineering workforce, and the historic supply, which is determined by those who actually did go on to work in an engineering occupation regarded as requiring level 4+ engineering-related skills.

Table 15.9 shows the supply of graduates with related skills at level 4 or above, by the subject that they studied and the level of qualification achieved.

As one would expect, the methodology used to calculate potential supply and historic supply is different. Historic supply is rather straightforward: it is the number of UK graduates who were employed in engineering roles equivalent to level 4.

This is calculated by summing the number of employed higher education qualifiers by the percentage who were employed in an engineering role at level 4+. The resultant figures for each step of this calculations are displayed in Table 15.8.

However, as potential supply concerns the pool of those who are able to work in an engineering occupation at level 4+, a different methodology is adopted.

As noted in Section 12 on graduate destinations, a large number of those with degrees outside of engineering and technology end up working in an engineering-related role. As such, we identify three tiers of graduate supply, based on the proportion of graduates from these subjects who have traditionally contributed to the engineering workforce.

1. Tier 1 contains graduates from subjects with the strongest link to engineering occupations. As expected, this is those with engineering and technology degrees.
2. Tier 2 contains graduates from key STEM subjects, from which a substantial proportion progress to working in an engineering occupation.
3. Tier 3 contains graduates from all other subjects, which have the lowest proportion of those who end up working in an engineering role.

As graduates from lower tiers are less likely to work in engineering-related occupations, we apply more stringent criteria to the calculating potential supply from their ranks.

In tier 1, qualifiers from all domiciles are considered and then multiplied by the percentage of qualifiers who were employed in the UK. This is the supply figure for this tier, since presumably all of those with an engineering-related degree who are employable are able to work in an engineering-related role at graduate level.

For tier two, the calculation is stricter, with only those qualifiers of all domiciles who actually worked in an engineering role considered as potentially contributing to the level 4+ supply. This is because graduates from this tier have high-level STEM skills that are closely related to those required in engineering roles.

The strictest criteria is adopted for tier three. Only those graduates of all domiciles who were working at graduate level in an engineering-related role are considered as contributing to the potential supply. This is because it cannot be taken for granted that those from tier 3 subjects, although well-educated, have the skills required for engineering occupations. Nonetheless, data shows that a proportion of such graduates do end up working in engineering roles at level 4+ and thus they should not be completely discounted.

Table 15.8: Supply of graduates with engineering-related skills at level 4+ (2013/14)

		Number of qualifiers – all domiciles	Number of qualifiers – UK domicile	Calculated number employed	Calculated number employed UK	Calculated number employed in engineering role	Calculated employed in engineering role UK	Calculated employed in engineering role at graduate level	Calculated employed in engineering role at graduate level UK	Potential supply	Historic supply
Total tier 1		50,185	28,218	39,044	21,673	25,397	14,336	22,965	12,847	39,044	12,847
Engineering and technology	Other undergraduate	4,667	3,797	3,236	2,633	2,335	1,900	1,823	1,484	3,236	1,484
	Foundation degree	1,662	1,572	1,282	1,212	880	832	741	701	1,282	701
	First degree	25,868	17,627	19,842	13,520	13,317	9,074	12,206	8,317	19,842	8,317
	Other postgraduate	15,152	4,053	12,066	3,227	7,769	2,078	7,135	1,909	12,066	1,909
	Doctorate	2,837	1,169	2,619	1,080	1,096	452	1,060	437	2,619	437
	All	50,185	28,218	39,044	21,673	25,397	14,336	22,965	12,847	39,044	12,847
Total tier 2		85,674	63,802	62,491	45,701	18,547	15,360	13,711	11,379	18,547	11,379
Architecture, building and planning	Undergraduate (incl PGCE)	1,957	1,911	1,404	1,370	1,015	991	504	492	1,015	492
	Foundation degree	297	292	230	226	129	127	67	66	129	66
	First degree	9,437	7,434	8,034	6,329	5,793	4,564	2,474	1,949	5,793	1,949
	Postgraduate (incl PGCE)	6,750	3,841	6,094	3,467	-	-	-	-	-	-
	Doctorate	296	112	256	97	63	24	34	13	63	13
	All	18,737	13,590	16,018	11,490	7,000	5,705	3,078	2,519	7,000	2,519
Computer science	Undergraduate (incl PGCE)	2,738	2,504	1,571	1,436	534	488	453	414	534	414
	Foundation degree	659	650	353	348	170	167	151	148	170	148
	First degree	16,082	13,457	12,496	10,457	6,988	5,848	6,779	5,672	6,988	5,672
	Postgraduate (incl PGCE)	6,704	2,214	5,308	1,753	-	-	-	-	-	-
	Doctorate	797	319	755	302	302	121	291	116	302	116
	All	26,981	19,143	20,483	14,295	7,994	6,624	7,672	6,351	7,994	6,351
Mathematical sciences	Undergraduate (incl PGCE)	809	719	532	473	97	86	80	71	97	71
	Foundation degree	-	-	-	-	-	-	-	-	-	-
	First degree	8,605	6,940	5,444	4,391	772	623	694	560	772	560
	Postgraduate (incl PGCE)	2,211	754	1,365	465	-	-	-	-	-	-
	Doctorate	556	270	482	234	63	30	63	30	63	30
	All	12,181	8,682	7,823	5,563	932	740	837	662	932	662
Physical sciences	Undergraduate (incl PGCE)	1,813	1,634	1,128	1,017	231	208	177	159	231	159
	Foundation degree	509	496	358	348	26	25	16	16	26	16
	First degree	17,299	15,731	10,397	9,455	2,016	1,833	1,619	1,472	2,016	1,472
	Postgraduate (incl PGCE)	5,410	2,756	3,843	1,958	-	-	-	-	-	-
	Doctorate	2,743	1,770	2,441	1,575	348	225	311	201	348	201
	All	27,774	22,388	18,167	14,353	2,621	2,291	2,123	1,848	2,621	1,848
Total tier 3		641,698	484,865	508,453	382,173	15,665	12,997	8,349	6,784	8,349	6,784
Medicine and dentistry	Undergraduate (incl PGCE)	342	303	191	169	113	100	-	-	-	-
	Foundation degree	-	-	-	-	-	-	-	-	-	-
	First degree	9,781	8,747	9,276	8,295	63	56	-	-	-	-
	Postgraduate (incl PGCE)	6,069	4,071	4,898	3,285	-	-	-	-	-	-
	Doctorate	2,051	1,487	1,857	1,346	57	41	42	31	42	31
	All	18,243	14,608	16,220	13,095	232	197	42	31	42	31
Subjects allied to medicine	Undergraduate (incl PGCE)	21,998	21,097	19,540	18,740	260	250	87	83	87	83
	Foundation degree	2,113	2,087	1,749	1,728	108	107	42	41	42	41
	First degree	41,450	38,201	36,519	33,656	964	889	571	526	571	526
	Postgraduate (incl PGCE)	17,403	14,210	15,293	12,487	-	-	-	-	-	-
	Doctorate	1,301	839	1,171	755	35	22	23	15	23	15
	All	84,265	76,433	74,272	67,365	1,367	1,267	723	666	723	666

Table 15.8: Supply of graduates with engineering-related skills at level 4+ (2013/14) – continued

		Number of qualifiers – all domiciles	Number of qualifiers – UK domicile	Calculated number employed	Calculated number employed UK	Calculated number employed in engineering role	Calculated employed in engineering role UK	Calculated employed in engineering role at graduate level	Calculated employed in engineering role at graduate level UK	Potential supply	Historic supply
Biological sciences	Undergraduate (incl PGCE)	4,412	157	2,623	93	243	9	155	6	155	6
	Foundation degree	1,265	1,247	618	609	38	37	17	17	17	17
	First degree	42,579	39,271	29,205	26,936	1,858	1,714	1,329	1,225	1,329	1,225
	Postgraduate (incl PGCE)	11,265	8,091	8,697	6,246	-	-	-	-	-	-
	Doctorate	3,192	2,263	2,877	2,040	83	59	60	43	60	43
	All	62,713	51,029	44,019	35,924	2,222	1,818	1,561	1,290	1,561	1,290
Veterinary science	Undergraduate (incl PGCE)	39	33	37	31	2	2	2	2	2	2
	Foundation degree	-	-	-	-	-	-	-	-	-	-
	First degree	899	705	840	658	-	-	-	-	-	-
	Postgraduate (incl PGCE)	159	115	122	88	-	-	-	-	-	-
	Doctorate	58	47	51	41	3	2	1	1	1	1
	All	1,155	900	1,049	819	5	4	4	3	4	3
Agriculture and related subjects	Undergraduate (incl PGCE)	803	732	469	427	29	27	29	27	29	27
	Foundation degree	935	906	513	497	-	-	-	-	-	-
	First degree	2,948	2,653	2,254	2,028	-	-	-	-	-	-
	Postgraduate (incl PGCE)	1,185	627	959	508	-	-	-	-	-	-
	Doctorate	190	92	167	81	10	5	5	2	5	2
	All	6,061	5,009	4,362	3,541	39	31	34	29	34	29
Social studies	Undergraduate (incl PGCE)	5,944	5,503	4,222	3,908	84	77	50	46	50	46
	Foundation degree	1,961	1,958	1,387	1,385	11	11	8	8	8	8
	First degree	42,720	36,926	31,370	27,115	931	805	585	505	585	505
	Postgraduate (incl PGCE)	22,282	11,144	18,208	9,107	-	-	-	-	-	-
	Doctorate	1,805	823	1,616	737	33	15	23	11	23	11
	All	74,713	56,355	56,803	42,252	1,059	909	666	570	666	570
Law	Undergraduate (incl PGCE)	2,157	1,963	1,300	1,182	170	154	36	32	36	32
	Foundation degree	117	116	63	63	-	-	-	-	-	-
	First degree	17,886	13,733	11,111	8,531	273	210	150	115	150	115
	Postgraduate (incl PGCE)	11,338	5,451	9,331	4,485	-	-	-	-	-	-
	Doctorate	383	146	357	137	9	4	6	2	6	2
	All	31,881	21,408	22,162	14,398	452	368	192	150	192	150
Business and administrative studies	Undergraduate (incl PGCE)	9,036	7,027	6,052	4,707	555	432	421	327	421	327
	Foundation degree	2,664	2,413	1,696	1,536	259	234	211	192	211	192
	First degree	64,001	40,650	50,985	32,382	2,516	1,598	1,681	1,067	1,681	1,067
	Postgraduate (incl PGCE)	58,166	15,504	50,738	13,524	-	-	-	-	-	-
	Doctorate	1,072	355	983	325	30	10	20	6	20	6
	All	134,940	65,950	110,454	52,475	3,360	2,274	2,332	1,593	2,332	1,593
Mass communications and documentation	Undergraduate (incl PGCE)	901	797	544	481	23	21	7	7	7	7
	Foundation degree	373	345	129	120	7	6	5	5	5	5
	First degree	12,351	10,357	9,922	8,320	339	284	194	163	194	163
	Postgraduate (incl PGCE)	6,139	2,698	5,346	2,349	-	-	-	-	-	-
	Doctorate	157	89	143	81	7	4	7	4	7	4
	All	19,920	14,285	16,084	11,351	377	316	215	179	215	179

