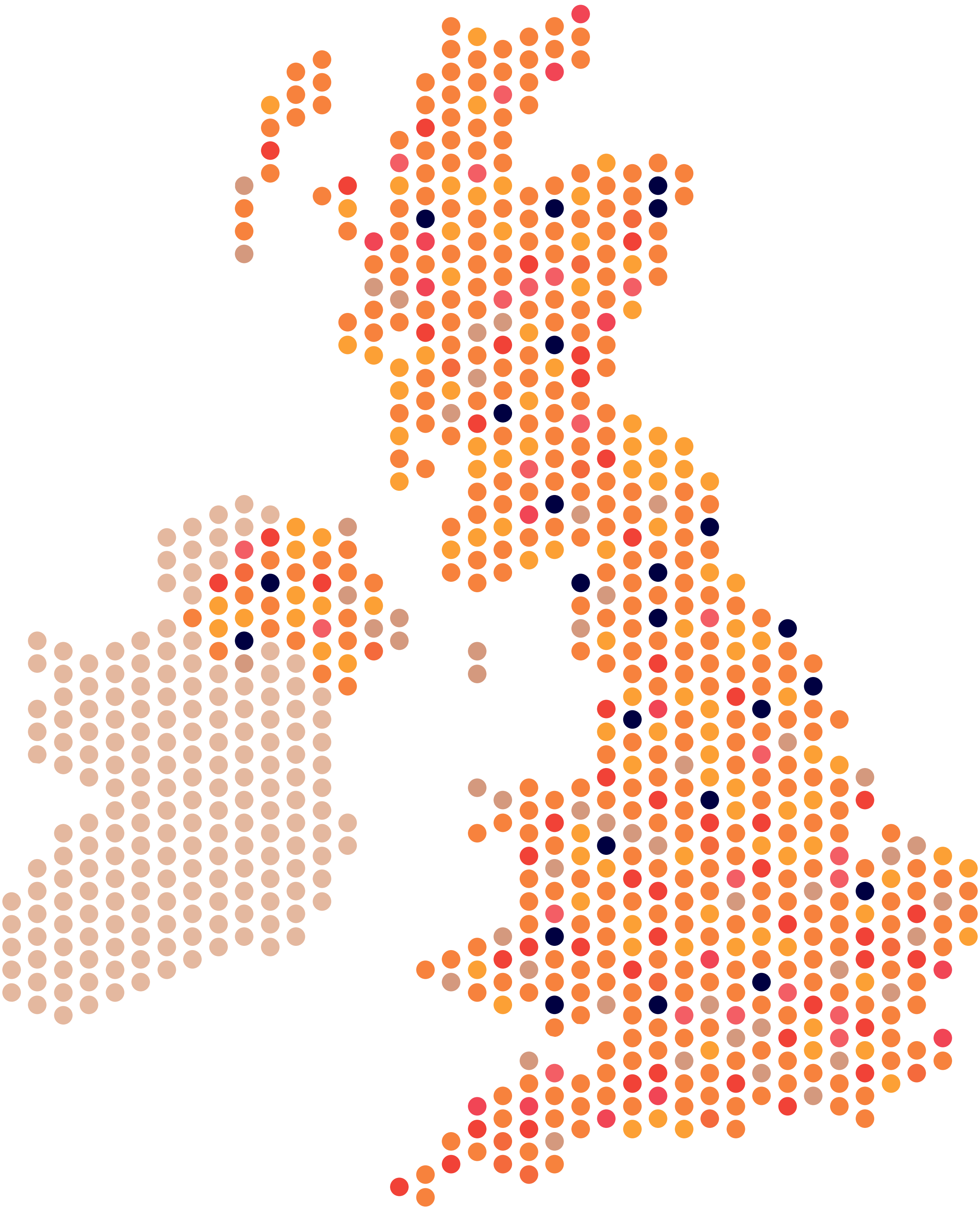
Engineering UK 2015

The state of engineering



EngineeringUK

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Engineering UK 2015 Authors

The lead authors for Engineering UK 2015 were Dr Anil Kumar, Director Education and Research, Neil Randerson, Senior Researcher and Elliott Johnson, Research Executive, with support from colleagues at EngineeringUK.