Table 15.8: Supply of graduates with engineering-related skills at level 4+ (2013/14) – continued

		Number of qualifiers – all domiciles	Number of qualifiers – UK domicile	Calculated number employed	Calculated number employed UK	Calculated number employed in engineering role	Calculated employed in engineering role UK	Calculated employed in engineering role at graduate level	Calculated employed in engineering role at graduate level UK	Potential supply	Historic supply
Languages	Undergraduate (incl PGCE)	4,385	2,200	2,516	1,263	205	103	158	79	158	79
	Foundation degree	16	11	3	2	-	-	-	-	-	-
	First degree	24,160	22,069	16,529	15,099	440	402	301	275	301	275
	Postgraduate (incl PGCE)	6,936	3,460	4,968	2,478	-	-	-	-	-	-
	Doctorate	1,165	627	975	525	14	8	14	8	14	8
	All	36,661	28,368	24,991	19,367	659	512	473	362	473	362
Historical and philosophical studies	Undergraduate (incl PGCE)	1,750	1,659	1,016	963	86	82	58	55	58	55
	Foundation degree	353	349	255	252	15	14	12	12	12	12
	First degree	18,643	17,652	12,133	11,488	471	446	279	265	279	265
	Postgraduate (incl PGCE)	6,041	4,038	4,140	2,767	-	-	-	-	-	-
	Doctorate	1,236	741	1,005	603	17	10	17	10	17	10
	All	28,023	24,438	18,550	16,073	589	553	365	341	365	341
Creative arts and designs	Undergraduate (incl PGCE)	4,051	3,372	1,959	1,631	131	109	47	39	47	39
	Foundation degree	2,229	1,983	902	803	77	68	19	17	19	17
	First degree	43,645	38,828	34,904	31,052	4,175	3,715	1,006	895	1,006	895
	Postgraduate (incl PGCE)	11,173	5,382	9,102	4,384	-	-	-	-	-	-
	Doctorate	609	385	536	339	24	15	19	12	19	12
	All	61,706	49,949	47,402	38,208	4,407	3,907	1,091	963	1,091	963
Education	Undergraduate (incl PGCE)	9,664	9,426	8,901	8,681	133	130	92	90	92	90
	Foundation degree	3,740	3,731	2,702	2,695	7	7	6	5	6	5
	First degree	18,865	18,453	15,512	15,172	120	117	67	65	67	65
	Postgraduate (incl PGCE)	42,192	38,364	40,187	36,541	107	97	91	83	91	83
	Doctorate	791	473	722	432	2	1	2	1	2	1
	All	75,251	70,446	68,023	63,522	369	353	257	244	257	244
Combined	Undergraduate (incl PGCE)	1,620	1,308	820	662	120	97	79	64	79	64
	Foundation degree	38	16	30	13	8	3	8	3	8	3
	First degree	4,413	4,281	3,121	3,028	400	388	305	296	305	296
	Postgraduate (incl PGCE)	92	80	92	80	-	-	-	-	-	-
	Doctorate	3	1	-	-	-	-	-	-	-	-
	All	6,166	5,686	4,063	3,782	528	488	392	363	392	363

Source: Higher Education Statistics Agency

However, it is not only graduates from higher education who contribute to the supply of level 4+ engineers. Those with higher apprenticeships in an engineering-related framework are eligible to become employed in a level 4+ engineering occupation (Table 15.9). Thus, the numbers of those achieving higher apprenticeships are added to each model of supply.

Table 15.9: Supply of apprenticeships at level 4+ (2013/14)

4+ apprenticeships (England)	140
4+ apprenticeships (Scotland)	311

Source: Department and Business, Innovation and Skills / Skills Development Scotland/ Northern Ireland Government

The different methodology used for each supply model is summarised in Table 15.10, which provides the final potential and historic (actual) supply numbers for those with level 4+ related skills.

The historic (actual) supply at this level amounts to 31,461, whilst the potential supply is considerably higher at 66,391. The large difference between these two figures attests to a waste of talent from those who have achieved all the necessary education and training to contribute to the engineering workforce at level 4+, but for some reason pursue other paths. In some respects, there are benefits associated with many of those with high-level engineering skills working in roles and industries other than engineering. For example, this may help nurture a greater sense of integration with, and understanding of, engineering across wider society. However, the finding that significant numbers of those eligible to contribute to the engineering workforce do not, raises further questions about where efforts should be marshalled to ensure that the UK has enough engineers to meet economic demand.

The potential supply at level 4+ of 66,000 is substantially lower than the figure of 82,000 reported in last year's report. Closer analysis reveals that this precipitous decline was not due to a reduction in those with engineering degrees (tier one), but was predominantly driven by a reduction of those graduating from other subjects who worked in engineering occupations. For example, the supply of graduates from tier two subjects fell by 30.4% from 26,663 in 2012/13 to 18,547 in 2013/14.

Table 15.10: Calculation of supply of those with engineering related skills at level 4+ (2013/14)

Supply source	Supply perspective	Criteria	Supply number
Tier 1: Engineering and technology	Potential supply	All domiciled qualifiers in employment	39,044
	Historic actual supply	UK domiciled qualifiers employed in an engineering-related role which is equivalent to graduate level (4+) skills and experience	12,847
Tier 2: Architecture, building and planning; computer science; mathematical sciences; physical sciences	Potential supply	All domiciled qualifiers who are employed in an engineering-related role	18,547
	Historic actual supply	UK domiciled qualifiers employed in an engineering-related role which is equivalent to graduate level (4+) skills and experience	11,379
Tier 3: Medicine and dentistry; subjects allied to medicine; biological sciences; veterinary science; agriculture and related subjects; social studies; law; business and administrative studies; mass communications and documentation; languages; historical and philosophical studies; creative arts and designs; education; combined	Potential supply	All domiciled qualifiers who are employed in an engineering-related role which is equivalent to graduate level (4+) skills and experience	8,349
	Historic actual supply	UK domiciled qualifiers employed in an engineering-related role which is equivalent to graduate level (4+) skills and experience	6,784
Engineering related apprenticeships		Apprenticeship achievements England and Scotland	451
Total supply at level 4	Potential supply	Tiers 1 + 2 + 3 + apprenticeships	66,391
	Historic actual supply	Tiers 1 + 2 + 3 + apprenticeships	31,461

Source: Engineering UK analysis

Likewise, the tier three supply number fell by 45% from 15,194 in 2012/13 to 8,349 in 2013/14.

This finding accords with data on qualifications obtained (Section 11.7), which showed that between 2012/13 and 2013/14, although achievements of first degrees increased across all subjects on average, all other degree types saw a decline in the numbers obtained (Table 11.12).

Considering the mode of study, it can be appreciated that this decline was largely driven by a fall in the number of those studying part-time. The number of those obtaining part-time qualifications fell by 19,580 between 2012/13 and 2013/14 (Figure 11.10).

Table 15.11 shows the annual shortfall in the supply of potential engineers by skill level. Overall, there is a shortfall of 69,000 for engineers at level 3+. At level 3 alone, the shortfall is 28,000, whilst at level 4 or above there is a deficit in the supply of 40,000 per year.

Table 15.11: Shortfall of those with engineering skills by level required by 2022

Level 4+ demand by 2022	1,066,581
Annual demand	106,658
Level 4+ supply (annual)	66,391
Annual shortfall	40,267
Level 3 demand by 2022	555,919
Annual demand	55,592
Level 3 supply (annual)	27,195
Annual shortfall	28,397
Level 3+ demand by 2022	1,622,500
Annual demand	162,250
Level 3+ supply (annual)	93,586
Annual shortfall	68,664

Source: UK Commission for Employment and Skills and Engineering UK analysis

15.7 Project MERCATOR – mapping the UK's engineering workforce

Authored by Tammy Simmons, Marketing and Communications Manager, Engineering Council

Professional registration provides the benchmark through which the public can have confidence and trust that engineers and technicians have met globally recognised professional standards and have had their competence and commitment independently assessed.

Nearly a quarter of a million men and women are currently listed on the Engineering Council's national register of Engineering Technicians (EngTech), Incorporated Engineers (IEng), Chartered Engineers (CEng) and Information and Communications Technology Technicians (ICT*Tech*). However, the UK has an aging population, and with the number of registrants over the age of 60 representing nearly 40%[999] of the total, the potential for a net outflow of skills and knowledge over the coming years remains a concern.

The Engineering Council's research project, Project MERCATOR, has continued to map the UK's engineering workforce in order to maintain a baseline for future comparison.

Project MERCATOR uses official data issued by the Office of National Statistics[1000] to provide an insight into the workforce, to observe areas of interest to the engineering profession, including: identifying which industries engineers and technicians work in; what level they are working at; their occupational title; where in the UK they work; as well as offering data on diversity.[1001] Most importantly, it provides an indication as to the number of engineers and technicians who are eligible for professional registration.[1002]

Given that it is in the public interest for the majority of engineers and technicians to be professionally registered, then the core aim of Project MERCATOR is to improve the profession's understanding of the working population for whom registration should be relevant. In particular, the project seeks to:

1. Articulate the scale of the engineering workforce in the UK
2. Ascertain the numbers of engineers and technicians eligible for professional registration, to understand the current level of market penetration
3. Provide details on the distribution of engineers and technicians across industry sectors and their geographical spread across the UK
4. Access reliable data which would lead to a repeatable process, enabling performance-related benchmarking reviews to be carried out
5. Provide an authoritative source of data

Table 15.12: Number of existing registrants[1003] in the UK compared with those deemed to be eligible[1004] for professional registration[1005]

	Actual	Eligible	Not yet registered
EngTech eligible	12,500	1,237,400	99.0%
IEng eligible	20,600	378,000	94.6%
CEng eligible	95,550	316,200	69.8%
Total	**128,650**	**1,931,600**	**93.3%**

Source: Engineering Council

In October 2014, the Royal Academy of Engineering published its Universe of Engineering report.[1006] This highlights how important engineering and engineers are to the UK economy and engineering's relationship to economic growth, the health and wellbeing of UK society, and to addressing global challenges. The report aims to:

- Draw attention to the size and scope of the universe of engineering
- Support the profession in its ambition to meet the needs of the society

One of the report's conclusions was that current national statistics do not lend themselves to providing a true picture of the contribution that engineering makes to the UK economy. The current Standard Industrial Classification (SIC) and Standard Occupational Classification (SOC) codes measures of economic activity tend to conceal a more complex and pervasive use of engineering skills across the economy. As such, a key recommendation was that the profession should work with government to develop the use of measures of economic activity that better reflect the role that engineering plays. Having undertaken the research for Project MERCATOR, the Engineering Council will continue to work with EngineeringUK to address this recommendation, attempting to ensure that all relevant data is harmonised and accurately reflects the numbers of engineers and technicians in the UK, the industries in which they work and the occupations they hold.

999 As at 31 December 2014 **1000** Annual Population Survey April 2011 – March 2012 and June 2012 – July 2013 **1001** Age, gender and ethnicity **1002** By levels of qualification and occupation **1003** Aged 20-64 **1004** Identified by core engineering Standard Occupational Classifications and level of academic qualifications held **1005** Aged 20-64 in the UK **1006** http://www.raeng.org.uk/publications/reports

Part 3 – Engineering in Employment
16.0 Concerted employer action

Through externally-provided case studies and cameos, this section highlights the need for effective employer and education engagement, as well as steps that employers and employer bodies are taking to deliver UK productivity.

16.1 Skills are an urgent priority – especially STEM

Authored by David Cairncross, Senior Policy Adviser, CBI

The skills needs of tomorrow will be different to those of today – but the drive towards a more productive, high-value economy means that the UK will require more and higher level skills. Businesses, however, are already reporting major skills shortages, including in sectors critical to the rebalancing of the economy – and when it comes to filling skilled roles in the future, businesses are not confident they will be able to find sufficient recruits.

Demand for science, technology, engineering and maths (STEM) skills is particularly strong. These skills underpin innovation and are critical to the UK's ability to compete successfully in high-value, high-growth sectors.

The CBI/Pearson Education and Skills Survey 2015[1007] shows that businesses are encountering difficulties in recruiting people with STEM skills at every level, from new entrants to train as apprentices, to people with more than five years' experience of STEM-related work.

Employers' views and priorities around skills – particularly STEM – are clearly shown from our survey results:

- **Changing technologies and markets demand rising levels of skills**
- **Demand for skills will be strongest in sectors essential for rebalancing, but businesses are concerned that the demand for skills cannot be met**
- **People with STEM skills are becoming particularly hard to recruit, and businesses expect these difficulties to intensify**
- **The STEM crisis can only be addressed by business and education working together, but government also has an important role to play**

1007 Inspiring Growth – CBI/Pearson Education and Skills Survey 2015, CBI, July 2015

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Changing technologies and markets demand rising levels of skills

As technologies, products, services and markets evolve, UK businesses will need more people able to fill skilled jobs in the years ahead. Levels of skills that were adequate in the past will not suffice in future. The results of our survey show the strength of the drive towards a higher-skill, higher-value economy and the anticipated impact in terms of changing future skill mixes (Table 16.1).

Table 16.1: Business demand for different skills levels over next 3-5 years*

	2015	2014	2013	2012	2011
Low skills	-6%	+5%	-4%	-3%	-5%
Intermediate skills	+36%	+40%	+30%	+35%	+28%
Higher skills	+65%	+71%	+59%	+61%	+58%

Source: CBI
* Firms reporting increased demand minus those reporting decreased demand

The positive balance of firms expecting to need more employees with higher skills has been close to or above +60% each year since 2010. The balance stands at +65% in 2015, with more than two thirds of survey respondents (68%) expecting to grow the number of higher-skilled employees over the next three to five years and only 3% anticipating reductions in their number.

As economic growth continues, businesses also expect to need more people with intermediate skills in the next three to five years. The balance of employers anticipating adding jobs over those cutting intermediate roles stands at +36% in 2015.

Demand for skills will be strongest in sectors essential for rebalancing...

Employer demand for more people with higher level skills in the next three to five years is expected to be particularly strong in those sectors that should lead the rebalancing of the economy (Table 16.2).

Table 16.2: Increased demand for skills over next 3-5 years by sector*

	Intermediate skills	Higher skills	Leadership and management
Manufacturing	52%	69%	66%
Construction	50%	73%	81%
Engineering, science and high tech	37%	52%	71%
Professional services	22%	50%	58%

Source: CBI
* Firms reporting increased demand minus those reporting decreased demand

Among firms in manufacturing and construction, positive balances of +50% and above anticipate needing more people with skills from intermediate levels upwards in the years ahead. A majority of businesses in engineering, science and high tech also expect to grow the numbers of people they employ in higher-skilled roles and jobs needing leadership and management skills (+52% and +71% respectively). Achieving sustained growth depends on the capacity to meet these skill needs, particularly by encouraging more young people to recognise the opportunities open to them in these sectors.

...although businesses are concerned that the demand for skills cannot be met

Many firms are concerned that there will not be sufficient people available to fill skilled roles in the future (Table 16.3). Whilst the majority of firms are confident in their ability to recruit to low-skilled and intermediate-skilled roles – at +57% and +27% respectively – this is not the case across all sectors. For example, in the construction sector, 34% of businesses are not confident about the supply of those with the intermediate skills they need.

When it comes to filling high-skilled jobs in future, there are widespread concerns. Last year, more than half of employers were not confident they would be able to recruit enough high-skilled employees (58%), while only a third were confident (35%), giving a negative confidence balance of -23%. This year has seen little improvement, with the majority of businesses still not confident they will be able to meet their need for high-skilled people in the years to come (with a balance of -16%).

People with STEM skills are becoming particularly hard to recruit...

Businesses report widespread difficulties in recruiting people with STEM skills (Table 16.4). The problems are encountered at every level, from new entrants taken on to train as apprentices (20%) to people with more than five years' experience of STEM-related work (32%).

Table 16.4: Current difficulties in recruiting people with STEM skills and knowledge

	2015	2014	2013
People to train as apprentices	20%	22%	12%
Technicians	26%	28%	14%
Graduates	26%	19%	12%
Postgraduates	17%	18%	7%
Experienced staff	32%	26%	22%

Source: CBI

These troubling results are not a new development. As our results from earlier years show, with the gathering pace of the economic recovery, the difficulties experienced in filling posts needing people with graduate skills and experience of STEM-related work have intensified. The proportion of businesses reporting problems in recruiting STEM graduates has more than doubled since 2013 (from 12%

Table 16.3: Employer confidence about accessing employees in the future

	Low-skilled			Intermediate-skilled			High-skilled		
	2015	2014	2013	2015	2014	2013	2015	2014	2013
Confident	75%	73%	80%	61%	53%	61%	39%	35%	46%
Not confident	18%	20%	15%	34%	41%	31%	55%	58%	46%
Don't know	9%	7%	5%	5%	6%	8%	6%	7%	8%

Source: CBI

to 26%). The shortfalls in experienced staff with STEM expertise have been consistently high and rising. Close to a third of firms (32%) this year report difficulties in meeting their need for such staff (up from 22% in 2013).

These shortfalls have a strong impact on key growth sectors (Table 16.5). In manufacturing, a third or more of firms report difficulties in recruiting at every level, from people to train through STEM-related apprenticeships (33%) to experienced STEM staff (38%). Among construction firms, close to half (47%) report current problems in recruiting technicians, a group highlighted as being in increasingly short supply in our 2014 survey.[1008] Across engineering, science and high tech firms, nearly half (44%) report difficulties in finding experienced recruits with the right STEM skills.

Crucial manufacturing supply chains are particularly hard hit by these growing shortages, as noted in the recent CBI report on industrial strategy, *Pulling Together*.[1009] While all businesses must contend with the challenge, it is often lower-profile and smaller ones, upstream in the supply chains of larger manufacturers, that must struggle hardest to compete for the limited resource or set up their own training programmes.

...and businesses expect these difficulties to intensify

Looking ahead three years, businesses believe the recruitment market for STEM-skilled staff will become even more difficult (Table 16.6).

Table 16.5: Current difficulties recruiting people with STEM skills and knowledge by sector

	People to train as apprentices	Technicians	Graduates	Experienced staff
Manufacturing	33%	37%	36%	38%
Construction	20%	47%	27%	20%
Engineering, science and high tech	13%	11%	26%	44%

Source: CBI

Table 16.6: Current and/or expected difficulties in next three years recruiting people with STEM skills and knowledge

People to train as apprentices	36%
Technicians	46%
Graduates	41%
Postgraduates	33%
Experienced staff	52%

Source: CBI

Adding those expecting difficulties in three years' time to those currently experiencing problems, over half of businesses (52%) see a shortfall in experienced STEM-skilled staff. The picture is not much more optimistic for other categories of STEM-related staff. Combining current and anticipated difficulties, a third of businesses (33%) view recruitment of postgraduates with STEM capability as a problem area, rising to close to half for technicians (46%). There is plainly an urgent need for action to address these intensifying STEM skill shortfalls.

The STEM crisis can only be addressed by business and education working together, but government also has an important role to play.

We asked respondents who reported difficulties in recruiting STEM-skilled staff what particular problems they encounter. The answers point to a range of concerns (Table 16.7).

Table 16.7: Barriers to recruiting STEM-skilled staff

Lack of general workplace experience	46%
Lack of appropriate attitude and aptitudes for working life	44%
Shortage of STEM graduates	40%
Content of qualification(s) not relevant to business needs	40%
Quality of STEM graduates	34%
Lack of applications	30%
Lack of practical experience/lab skills	26%
Other	7%

Source: CBI

A lack of general workplace experience among applicants (46%) and weaknesses in the attitudes and aptitudes for working life among candidates (44%) are identified as the most widespread problems.

1008 Gateway to growth: CBI/Pearson education and skills survey 2014, CBI, 2014 1009 Pulling together: strengthening the UK's supply chains, CBI, October 2014

Ranking almost as highly are a shortage of STEM graduates (at 40%) and concerns that the content of qualifications at all levels is too often not relevant to business needs (40%). More than a third (34%) also report the quality of STEM graduates as not good enough. These findings highlight the need for firms and providers of education and training to work together to ensure programmes of study properly reflect workplace developments and technological advances in manufacturing and science-based industries.

There is a clear need for action by all concerned to promote the study of STEM subjects and so increase the future supply of potential STEM-skilled employees (Table 16.8).

Table 16.8: Priority actions to promote STEM study

More STEM apprenticeships	54%
Businesses engaging with schools to enthuse pupils about STEM study	54%
Businesses and universities working together to develop business-relevant STEM courses	51%
More specialist teachers in schools/ colleges	47%
Businesses providing more high-quality work placements	36%
Encouraging employees to become STEM ambassadors	33%
Government tilting higher education in favour of STEM subjects	33%
Streamlining of government and stakeholder initiatives	27%
Businesses providing financial incentives for students	19%

Source: CBI

Three priorities for action are identified by more than half of respondents to our survey. First, businesses need to create more STEM-related apprenticeships (54%). If young people are confident the career openings are there, they will be more encouraged to prepare via STEM study. It is equally important for employers to engage with schools to enthuse pupils about STEM study (54%). They can inject an invaluable 'real world' perspective, opening young people's eyes to the practical value and exciting creative scope of STEM subjects. And as set out in the recent CBI report *Tomorrow's World*,[1010] this should be happening from primary school onwards.

A majority of respondents (54%) also point to the need to tackle the low business relevance of some STEM qualifications in higher education. This requires employers and universities to work together more closely to develop STEM courses with built-in business relevance – for example, by employers participating in degree programme advisory boards or sponsoring new degrees.