EngineeringUK would also like to thank the following for their valuable contributions:

Grace Breen
Policy Advisor, CBI

Verity O'Keefe
Employment and Skills Policy Adviser,
EEF, the manufacturers' organisation

Professor Michael J. Reiss
Professor of Science Education,
Institute of Education, University of London

Dr Tamjid Mujtaba
Research Officer, Institute of Education,
University of London

Barry Brooks
Strategic Adviser to the Tribal Board, Tribal plc

Keith Gallagher
Managing Director, Roevin

Peter Main
Education Advisor, Institute of Physics

Jon Prichard
CEO, Engineering Council

Tammy Simmons
Senior Marketing Executive, Engineering Council

Rhys Morgan
Director Engineering and Education,
Royal Academy of Engineering

Katy Morris
Senior Researcher,
Education & Employers Taskforce

Foreword
The Rt. Hon Dr Vince Cable MP

The Engineering UK Report continues to provide a valuable annual update on the state of the engineering sector. It reminds us of the talent our country possesses, the opportunities for economic growth, and the challenges we need to overcome if we are to realise this potential.

A strong British engineering sector is vital to the long term sustainability of our economic recovery, and increasing the supply of engineers is at the heart of this. That is why I have made it a key part of the government's industrial strategy, which is helping engineering companies and manufacturers across the country create jobs and wealth, and give them confidence to invest.

As a country we excel in hi-tech industries but we need engineers to make sure the UK stays ahead of our competitors: the rest of the world isn't standing still, so we must do everything we can to uphold our position as a leading engineering nation.

This year's report finds that engineering businesses have the potential to contribute an extra £27 billion to the UK economy every year from 2022 if we can meet the demand for a quarter of a million new vacancies in the same timeframe.

In Government, we're working hard to make sure we have the skills we need in 2022 and beyond, but we need to work with industry to make sure we inspire the engineers of tomorrow, today.

In higher education, it has been encouraging to see entrant numbers to all AS level STEM subjects rising by a third over the past ten years, and by 5 per cent between 2013 and 2014 alone. A-level mathematics and physics entrants have also increased significantly in the past decade. These subjects are the first step to a career in engineering, so their increasing popularity is a positive sign. Applications for engineering higher education courses have also increased by 5.5 per cent in the past year, with accepted applicants to engineering rising by 6.8 per cent.

However, with a year-on-year increase from 12 to 19 per cent of firms reporting difficulties in finding suitable graduate recruits, it is clear a skills gap still exists.

When encouraging young people to pursue any career, inspiration is as important as opportunity. Government cannot do this alone. Working together with industry, universities, colleges and schools is utterly essential if we are to showcase engineering as the exciting and fulfilling career path we know it can be. The major successes of this year's Big Bang Fair and the second annual Tomorrow's Engineers Week demonstrates what can be achieved through collaboration.

Alongside higher education, apprenticeships form a crucial part of meeting demand for skilled engineers and I am pleased to say that we are on track to create two million new apprentices within this Parliament. Through employer-led training and industry designed apprenticeships we are putting engineering employers in the driving seat so they are able to equip young people and adults with the skills the sector needs.

The continued inequality in the uptake and progression of women into engineering remains a problem. There is no way we can generate the number of scientists and engineers the economy requires without addressing this situation. In 2014 only 23.7% of entrants in A-level physics and 39.4% of entrants in A-level maths were women. While this is a slight improvement on 2013 figures, the disparity is even starker in vocational routes with just 490 women studying engineering apprenticeships in 2011/12 in England. However, with an increase of 8.5% on the number of female First Degree qualifiers in the past year, there are signs that our efforts to close the gender gap are starting to have an impact. We are committed to ensuring that women have the support and opportunity to build successful careers in engineering. That's why we have made £10 million match of funding available to employers to develop training projects aimed at increasing the number of women in engineering. This money forms part of a £30 million match fund that will support innovative training programmes to address skills shortages affecting engineering.

This report makes another important contribution to the national debate, as it has done throughout my time as Business Secretary. It reminds us of the fantastic contribution made to our economy and society by the engineering sector, and the possibilities within our grasp if we continue to work together to tackle the challenges before us.