Almost half of businesses (47%) point to the need for more specialist science and maths teachers in schools and colleges, reflecting the worries discussed above. In addition, firing young people's interest in STEM careers through providing high-quality work placements (36%) and schemes such as the STEM ambassadors' programme[1011] (33%) are widely recognised as important.

16.2 Shining the spotlight on engineering as pioneers of apprenticeships

Authored by Verity O'Keefe, Senior Employment and Skills Policy Adviser, EEF

Apprenticeships take centre stage

A new government has formed and, much to the delight of manufacturing and engineering companies, 'apprenticeships' is a buzzword being used in all major speeches, including that from the Prime Minister. Apprenticeships are very much taking centre stage.

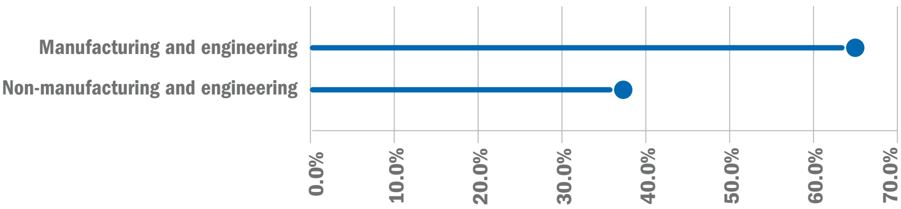
The new government has committed to creating three million apprenticeships over this parliament. This is an ambitious target, given that just over two million were created in the last parliament. With over half a million starts, 2011/12 was quite a milestone year for apprenticeships. However, in the final year of the last parliament, starts took a slight dip to 440,400. Hitting that three million target will, then, be quite a challenge.

Manufacturers are taking on the challenge

It's a challenge that manufacturers will happily take on. Two-thirds of manufacturers plan to recruit an engineering apprentice in the next 12 months. This trend for planned recruitment has been consistent over the past couple of years. Interestingly, 38% of manufacturers plan to recruit an apprentice outside of engineering (Figure 16.1). Speaking directly to employers, they are keen to place apprentices in other functions within their business, such as IT – not only to ensure they have the technical skills and experience to succeed in the job, but also to bring in more young, fresh talent into the business.

The number of manufacturing and engineering apprenticeships has seen steady growth over the past 10 years. This is in contrast to all apprenticeships, which saw a massive peak following the formation of the coalition government, before taking quite a tumble in the last year (Figure 16.2). In fact, manufacturing and engineering apprenticeships represented 15% of all apprenticeship starts in 2013/14. This is higher than the proportion of the workforce employed in manufacturing. Apprenticeships are, in some way, punching above their weight.

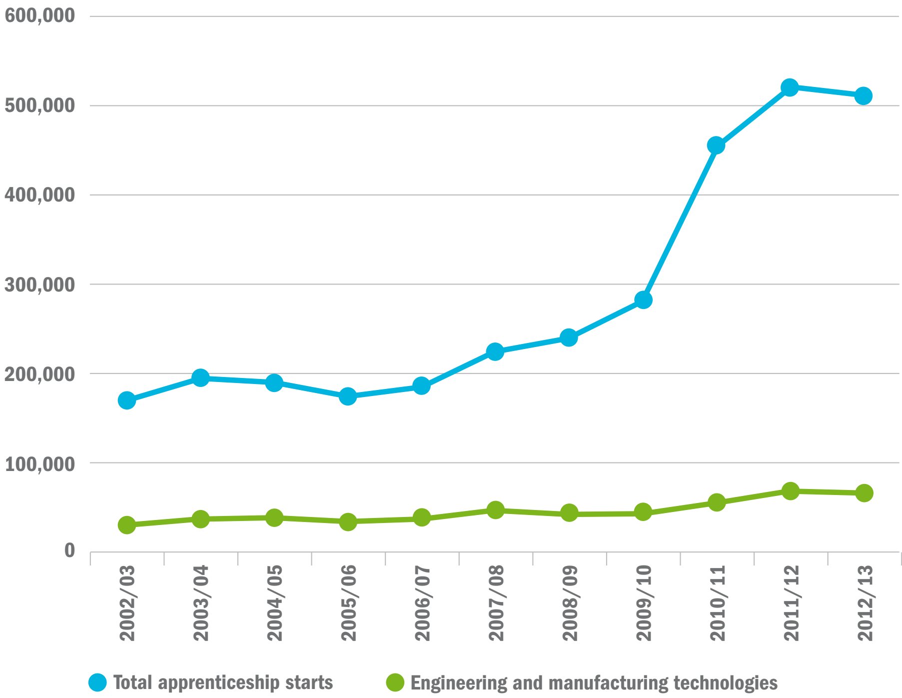
Figure 16.1: Manufacturers' plans to recruit more apprentices continue: percentage of companies reporting plans to recruit apprentices in the next 12 months



Source: UK Commission for Employment and Skills

1010 Tomorrow's world: inspiring primary scientists, CBI, March 2015 **1011** http://www.stemnet.org.uk/content/ambassadors

Figure 16.2: Manufacturing and engineering apprenticeships have maintained a steady rise: number of starts by year



Source: Data Service

Apprenticeships serve manufacturers' skills needs

Why do manufacturers offer apprenticeships in such volumes? There are a number of reasons they do so, but at the top of the list is to fulfil companies' future skills needs and acquire specific skills that these businesses need (Figure 16.3). Apprenticeships give employers the opportunity to shape their training programmes, so they are confident that the learner will make every success in the job role offered to them upon completion. Three-quarters of EEF members say that all their apprentices stay with them after they have finished their apprenticeship, so it is an investment that clearly pays off.

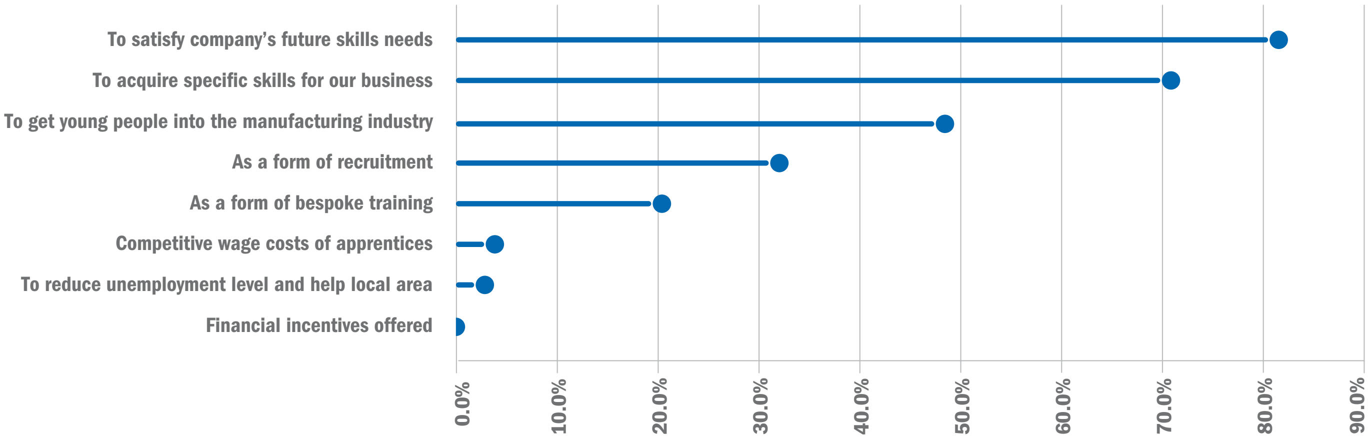
What is also interesting is that almost half of manufacturers say that they offer apprenticeships in order to encourage more young people into the industry. In its last annual report, EngineeringUK predicted that, to meet the number of skilled workers needed by 2022, the number of engineering apprentices would need to increase two-fold.

It is unsurprising then that, when asked, some 70% of manufacturers said that raising awareness of apprenticeships was the best way to get more young people into the manufacturing industry. This focus on young people taking manufacturing and engineering apprenticeships sets our sector apart from many others. Three-quarters of companies in the manufacturing industry told us they generally recruit apprentices aged 16 to 18.

For manufacturers, it's not just a numbers game

We talk a lot about numbers and it's good to set ambitious targets. However, we also need to establish quality. Quality is difficult to define – and arguably it could be defined by outcomes – but it is likely to be influenced by the length of the apprenticeship, the level of training and career prospects (long-term employment, opportunities for career progression, salary levels) that result from successful completion.

Figure 16.3: Apprenticeships are key to acquiring skills and supplying next generation of workers: percentage of manufacturers reporting reasons why they offer apprenticeships



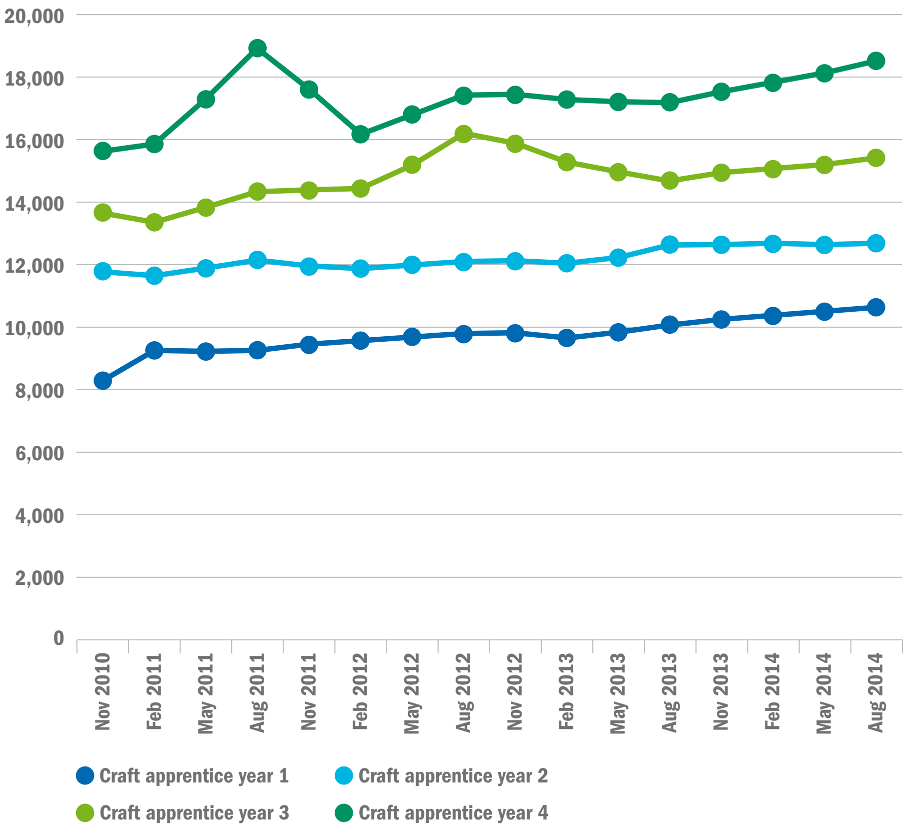
Source: EEF Skills Survey

In all these measures, manufacturing and engineering apprenticeships trump nearly all others. The average pay for an engineering apprentice is over £7 per hour, and EEF's own pay benchmarking data shows a craft apprentice in their fourth year earns on average over £18,000 (Figure 16.4).

Three-quarters of manufacturers say all their apprentices stay with them on completion of their training – and this is training that lasts on average four years and includes significant investment in both time and money from employers. Co-investment is nothing new in the manufacturing sector. Indeed, a third of companies say they fund their apprenticeships entirely themselves (Figure 16.5).

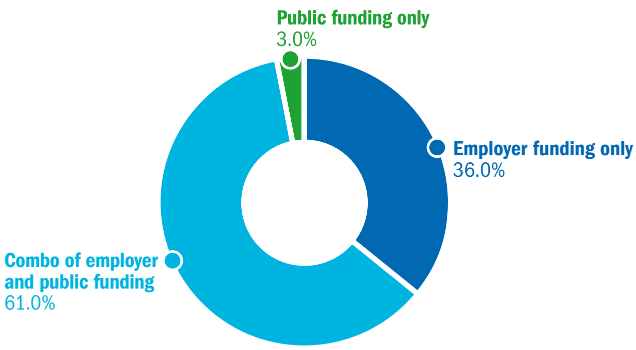
Apprenticeships have rightly found their place back in the spotlight, and aspiring targets have been set. Striking the balance between quantity and quality will be essential. If we want to look to sectors that are the true pioneers of apprenticeship, then look no further: manufacturing and engineering apprenticeships are the gold standard that others should be aiming for.

Figure 16.4: Pay for apprentices in manufacturing is on the rise: average salary paid to craft apprentices for each year of apprenticeship



Source: EEF Workforce Pay Benchmarking

Figure 16.5: Manufacturers co-invest in apprenticeships: percentage of companies reporting how they fund apprenticeships



Source: EEF Skills Survey

16.3 Recognising professional excellence in engineering

Authored by Jon Prichard, CEO, Engineering Council

Regulation of the engineering profession

There are many forms of regulation in the UK, ranging from statutory regulation that imposes legally enforceable restrictions and requirements, through to self-regulation that is based on voluntary codes and practices. Statutory regulation should only exist where there is a legitimate public interest. The UK democratic system generally prefers professions to be self-regulating. In the main, there is no statutory requirement for engineers or technicians to be registered, although there are some isolated areas of practice where public registers are maintained, including: supervision for reservoir safety; aircraft repair and maintenance; and nuclear process safety.

The government does, however, recognise the value of professional self-regulation and accordingly over the years has awarded Royal Charters to appropriate professional bodies to deliver this public benefit, thereby encouraging the attainment of professional standards and adherence to codes of conduct. As a result, society can have confidence that professionally-registered engineers and technicians have made a commitment to maintain their competence and to adhere to a code of conduct.

Professional registration

The Engineering Council is the chartered body where the engineering institutions meet to set the collectively-agreed standards[1012] for the registration of competent engineers and technicians on behalf of society. It maintains the national register of all those who have been assessed as attaining or exceeding these standards, and keeps the standards under periodic review to ensure that they continue to meet the needs of both employers and the public at large.

The resulting UK Standard for Professional Competence (UK-SPEC) is published by the Engineering Council. It was most recently reviewed in 2013 and the third edition was published in January 2014. The engineering institutions have collectively agreed the procedures that they must each follow to ensure that a consistent registration standard is maintained. They then subject themselves to periodic review by their peers through a licensing process that is managed by the Engineering Council.

1012 UK Standards for Professional Engineering Competence (UK-SPEC) www.engc.org.uk/ukspec

The actual process of assessing individuals for admission to the national register is therefore undertaken independently by each licensed professional engineering institution. There are currently 35 of these.[1013] The Engineering Council manages the programme of periodic peer review to ensure ongoing compliance, and also works with international partners to ensure that registered engineers and technicians satisfy internationally-agreed standards of education and practice.

The categories of registration set out in UK-SPEC are:

- Engineering Technician (EngTech), which requires evidence of competence, including academic knowledge and understanding at or above level 3.[1014]
- Incorporated Engineer (IEng), which requires competence underpinned by academic knowledge and understanding at or above level 6 of the National Qualifications Framework, for example, an accredited bachelors degree or equivalent.
- Chartered Engineer (CEng), which requires competence underpinned by academic knowledge and understanding at or above level 7 of the National Qualifications Framework, for example, an accredited integrated master's (MEng) degree or equivalent.

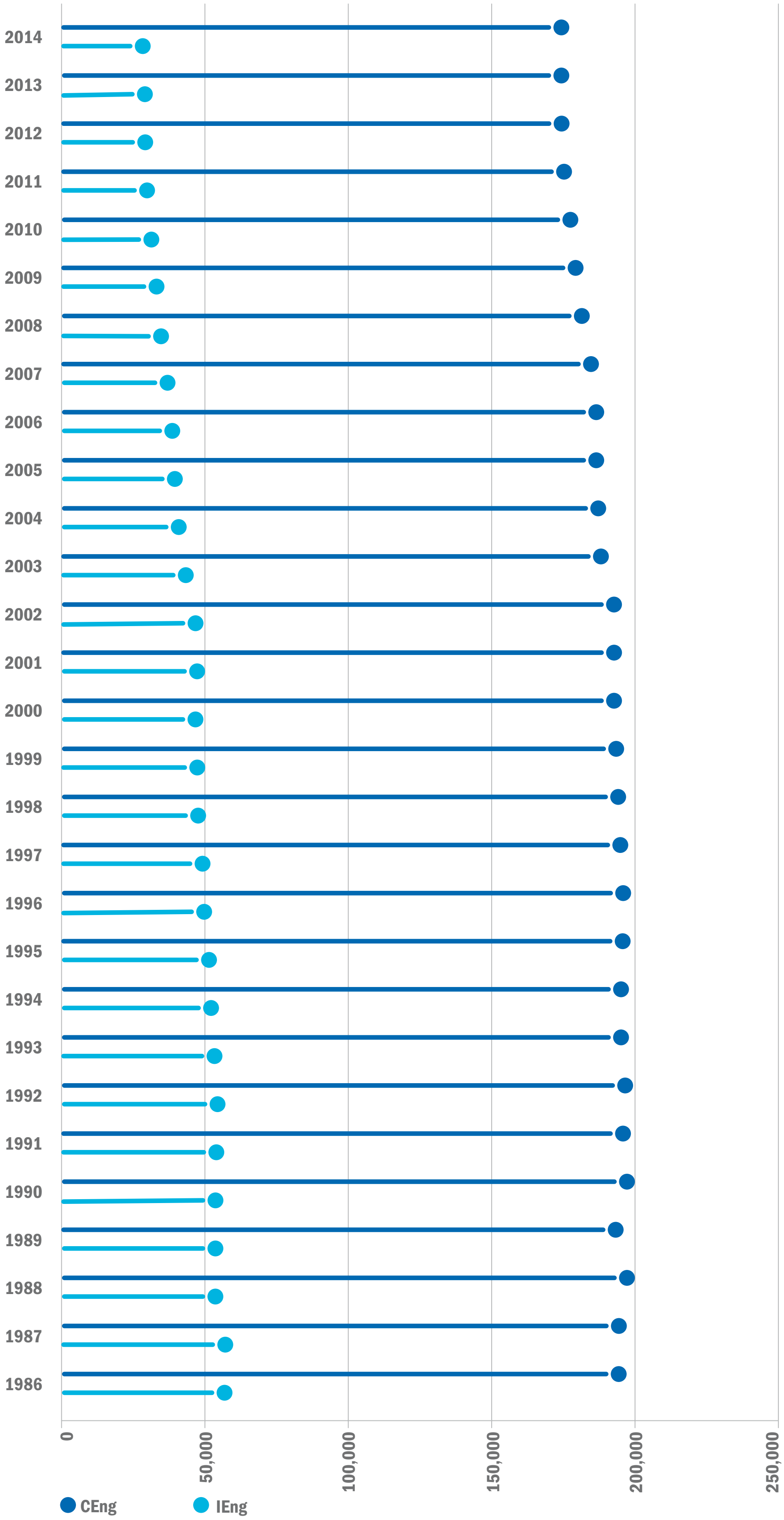
The Engineering Council also operates the register for those that meet the ICT Technician (ICTTech) standard,[1015] which is broadly equivalent to that of Engineering Technician.

Candidates for all four registers must demonstrate their competence to practise in accordance with the relevant standard, and demonstrate that they are committed to maintaining their competence and to acting in a professional and socially-responsible manner.

The number of professionally-registered engineers

Over 175,000 individuals are currently registered with the Engineering Council as Chartered Engineers, and 30,000 as Incorporated Engineers. The trend for the overall number of professionally-registered engineers has shown a decline since its peak in the 1980s (Figure 16.6). However, over the last couple of years there has been a levelling out.

Figure 16.6: Total number of registered Incorporated Engineers and Chartered Engineers (1986-2014)



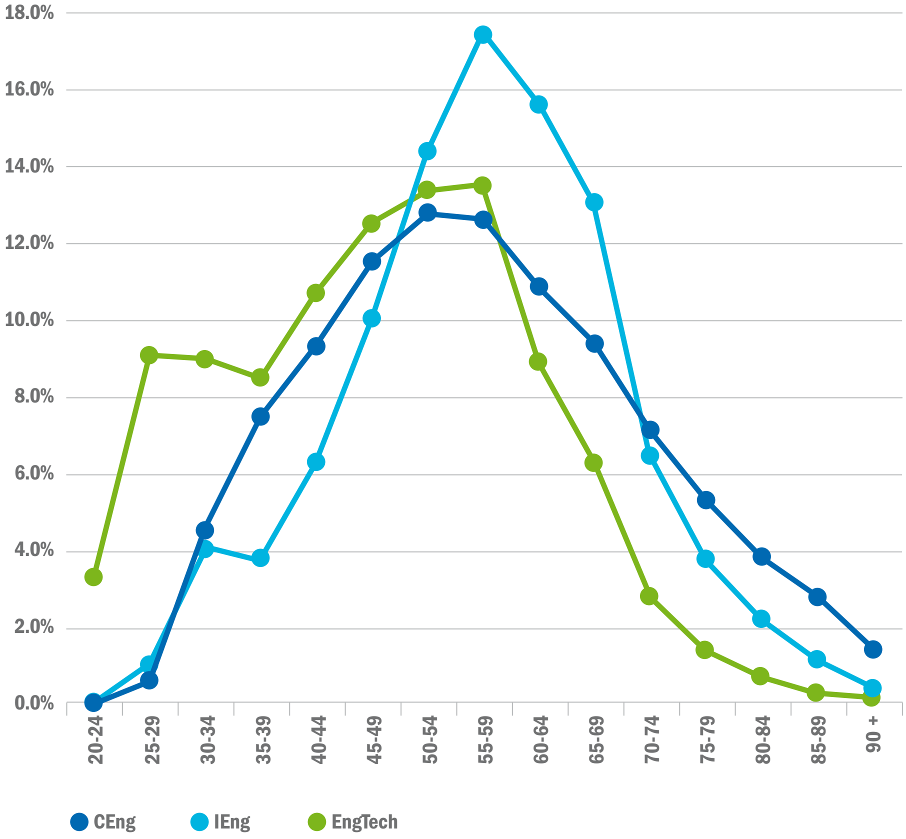
Source: Engineering Council Annual Registration Statistics 2014

1013 www.engc.org.uk/institutions **1014** The equivalent academic standards in the Scottish Credit and Curriculum Framework are 6, 9/10 and 11 respectively **1015** www.engc.org.uk/icttech

When looking at the age profile of registrants, and making assumptions about age of retirement, the downward trend in the number of professionally-registered engineers appears to reflect the demographics of the national population, and is therefore not a huge surprise (Figure 16.7).