Rt. Hon Vince Cable MP
Secretary of State for Business, Innovation and Skills

EngineeringUK
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 the value of engineering and the opportunities that engineering provides. Our goal is to improve 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 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

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 is made up of:

The Big Bang UK Young Scientists and Engineers Fair – the largest celebration of science, technology, engineering and mathematics for young people in the UK. The Fair plays host to the finals of the National Science & Engineering Competition, which recognises the country's brightest and best young scientists and engineers. 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 75,000 people through its doors in its fifth year.

The Big Bang Near Me and the new **Big Bang @ School** events take place across the UK, providing young people with the opportunity to experience, close to home, the excitement and opportunities available through STEM. In 2014 over 82,000 young people took part in a Near Me Fair or an @ School event.

We expect 80,000 people to attend The Big bang Fair in 2015 and our ambition for 2020 is that 100,000 children and young people each year will experience The Big Bang for themselves. Our ultimate goal is that every child in the UK should know someone involved with it.

Tomorrow's Engineers

Tomorrow's Engineers is a careers programme led by EngineeringUK and the Royal Academy of Engineering. It is delivered through a broad partnership between business and industry, the engineering profession, activity delivery organisations and schools, working together to inspire learners and their influencers. Our long term objective is to reach every state-funded secondary school in the UK in order to:

- improve awareness about engineering and what engineers do among pupils, their teachers and parents
- enthuse young people about engineering and the career opportunities available
- encourage young people to make the subject choices that keep open the routes into a career in engineering

In order to help achieve these objectives, Tomorrow's Engineers:

- funds a variety of experienced delivery partners, who provide a wide range of practical enhancement and enrichment activities delivered to targeted schools
- leads an employer engagement programme to ensure the work of the engineering community in schools is joined-up, effective and sustainable
- implements a common independent evaluation for activities that measures participants' learning about engineering and engineering careers, the impact on their perceptions, and their likely future subject and career choices
- provides careers information resources that help to engage pupils and teachers in understanding engineering career opportunities and routes into those careers

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 our activities on twitter.com/_EngineeringUK

Paul Jackson,
Chief Executive
EngineeringUK

Engineering UK 2015
Synopsis, recommendations and calls for action

Engineering employers have the potential to generate an additional £27 billion per year from 2022 which is equivalent to the cost of building 1,800 secondary schools or 110 new hospitals. If the UK is to benefit economically from this, we will need to meet the forecasted demand for 257,000 new vacancies in engineering enterprises in the same timescale. Achieving this will take persistent and collaborative delivery.

Failing to meet our engineering workforce requirements will not only damage the UK economically, but it will also have a detrimental effect on individual employees' prosperity and the economic sustainability of engineering employers. What's more, failure will impact on engineering's role in providing a lasting legacy for future generations through ensuring the supply of food, clean water and energy – a tough challenge against a backdrop of climate change and ageing populations. The single biggest threat to success lies with education: to meet demand, we need enough young people to study STEM subjects at schools and colleges. Currently, there are not enough specialist STEM teachers trained to a sufficient level to support this aim.

On the surface, the glass is half full. We have top level cross party endorsement of the importance of STEM education and skills and careers advice. The **Industrial Strategy, Eight Great Technologies and Growth Plan** are all moving in the right direction and the new devolved local agenda and role of LEPs promises to focus growth at a local level. NEETs are at lowest level since records began. The perceptions of engineering are up and the numbers studying engineering are increasing.

Despite these encouraging signs, the rate of change in the growth of supply is far too slow to meet the forecast UK demand for engineering skills. Our extension to *Working Futures 2012-2022* shows that over this period engineering employers will need to recruit 2.56 million people, 257,000 of whom for new vacancies. Overall, 1.82 million of these workers will need engineering skills: pro rata, that is an average of 182,000 people per year. Within the engineering-related demand, 56,000 jobs per year will be needed at level 3 (Advanced Apprenticeships) and 107,000 per year at level 4+. Yet current figures show that only 26,000 people are entering engineering occupations with level 3 Advanced Apprenticeships and only 82,000 at level 4+ (HND/C, foundation degree, undergraduate or postgraduate and equivalent). The scale of the challenge is clear.