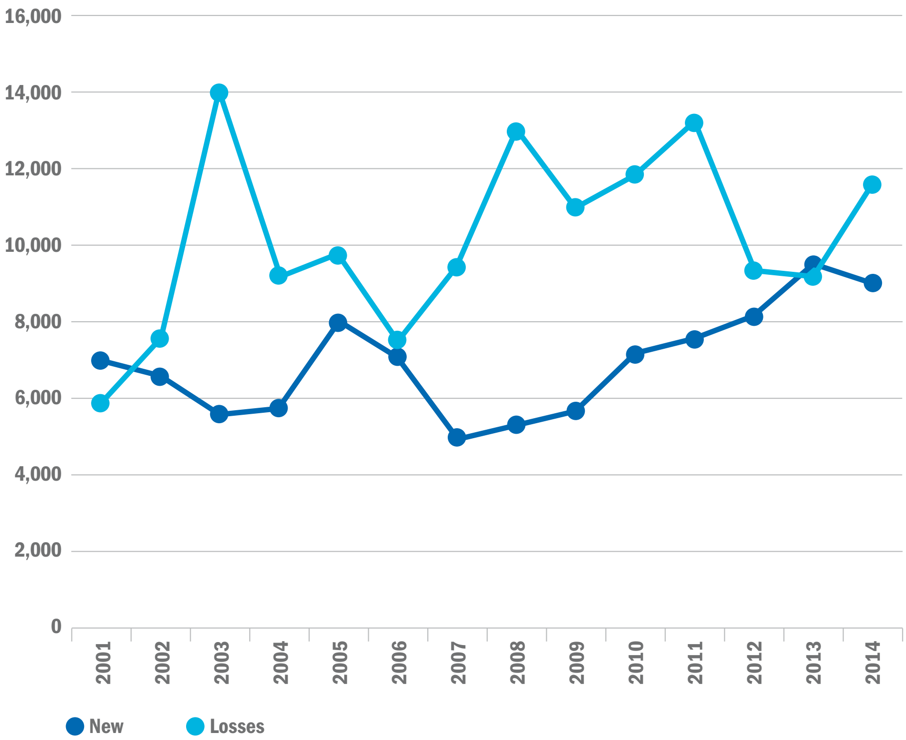
However, the trend for new registrations has shown a gradual increase over the last few years (Figure 16.8). This indicates that more graduates are electing to join professional bodies and being encouraged to become professionally-registered than was the case in the previous decade.

Figure 16.7: Age distribution of Engineering Technicians, Incorporated Engineers and Chartered Engineers



Source: Engineering Council Annual Registration Statistics 2014

Figure 16.8: New registrants versus losses from the register (2001-2014)



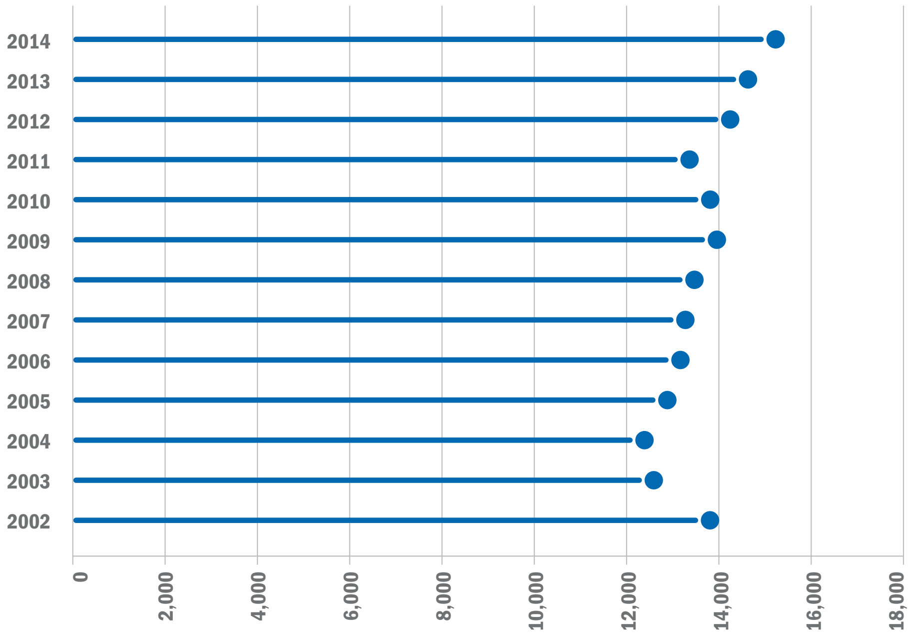
Source: Engineering Council Annual Registration Statistics 2014

The number of professionally-registered Engineering Technicians (Figure 16.9) is significantly below the number of potential technicians in the UK. Major initiatives are currently underway to address this. (Section 10.9 for more information on registered Technicians).

Professionally-registered female engineers and technicians

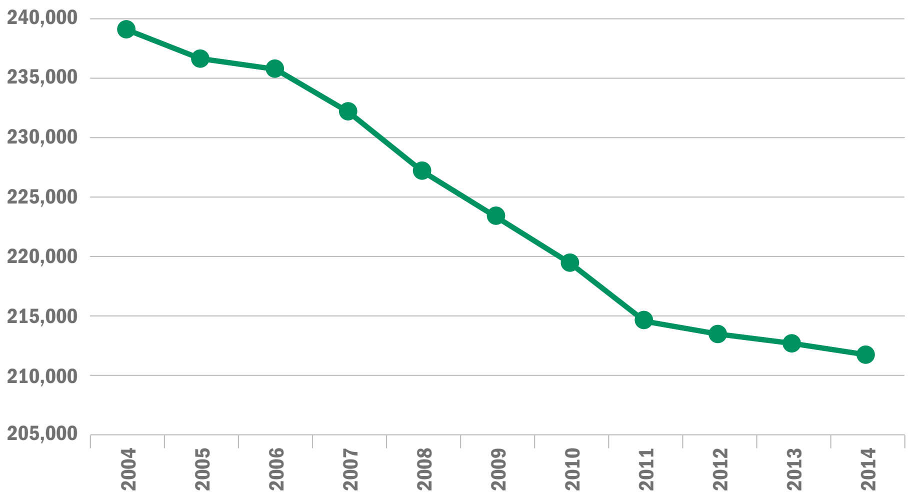
Although females currently only represent 4.59% of those on the national register, their total numbers continue to rise steadily, albeit from a low base. It is worth noting that this increase compares well when set against a backdrop of a decreasing male population over the same period. (Figures 16.10 and 16.11).

Figure 16.9: Total number of Engineering Technicians (2002-2014)



Source: Engineering Council Annual Registration Statistics 2014

Figure 16.10: Total number of male registrants (2004-2014)

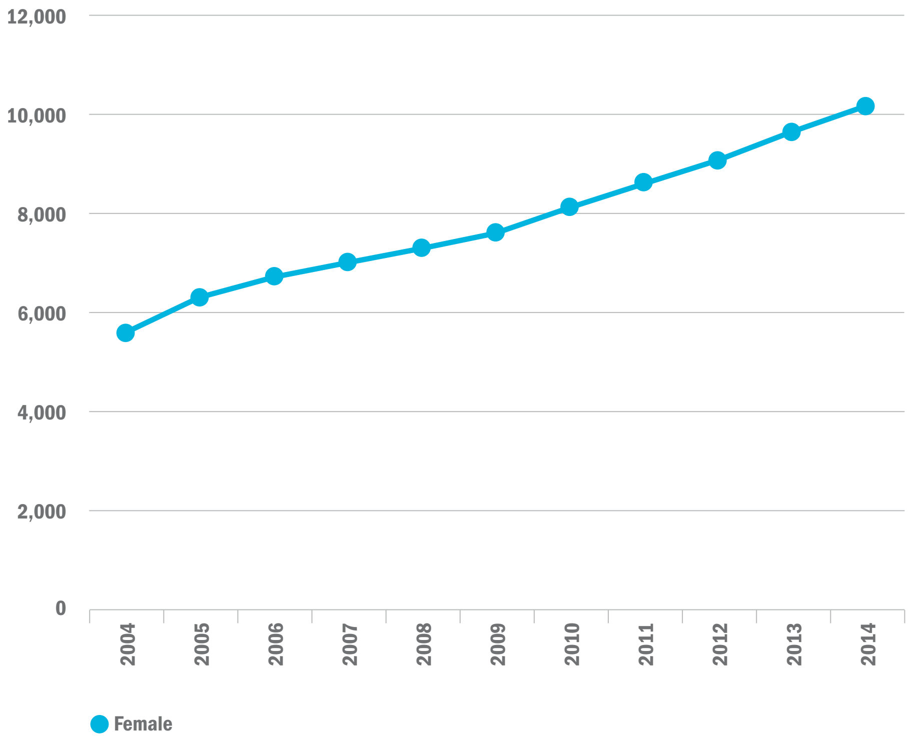


Source: Engineering Council Annual Registration Statistics 2014

International comparison of professional engineer and technologist registration

As engineering is a highly mobile profession, the Engineering Council works closely with similar organisations around the world to ensure that UK standards are globally recognised, and to facilitate the international mobility of engineering professionals. Table 16.9 shows a comparison of professionally-registered engineers in some of the partner countries. It should be noted that Canada is the only country to have statutory regulation.

Figure 16.11: Total number of female registrants (2004-2014)



Source: Engineering Council Annual Registration Statistics 2014

Table 16.9: International comparison of professional engineer and technologist registration

	Engineering Council	Engineers Ireland	Engineering Council South Africa	Institution of Professional Engineers New Zealand	Hong Kong Institution of Engineers	Engineers Australia	Engineers Canada	Chinese Institute of Engineers Taiwan
National population ('000s)	63,181	4,576	52,800	4,400	7,174	23,100	33,480	23,000
CEng/professional engineers (total in professional membership/registered)	176,479	93	15,826	6,000	14,157	58,094	260,561	24,856
IEng/technologists (total in professional membership/registered)	31,443	332	4,593	200	1,230	1,074	65,000	3,369,240
Technicians (total in professional membership/registered)	14,447	152	4,207	300	0	-	-	0
CEng/professional engineers per 1000 population	2.79	337	3.33	1.36	1.97	2.51	7.78	1.08
Ratio Engineer:technologist Engineer:technician Technologist:technician	5.6:1 12.2:1 2.2:1	42.5:1 231:1 5.4:1	3.4:1 3.7:1 1.09:1	30:1 20:1 0.66:1	12:1	54:1	4:1	1:135

Source: Engineering Council August 2013
*data not available

16.4 The employer activists

It remains the case that engineering employers themselves will make the most significant contribution to their own success and, in turn, to UK productivity.

It is therefore important to note the top level findings from the UKCES Employer Perspective Survey 2014, that are based around access to work placements and work inspiration.[1016]

Across England, 17% of employers offered some kind of work inspiration[1017] activity in the previous 12 months. This varied considerably by geography, from 11% in the Tees Valley to 25% of employers in Cheshire and Warrington. People in education were most likely to be offered work inspiration activities in the region surrounding Oxfordshire and Buckinghamshire, around Liverpool City Region and Cheshire and Warrington, and in Dorset. This contrasts with the Heart of the South West LEP and the Tees Valley, where the proportion of employers engaged in work inspiration activities was lowest.[1018]

Of the 17% of all English employers who conducted work inspiration, 54% did so with schools, 46% with colleges and 36% with universities. Therefore, activity with schools is only carried out by 9.2% of English employers.

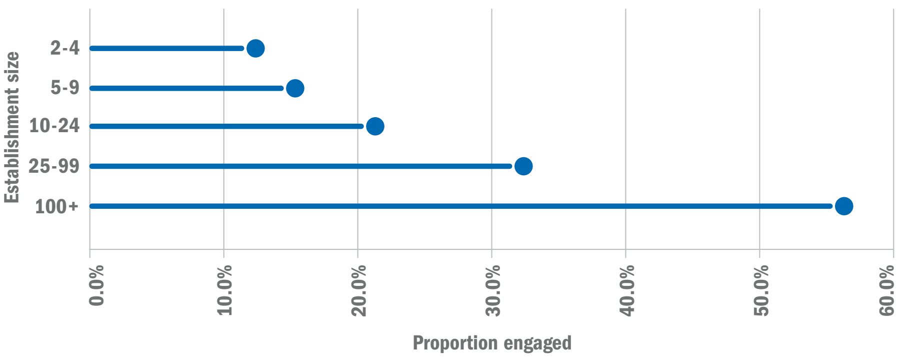
Sectors such as manufacturing (13%) and construction (6%) were less likely to offer work inspiration than financial services (18%) and business services (19%).[1019]

The survey found that where you live influences your likelihood of accessing work placements – across England, there is a postcode lottery of opportunity.

In the 12 months prior to the 2014 Employer Perspectives Survey, 38% of employers across England had offered a work experience placement. There was wide variation by local area though, with 29% offering placements in the Humber area but 46% in London, and Cheshire and Warrington. On the whole, people in the south of England are more likely to be offered work experience: on average, 40% of employers in the south of England offer work experience, compared with 35% elsewhere.[1020]

As with work inspiration, provision of work experience also varied by sector, with 24% of manufacturing businesses offering opportunities, 20% of construction businesses, 40% in the businesses and other services sector, and 65% of non-market services businesses.

Figure 16.12: Proportion of employers who had engaged with educational institutions for work inspiration,[1022] by all establishments (2014) – UK



Source: UKCES

Finally, it is interesting to note the difference that establishment size makes to an employer's engagement with schools in providing work inspiration.[1021] Figure 16.12 unsurprisingly shows that larger employers are more engaged than smaller ones.

16.4.1 Why does employer engagement make a difference to young people?

Authored by Anthony Mann, Director of Policy and Research, Education and Employers Taskforce, and Steven Jones, Senior Lecturer, University of Manchester

It is now more than fifty years since the British state first acted to enable schools to bring workplace experience into the schooling of young people. The 1963 Newsom Report paved the way for the first formalised work experience placements aimed at young people intent on going into work during their mid-teens. In the half century that followed, experience of workplace has moved from a marginal activity, affecting fewer than 5% of pupils in the 1960s, to a universal expectation. Through the rolling waves of government, charitable and business initiatives, a tidal change has been witnessed in both the UK and in countries around the world.

The policy push for closer ties between schools and employers has been primarily driven by an expectation that employer engagement will enhance young people's labour market prospects. This was an explicit rationale behind the reforms of both the Labour Party in the

1016 Geographical variation in access to work placements and work inspiration: data from the Employer Perspectives Survey 2014, UKCES, February 2015 **1017** Work inspiration is defined as employers being involved in one of the following: organising site visits for students; undertaking careers talks; providing one-to-one mentoring support; conducting mock interviews; helping design or set coursework sponsoring, supporting or participating in enterprise competitions. **1018** Data from The Employer Perspectives Survey 2014, (UKCES). The data is available publicly at: https://www.gov.uk/government/publications/Employer-Perspectives-Survey-2014-England-and-local-data **1019** *ibid* **1020** *ibid* **1021** Catch 16-24, UKCES, February 2015, p13 **1022** Site visits, careers talks, mentoring, mock interviews, coursework design, competition sponsorship.

2000s and of the Conservatives in the 2010s. Historically, with little evidence available on impact, policy makers were required to trust their instincts. In recent years, however, a growing body of US and UK research literature has tested whether school-mediated exposure to the workplace can be linked to improved outcomes in the early labour market. While some studies raise reasonable questions about methodological approaches, a compelling story emerges of improved employment outcomes: notably, in terms of wage premiums (found up to age 24) accruing to young adults who, as teenagers, engaged in higher volume levels of employer engagement through their schools than comparable peers.[1023]

Within research and policy debates, increasingly it has been asked not whether employer engagement makes a difference to the prospects of young people, but why it does so and how it can be optimally delivered. Stanley and Mann (2014), for example, draw on insights from three inter-related concepts commonly used in academic and public policy literature to explain relative advantage and disadvantage experienced by individuals within the labour market: human, social and cultural capital.[1024] Drawing particularly on work by sociologists Pierre Bourdieu and Mark Granovetter, Stanley and Mann offered 'a theoretical framework that can comprehend accounts of how employer engagement is experienced and how it provides resources that aid progression in the labour market.' In new research, this framework is tested for the first time.[1025]

Steven Jones (University of Manchester) and colleagues have analysed 488 responses to an open question in a 2011 YouGov survey exploring young adults' experiences of school-mediated employer engagement: for example, work experience, careers talks, enterprise education, business mentoring. They look at answers to a broad question which invited respondents to reflect on 'what [they] got out of employers being involved in [their] education.' Participants were prompted to consider whether the involvement was responsible for 'changing the way [they] thought about school or college, providing useful information or encouragement for thinking about possible jobs or careers, helping to get actual jobs either through people [they] got to know or giving [them] something useful for job applications or interviews, or in getting into a course at college or university.' A reassurance was added that 'maybe [they] got nothing out of it at all.' In the analysis, responses from 190 young people providing sufficient information relating to personal benefit of some type were considered. Not all young people reported positive benefits, it should be noted. As one individual reported:

"I worked in a bookshop doing the jobs no-one else wanted. This did not affect my decision to become a diagnostic radiographer."

Using textual analysis of the statements, the researchers explored whether any evidence was apparent of different types of capital (human, social or cultural) being accumulated through experiences.

Perhaps, the most striking finding from the study emerged from its attempt to find evidence of human capital accumulation. It is a theory at the heart of most educational policy – that the more young people know and can do, the better their employment outcomes will be. In the field of employer engagement, considerable attention is devoted to the idea of 'employability skills', or the abilities that allow an individual to act effectively in a workplace. It has long been posited that exposure to authentic workplace situations in some ways serves to improve communication, problem solving, team working skills etc. While teachers often testify this is what they routinely observed in episodes of work-related learning, questions have been raised as to whether the typical British experience of school-mediated employer engagement (episodic, short duration, non-assessed, not integrated into the curriculum) could generate significant variation in such skills years into labour market participation.[1026]

And in the analysis of reflective statements, this scepticism was upheld (Figure 16.13). Little evidence of human capital accumulation was found. Significantly less apparent than evidence of cultural and social capital accumulation, improvements in human capital were most commonly witnessed in an indirect fashion – reflections on how workplace exposure led to increased academic application or experiences enabled easier progression into further study – especially at university level. It was in the realm of social and cultural capital that young adults reported the greatest benefits to them emerging from their workplace experiences.

Young people, particularly from independent school backgrounds, provided evidence of social capital in a number of forms. It was expressed as access to information and guidance which was unusually useful and trustworthy because it was deemed authentic:

"Told us from experience. Told us straight."

"I trusted the word of someone in the working world as opposed to a careers' advisor or teacher 'telling' you what to do."

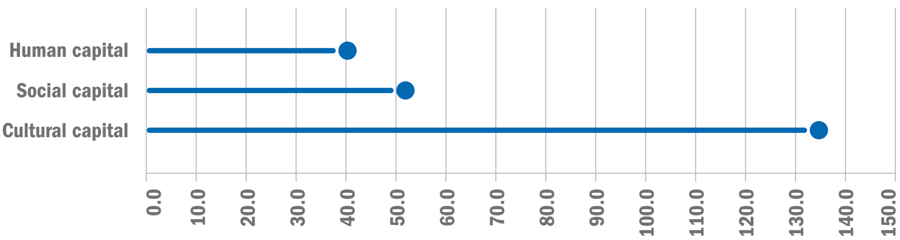
Others reported that economic opportunities emerged from connections made initially through school-mediated engagements:

"Following my work experience placement I obtained permanent part-time work at the same business. This steady job helped as a stepping stone into the working world."

Most striking, however, was evidence that employer engagement activities had in some ways contributed to accumulations of cultural capital. Particular use is made of Bourdieu's idea of 'habitus': that the behaviour and decisions of an individual are shaped and constrained through often inherited and/or unconsciously acquired attitudes and self-perceptions that are linked, to some degree, to wider social structures such as social class, ethnicity and gender. Policy makers often attempt to influence such ways of thinking – for example, in challenging gender stereotyping or making university attendance 'thinkable'. Mentoring programmes and careers-focused campaigns in a similar vein are commonly designed to encourage young people to think differently about themselves and who they might become.

The new research finds considerable evidence of changes in thinking that can be related to an ultimate economic importance: of young people gaining confidence around their decisions, broadening or eliminating potential options and

Figure 16.13: Distribution of human, social and cultural capital in the data



Source: EETF

1023 For an overview of the literature, see Mann, A. & Dawkins, J. 2014. Employer engagement in education: literature review. Reading: CfBT **1024** Stanley, J. & Mann, A. 2014. 'A theoretical framework for employer engagement' in Mann et al, eds. 2014. Understanding Employer Engagement in Education. London: Routledge. **1025** Jones, S., Mann, A., & Morris, K. (forthcoming) 'The 'Employer Engagement Cycle' in Secondary Education: analysing the testimonies of young British adults' Journal of Education and Work **1026** Mann, A & C. Percy. 2014. Employer engagement in British secondary education: wage earning outcomes experienced by young adults. Journal of Education and Work 27 (5): p496-523 changing the ways in which education itself was seen:

"It stopped me from leaving school early and made me stay on to go to uni which I think was a good thing in the end."