This year we are able to present the size and vital importance of the engineering sector to the UK's economy as Gross Domestic Product (GDP). This is because GDP is arguably the most important of all economic statistics as it attempts to capture the state of the economy in one number. In 2014, the engineering sector contributed an estimated £455.6 billion (27.1%) of the UK's total £1,683 billion GDP.

Last but not least, there will be some significant population challenges in the UK in the coming years that will affect the pool of GCSE level and equivalent pupils and the pool available for progressing into Higher Education. The number of 14-year-olds is set to fluctuate significantly, falling by 7.3% between 2012 and 2017 before jumping by 15.9% five years later. The number of 18-year-olds will also decrease by 8.9% between 2012 and 2022. To further compound the population issue, if we assume that currently people start work at 18 and stay in employment until 65 then the average number of years of employment the average person in the UK has is 24 years; this points to the fact that over the next 24 years, half of the current working population will retire.

Jobs and growth

The contribution of engineering and engineers to the UK economy should not be underestimated. The number of engineering enterprises in the UK has grown by 2.0% over a 12 month period to March 2013. However, this growth has not been even across the country, with London growing by 5.3%. Engineering enterprises employ 5.4 million workers, which is a fifth (19.3%) of all people employed in UK enterprises. Finally, engineering enterprises had a collective turnover of £1.17 trillion. This is a 6.7% increase over 12 months and 9.0% higher than the start of the recession, representing a quarter (24.9%) of the turnover of all UK enterprises. In comparison, the retail sector turns over less than a third (30%) of the engineering sector.

It is worth noting that most engineering enterprises (97.1%) are either small or micro and, overall, 86.9% of engineering enterprises have fewer than 10 employees. However, while companies with at least 250 employees represented 0.4% of all engineering enterprises, they employ over two fifths (42.4%) of those working in engineering enterprises.

At a time of tight control over public spending, the Government continues to offer strong support for science, engineering and research. Recognising that world class research plays a key role in economic growth and improvement to the health and wellbeing of society, the Government continues to protect the cash that has been ring fenced for science for the financial year 2015/16. In addition, the Chancellor has increased investment in science, including a long-term commitment to investment in science infrastructure of £1.1 billion in real terms to 2021. This brings overall investment in science and research to £5.8 billion for 2015/16 – an increase in overall spending compared with recent years.

The UK punches above its weight as a research nation. While we represent just 0.9% of global population, 3.2% of R&D expenditure and 4.1% of researchers, we account for 11.6% of citations, 15.9% of the world's most highly-cited articles and 30 of the top 200 universities in the world. Within engineering, there is an equally good story to tell: the UK ranks 3rd in the G8 for number of citations and 2nd in the EU27. For number of citations per billion dollars GDP, the UK ranks 1st in the G8 showing excellent value for money.

The Government has, for England, also positioned LEPs as key players in steering support for innovation at the local level (as well as their role of supporting education and skills and those Not in Education, Employment or Training), and their role is growing. In 2013, the Department for Business Innovation and Skills announced notional allocations to each LEP for 2014-2020, to come from the £5.3 billion of European Structural and Investment Funds (ESIF). At least £660 million will be directed towards supporting innovation.

Engineering continues to break away from its Victorian image, however it still needs to be reinforced that modern engineering encompasses a broad church of technologies and industries. This is best illustrated by the following list, which depicts new or existing engineering sub-sectors where the UK has proven strengths and is showing the capability for growth:

Automotive

The automotive sector continues to be a success, building 1,597,433 vehicles across more than 70 different types of model in 2013 and generating exports of £30.7 billion – 10% of the UK trade in goods. Notably it employs 731,000 people, generates £59.3 billion turnover, accounts for 3% of UK GDP and invested £1.7 billion in R&D.