"I found my work experience horrible, which is why I made an effort to get a better education and a better job."

Ultimately, however, complexity is found in the relationships between different types of capital accumulation, as illustrated by this statement:

"Work experience helped me to better understand how my school studies translate into the job world and which areas of my studies would be useful in work. This provided motivation to work hard at university modules that were not necessarily the most appealing in terms of enjoyment but I could see that they would be valuable to finding employment later on."

Considering such relationships, Jones and colleagues argue that young people gain access to multiple, complex and overlapping opportunities to gain benefit, proposing an Employer Engagement Cycle (Figure 16.14).

For example, through employer engagement activities, a teenager may make the contacts needed to be offered a job (social capital … as access to employment) while simultaneously acquiring the expertise or ability to make them employable in that role (human capital … as skills development). Or, to give another example, a young adult may report maturing and becoming more assured about themselves (cultural capital … as enhanced personal confidence) as a result of trusted information from employers (social capital … as authentic guidance). The research joins a growing body of literature that demands policy makers and practitioners think afresh of employer engagement initiatives, how they relate to a young person's wider life and what truly drives the significant benefits many appear to experience.

Figure 16.14: The 'Employer Engagement Cycle' in secondary education

Source: Education and Employers Taskforce

16.4.2 Employer cameos

Although the need for, and benefits of, more employer engagement has been recognised by all stakeholders, we should also appreciate that many enlightened STEM employers have been successfully actively engaging with all levels of education for many years.

Figure 16.15 provides several brief cameos from companies who belong to our high-level business and industry panel. The cameos describe their short responses to the question, "What contribution do apprentices and technicians make to your organisation?"

Figure 16.15: What contribution do apprentices and technicians make to your organisation?

ARUP

Arup seeks ever better ways to imagine, re-imagine and reshape the built environment and deliver real value to clients, which means continually ensuring our talented employees are equipped to maximise their potential. Only with a diverse range of people, talents and experiences will we develop the skills we need for the future. In addition to our graduate intake, our apprentices and technicians contribute a huge part to this ethos and we have been running an apprenticeship scheme for around 30 years. In that time, our scheme has produced many of the organisation's senior technicians and engineers.

Cummins, a global power leader, are involved in the design, development, manufacture, distribution and servicing of a broad range of power solutions covering truck, bus, rail, marine, power generation and mining markets. Cummins has operations in 197 countries, over 44,000 people worldwide and sales of over $19 billion. With eight locations across the UK, its broad international reach and a strategy of hiring to develop, Cummins provides an exciting environment in which to grow and develop for apprentices, technicians and graduates, providing the opportunity to work in different business sectors, gain a diverse range of skills and experiences whilst building a long term career.

Jaguar Land Rover is the largest investor in automotive research, development and engineering in the UK, symbolising British craftsmanship, engineering skills and quality in markets around the world. Over the past five years, we have created 18,000 UK jobs, including 2,500 apprenticeships and graduate positions. Through a strong blend of real world experience and academic learning, our apprentices acquire the technical and other vocational skills that we need to secure our long-term business success. They work in cutting-edge product engineering and manufacturing environments to develop vehicles for two of the most iconic global motoring marques and deliver class-leading experiences for our customers.

As one of the largest global engineering and programme management companies, CH2M relies on our people to deliver some of the world's most challenging infrastructure projects. We are investing in the next generation of talent; ensuring that young people are inspired to study STEM subjects and to pursue careers in engineering. We do this by investing in apprenticeships, supporting social mobility, training today's school leavers to be tomorrow's engineers. It is vital the industry works alongside the UK Government to invest in training engineers, helping to bridge the skills gap and improving the UK's competitiveness.

At Doosan Babcock, the investment we commit to our industry-leading craft and technical apprenticeship schemes represents an important investment in the future of our company and our industry, providing young people with the world-class training they need for a successful career in engineering. We expect big demand for skilled workers in our industry over the coming years, particularly with the advent of UK nuclear new build. Our bright young apprentices and technicians provide those critical skills and ensure that Doosan Babcock continues to offer the expertise vital to supporting the development of the UK's energy infrastructure.

Matchtech, along with our engineering clients, recognise the huge value and importance that apprentices play to the overall engineering skills picture. We are working with our clients to support the growth of apprenticeship schemes alongside their experienced hire programmes. As well as young apprentices we have also witnessed some of our clients utilising adult apprenticeships successfully, which has further increased the talent pool and is starting to encourage a more diverse workforce. We also work with our clients on alternative ways to fill the skills gap, such as utilising candidates with transferable skills from other industries, or those returning from a career break to fill the skills gaps of today.

Crossrail is Europe's largest infrastructure project, and when completed, will transform the way that people travel across the capital. We are committed to meeting the skill requirements of the industry and inspiring the next generation of leaders. This is why we have delivered over 450 apprenticeships, providing people with the experience and skills to perform in the industry. We also recognise the challenges facing the engineering sector. Through the Young Crossrail Programme we are working with partner schools to change the perception of engineering, encouraging the take-up of STEM subjects and encouraging more young people to consider engineering as a career.

GE imagines things others don't, builds things others can't and delivers outcomes that make the world work better. In order to fulfil that promise we rely on a culture of leadership, diversity and inclusiveness. GE has recently joined the EU Alliance for Apprenticeships, an initiative of the European Commission, by pledging to provide 3,000 placements in its businesses across Europe. Through a programme of structured learning, organised around professional tasks, supervised by mentors, interspersed with appropriate and relevant education, and ending with a recognised qualification, apprentices are vital to helping GE create a limitless source of ideas and opportunities.

MWH has always recruited Engineering Technicians. Many have gone on to become loyal and valued staff. Some have obtained higher qualifications and two are now UK Directors. This year, we will induct ten apprentices to our Professional Development Foundation. From here, they can develop a successful career as an Engineering Technician or progress to our full Professional Development Programme where we will guide them towards Incorporated or Chartered Engineer status. Diversity is key to our sustained success and we will build a diverse workforce that will include male and female apprentices and graduates from all kinds of backgrounds.

nationalgrid

Engineers and technicians are essential to the future prosperity of the United Kingdom, National Grid joins with others to galvanise efforts to inspire young people. Our approach is to build a pipeline of opportunities for apprentices and graduates, to put in place a range of programmes that will help young people think positively about engineering as their chosen career. Apprenticeships are proven to be one of the most effective ways for us to develop our pipeline, drive up productivity and ensure the sustainability of our workforce. With a retention rate of 95% after five years we are convinced that growing our own talent also improves employee motivation, performance and commitment.

Rolls-Royce

Rolls-Royce designs, develops, manufactures and services integrated power systems for use in the air, on land and at sea. Apprentices and technicians help Rolls-Royce to develop the specialist skills and innovation we need in order to be "trusted to deliver excellence" in all that we do. They bring passion and innovation into our business by thinking and operating differently, and we empower them to generate new ideas. Alongside this, they are often inspirational role models in our local communities, actively encouraging the next generation of potential engineers, scientists and technicians to consider STEM careers, vital for a future talent pipeline

TRANSPORT FOR LONDON

Transport for London's purpose is to keep London working, growing and to make it a better place in which to live. Apprentices are key to our vision of achieving a world class transport system to meet London's growing population. In 2015 we had 14 different apprenticeship schemes ranging from level 2 to level 6 and were involved in 11 apprentice Trailblazer standards. Whether it is inventing new ticketing systems, making our aging infrastructure more reliable or upgrading our London Underground network, apprentices will continue to lead the way in providing the skilled work force we, and London, needs.

NetworkRail

At Network Rail our apprentices provide the skilled labour that Britain's railway needs as we invest our £38bn Railway Upgrade Plan. After a year at Europe's largest engineering training facility, apprentices gain two years of 'on-the-job' training on the railway's front line, forming part of the 35,000-strong team helping people safely take more than 1.5bn journeys every year. Over 2,000 apprentices have come through our apprenticeship scheme since it launched in 2005, with many now team leaders across the network – in fact 85% of our first intake still work for us, all playing a vital role in shaping the future of Britain's railway.

Selex ES
A Finmeccanica Company

With Queen's Awards for international trade and innovation, Finmeccanica – Selex ES relies on advanced level apprentices to provide the backbone of our capability in advanced technology electronic systems, sensors, communications and software. Their impact is evident from development all the way through manufacturing and testing, to their support for the end users. We benefit from this valuable inrush of energetic talent, who develop a broad understanding of the business, its interdependencies and the processes that make it work. Our apprentices flourish in every facet of our company through their innovation, providing the seeding ground to lead us into the future.

THALES
Together • Safer • Everywhere

In the UK, Thales employs around 4,000 engineers and technicians and we are a member of the '5% club' underpinning our commitment to graduate and apprenticeship recruitment and training. Thales recognises the importance of growing key skills for the future through both training and mentoring/coaching of engineers and we also offer a unique expert career path for those wanting to maintain a strong technical focus. Thales has a unique capability to design and deploy equipment, systems and services to meet the most complex requirements and our graduates and technicians contribute to all phases of the development lifecycle from the moment they join us.

NATIONAL NUCLEAR LABORATORY

As the UK's National Nuclear Laboratory we are a leading STEM employer offering science and technology services to nuclear companies in the UK and overseas. We recruit university graduates, apprentices and technicians, who all play key roles right across our business. From ensuring the safe and smooth running of our world-leading facilities and equipment, to delivering virtually every aspect of our work for customers, apprentices and technicians perform a range of vital tasks without which we could not operate. They also have many career tracks available to them once they join NNL – including the option to study for a degree after completing their apprenticeship.

SIEMENS

Siemens is one of the UK's leading apprenticeship employers with more than 500 apprentices on its longstanding programme. As a major engineering employer in the UK, there is little doubt that apprenticeships deliver value for Siemens. Siemens provides innovative solutions to help tackle the world's major challenges in the areas of electrification, automation and digitalisation and we depend on our people to help us shape the future. Apprenticeships are a great way for us to turn today's talented young people into the experts we need tomorrow. Nurturing this talent, as well as attracting and developing the next generation of engineers, is critical to our future.

Annex

The annex is a standalone, web-based document. By making the annex a standalone document, we are able to include more detailed information and will also be able to update it if required during the course of the year.

The annex can be accessed at:

http://www.engineeringuk.com/_resources/documents/EngineeringUK-Report-2016-Annex.pdf

EngineeringUK

EngineeringUK is an independent organisation that promotes the vital contribution of engineers, engineering and technology in our society. EngineeringUK partners business and industry, government and the wider science and engineering community: producing and sharing evidence on the state of engineering, inspiring young people to choose a career in engineering and matching employers' demand for skills. EngineeringUK works across the engineering community to deliver two programmes: The Big Bang and Tomorrow's Engineers.

For more information about EngineeringUK please visit

www.EngineeringUK.com

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