Aerospace

The UK has a 17% global market share in aerospace industry revenues: the largest in Europe and second only to the US worldwide. In 2012, the industry had a turnover of some £20 billion. Furthermore the sector supports more than 3,000 companies distributed across the UK, directly employing 100,000 people and supporting an additional 130,000 jobs indirectly. In 2011, the UK aerospace revenue was £24.2 billion, a real terms increase of 2.5% compared with 2010. Finally, It has been estimated that there will be global demand for 27,000 new passenger aircraft, worth around $3.7 trillion, by 2031. In addition, global demand for commercial helicopters is expected to be in excess of 40,000 and worth circa $165 billion by 2031.

Construction

In 2013, construction contributed £83.0 billion to economic output – 6% of the total – and employed 2.15 million people or 6.5% of the UK total. The global construction market is forecast to grow by over 70% by 2025, concentrated primarily in emerging economies. In support of the sector, in July 2013, the Government published *Construction 2025*, which summarises the industrial strategy for the construction sector in the coming decade.

Biosciences

Biosciences are vital to develop the products and processes integral to our lives, from the food we eat to our medical care. Between them, the UK biosciences sectors of pharmaceuticals and industrial biotechnology represent over 13,000 companies, generate over £134 billion in turnover and contribute £41 billion to the economy.

Space

Space technology provides the basis for much of modern life, with services supporting communications, environmental monitoring, navigation and security. The UK space sector contributes £9.1 billion a year to the UK economy and directly employs 28, 900 people. It is also one of the UK economy's fastest growing sectors, with an average growth rate of almost 7.5%. The sector has the potential to be a great success story for the UK economy, with ambitions to increase its annual turnover to £40 billion by 2030. The worldwide space market was worth £160 billion in 2008 and is forecast to grow to £400 billion in 2030.

Chemicals

Whether in household products, in food or medicines, or in advanced materials, fuels and process technologies, the UK chemicals sector is fundamental to our economy and quality of life. In 2012, the UK chemicals sector generated annual sales of nearly £31 billion – 11% of all manufacturing exports by value – and employed over 111,000 people directly. The sector generated £8.6 billion in Gross Value Added (GVA) in 2012, and contributed a total of £591 million in R&D investment.

Creative industries

Government analysis shows the sector punches above its weight for the economy, generating £8 million an hour, contributing £71.4 billion GVA and providing 1.68 million jobs (or 2.2 million if we count creative jobs in other sectors) in 2012.

Advanced materials

Advanced materials underpin many sectors including manufacturing, construction, cleantech and transport. The interdependency of advanced materials and high value manufacturing in particular offers a large opportunity for UK innovation and growth. Businesses that produce, process, fabricate and recycle materials form a critical element in high value manufacturing. They have an annual turnover of around £197 billion and contribute £53 billion to the economy.

Electronic, sensors and photonics

Electronics, sensors and photonics underpin many industrial sectors. The UK's electronics sector generates approximately £29 billion a year in revenues, contributing over £12 billion to GVA and employing an estimated 850,000 people in the UK.

Agri-tech

Agri-tech underpins our food and drink manufacturing sector, which is the UK's largest manufacturing sector, worth £25 billion. The entire agri-food supply chain – from farm to table – is worth £96 billion. A UK Strategy for Agricultural Technologies defines this new industrial sector for the first time.

Renewables

Generation from renewables, including wind, wave and tidal, currently makes up around 15% of the UK's electricity supply. The largest contributor to this is the combination of on-shore and off-shore wind power. Wind, wave and tidal power currently provide employment for 34,500 people in the UK, and have the potential to create 70,000 more jobs over the next decade.

The UK has made a firm commitment to cut carbon emissions by at least 80% by 2050. Between 2010 and 2020, the UK is expected to cut greenhouse emissions by 29%, and must reduce this amount by a further 85% by 2030.

Rail

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, This will be enhanced by strategic investments such as HS2, Crossrail, Thameslink, London Underground upgrades and the nationwide electrification programme.

Retail

Retail turnover is around £320 billion per year in the UK. Despite the economic climate, the sector has continued to show growth. Retail employs three million people (one in 10 of the workforce) across 180,000 businesses, operating in every postcode in the country. It also underpins local economies, and is a key partner in delivering Government policy in a number of areas.

Oil and gas

The UK oil and gas supply chain is well positioned across the value chain, with 1,100 companies achieving combined revenues of £27 billion in 2011. Currently, oil and gas provide some 73% of the UK's total primary energy, with oil for transport and gas for heating being dominant in these markets. The industry supports some 450,000 jobs, many highly skilled, across the whole economy. In 2013, capital investment of £14.4 billion in the UK's oil and gas reserves was the highest for 30 years.

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. 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 $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%.

Universities

In 2011/12, the Higher Education sector made a substantial contribution to economic activity, and generated over £73 billion of output (both direct and indirect effects). In addition the sector; contributed 2.8% of UK GDP up from 2.3% in 2007, generated significant employment opportunities across the economy, accounted for 2.7% of all UK employment (up from 2.6% in 2007) which is the equivalent to 757,268 full-time jobs, directly employed 378,250 people (approximately 319,474 full-time equivalent jobs – just over 1% of all UK employment in 2011 and generated an estimated £10 billion of export earnings for the UK in 2011/12.

Cities

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. As well as being important in terms of scale, they are also important in terms of efficiency. Cities in the UK produce 15% more output for every worker than non-city areas, while they produce 32% fewer carbon dioxide emissions than non-city areas.

The UK's future prosperity depends on them because cities host 73% of all highly skilled jobs. However, 64% of unemployment is in cities.

Intangible assets

Latest figures published show that UK business is building success through 'knowledge' and 'creative assets'. Investment in 'intangible' assets has increased by more than 5% to £137.5 billion from 2009 to 2011. Nearly half of this investment was protected by formal Intellectual Property Rights. Of this, 46% was protected by copyright, 21% by unregistered design rights and 21% by trademarks.

Data shows investment in intellectual property and 'intangible' assets is growing and continues to outstrip investment in tangible assets such as buildings and machinery, which fell slightly from £93 billion to £89.8 billion. These figures signal the growing value UK businesses attach to knowledge, innovation and creativity.

Professional and business services

We are among the world leaders in most of the highly-skilled services that make up the professional and business services (PBS) sector.

The PBS sector generates 11% of UK gross value added and provides nearly 12% of UK employment. It also contributes strongly to economic growth and productivity: despite the economic downturn, PBS has seen growth of nearly 4% a year in the last decade. Export performance is strong, totaling £47 billion in 2011, with a trade surplus of £19 billion (a third of the UK's total services sector surplus).

Information economy

The information economy is transforming the way we live and work. It enables process, product and service innovation across all sectors, leading to increased competitiveness and sustainability. It is crucial to our success on the global stage, our competitiveness and our connectedness – to our whole economy.

The UK ICT sector comprises more than 116,000 companies with revenues of more than £137 billion and contributes £66 billion to the UK economy. The overwhelming majority of information economy businesses – 95 % of the 120,000 enterprises in the sector – employ fewer than ten people. There were 1.3 million jobs in the ICT sector in 2011.

Big data

Big data refers to ways of handling data sets so large, dynamic and complex that traditional techniques are insufficient to analyse their content.

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. 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.

Manufacturing

UK Manufacturing is and must continue to be an essential part of the UK economy. It contributed £139 billion to UK GDP in 2012, employed more than 2.6 million people, was the 11th largest manufacturer in the world and accounted for 54% of UK exports. Manufacturing in the UK is definitely alive and well. The idea of **reshoring** has come of age. Over the past two years, reshoring has added £600 million to the UK economy and created approximately 10, 000 new jobs. Indeed, 15% of UK manufacturers have brought production back from overseas during the past year or are in the process of doing so. This compares with only 4% that off-shored in the past year. The economic potential of reshoring is huge. It is estimated that this trend could create around 100-200,000 extra UK jobs over the next decade, and boost annual national output by around £6-12 billion at today's values (c.0.4-0.8% of GDP) by the mid-2020s. Alongside this, the growing trend for remanufacturing (a series of manufacturing steps acting on an end-of-life part or product to return it to like-new or better performance, with a warranty to match) is also adding to the future resurgence of the sector. Estimates suggest that the value of remanufacturing in the UK is £2.4 billion. However, it has the potential to increase to £5.6 billion, as well as create thousands of skilled jobs.

To take advantage of this opportunity, UK Trade and Investment (UKTI) has joined forces with the Manufacturing Advisory Service (MAS) to launch Reshore UK, a new one-stop-shop to help companies bring production back to the UK.

Skills

The Manpower Group's *Global Talent Shortage Survey 2014* shows that the top three shortages globally are skilled trades, engineers (second place for the third year running) then technicians. The UK is clearly not alone in the struggle for skilled engineers and technicians.

The UK Commission for Employment and Skills' *Employer Skills Survey 2013* report provides a reliable, timely and valuable insight into the skills issues being faced by employers and the action they are taking to address these. The survey reports that economic growth and recovery may be constrained by skill shortages as the labour market responds to employer requirements. While in most cases demand for skills is met through successful recruitment, almost three in ten vacancies are reported to be hard-to-fill, and shortages in suitably skilled, qualified and/or experienced workers are the main reason for this.

Since the last *Employer Skills Survey* in 2011, there has been a rise of 12% in the volume of vacancies. However, Skills Shortage Vacancies have increased at five times that rate (up 60% on 2011) and now account for just under a quarter of all vacancies. In addition, nearly three in ten vacancies are classed, by the employer, as hard-to-fill. While skills shortages and hard-to-fill vacancies are not universal, those employers who are affected by them can be hit hard.

Analysing the UK data by sector shows that engineering enterprises are more likely than average to have hard-to-fill vacancies for professionals (31.7% compared with 17.6%) and skilled trades occupations (24.8% compared with 12.6%). Furthermore, nearly half (48.3%) of engineering enterprises said that hard-to-fill vacancies meant they had delays developing new products or services, while 44.8% said they experienced increased operating costs. This shows the tangible effect of skills shortages.

Employers themselves support this data. For example, the CBI reports that:

People with STEM skills are becoming harder to recruit – more than one in four employers report difficulties in meeting their need for technicians (28%) and experienced staff with STEM expertise (26%). Finding suitable graduate recruits has also become more of a problem, with nearly one in five (19%) reporting difficulties in 2014, compared with 12% in 2013. There has been a jump too in the proportion of employers reporting difficulties in recruiting people with STEM skills to train as apprentices (from 12% to 22%).

Businesses expect the difficulties to intensify – businesses needing STEM-skilled staff believe the recruitment market will become much more difficult in the years ahead, as the economic recovery gathers momentum. The proportion anticipating difficulties over the next three years has climbed from two in five (41%) in 2013 to more than half (53%) in 2014.

The calibre of STEM graduates also needs attention – when asked about the barriers they encounter in filling jobs that require STEM-linked skills and qualifications, employers point to a range of concerns.

Heading the list is the troubling finding that nearly half of those respondents (48%) experiencing problems have concerns about the quality of STEM graduates. This ranks just ahead of the problem of a shortage of STEM graduates (at 46%).

A lack of general workplace experience among applicants (39%) and weaknesses in the attitudes and aptitudes for working life among candidates (30%) are also identified as common problems. These findings highlight the need for young people to develop their understanding and gain some experience of the day-to-day demands of the workplace.

The Government is addressing the barriers faced by industry through the concerted efforts of the Industrial Strategy, the launch of the Eight Great Technologies and the Regional Growth Fund. The latter alone has delivered £2.6 billion of investment to 400 local projects and programmes, which has unlocked nearly £15 billion of private investment and delivered 550,000 jobs.

In parallel, the Government is taking steps to realise the potential value of STEM skills to the UK and over the past year has made several major announcements in terms of science, innovation, education and skills. These include:

- Recognising the need to improve the supply of engineering skills with the launch of a £30 million fund to encourage more women into the sector and to address skills shortages in smaller companies.
- Extending the Apprenticeship Grant for Employers scheme through providing £85 million in the financial years 2014/15 and 2015/16. This will fund over 100,000 additional incentive payments for employers – particularly small and medium-sized businesses – to take on young apprentices.
- Investing £74 million in the Catapult network, which bridges the gap between research and development and the market, turning innovative ideas into reality. This new investment will ensure the UK can remain at the forefront in two of our rapidly growing new industries: graphene and cell therapies. Catapult centres are closely aligned to Government industrial strategy sectors.
- Approving 50 University Technical Colleges and 46 studio schools.
- Launching The Technology Strategy Board (TSB) 2014/15 Delivery Plan, an ambitious £400 million plan for developing and nurturing the very best of British entrepreneurial talent.

UK labour force projections

The *Working Futures 2012-2022* report provides a comprehensive and detailed picture of the UK labour market. It highlights that out of a total 14.356 million UK job openings, 12.501 million will be created by people leaving the labour market (so called replacement demand) and 1.855 million resulting from the creation of new jobs.

However, this still means that even those occupations where employment is projected to decline may still offer good career prospects, with a significant number of job openings. So long as significant numbers are employed in such jobs, employers will need to replace those workers who leave due to retirement, career moves, mortality or other reasons.

Finally, given that between 2012 and 2022 approximately 8,990,000 21-year-olds will enter the workforce, a question is raised about how the UK will fill the 14.356 million job openings over the period. To further compound the skills demand challenge, over half the current working population will retire in the next 24 years (based on the fact that if we assume that currently people start work at 18 and stay in employment until 65 then the average number of years of employment the average person in the UK has is 24 years).

The extension to *Working Futures 2012-2022*, which generates UK work force demand forecast, re-cuts the *Working Futures* data by the EngineeringUK standard industrial classification (SIC) engineering footprint shows that over this period engineering companies will need to recruit 2.56 million people, 257,000 of these will be needed to fill new vacancies. This represents 17.8% of all job openings across all industries: equivalent to 47.2% of the current engineering workforce (5.4 million). Of these workers, 1.82 million will need engineering skills: pro rata, that is an average of 182,000 people per year. Occupations at level 4+ (HND/C, foundation degree, undergraduate or postgraduate and equivalent) are most likely to require engineering skills, and these account for approximately 107,000 openings per year, with another 56,000 openings in need of level 3 skills (Advanced Apprenticeships). However, our analysis of the supply data shows that the supply at level 4+ is just 82,000 (a shortfall of 25,000 per year) and at level 3 it is 26,000 (a shortfall of 30,000 per year). On the surface the 82,000 level 4+ will appear to be a significant increase from last year's figure of 51,000; however access to better more detailed data has allowed us to determine a more robust figure. We have been able to determine and incorporate the supply from those students from engineering and technology and other related STEM and non-STEM courses (such as architecture, building and planning, computer sciences, mass communications and documentation, creative arts and design and education) who enter engineering occupations on leaving Further and Higher Education.

Of the 2.56 million job openings that will emerge in engineering companies between 2012 and 2022, nearly a third (32.0%) are forecasted to be filled by women. If you look at just expansion demand (creation of new jobs), then half (51.9%) of these job openings are forecasted to be filled by women.

Alongside this, our analysis of the UK Commission Employer Skills Survey shows that engineering enterprises are more likely than average to have hard-to-fill vacancies for professionals (31.7% compared with 17.6%) and skilled trades occupations (24.8% compared with 12.6%). Furthermore, nearly half (48.3%) of engineering enterprises said that hard-to-fill vacancies meant they had delays developing new products or services, while 44.8% said they experienced increased operating costs. This shows the tangible effects of skills shortages.

Finally it is worth noting the research by Deloittes into the impact of technology and automation on the labour market which highlighted that more than a third of all UK jobs are at high risk of disappearing over the next 20 years. Jobs requiring repetitive processing, clerical and support services are likely to be replaced with roles requiring digital management and creative skills. However, four out of 10 jobs were at low or no risk and reassuringly engineering and computing were within this cohort.

Graduate employment, destinations and salaries

Engineering and technology graduates are very employable: 66.3% were in full-time employment within six months of graduating from their course. This is higher than the percentage of all graduates who are going into full-time employment (57.7%).

Over three quarters (77.5%) of engineering and technology graduates were in some form of employment: either working full-time, part-time, or combining work with study. Two thirds (64.1%) of engineering and technology graduates who were in employment were working as engineers and two thirds (64.3%) were working for engineering companies. Only 2.1% of engineering graduates went to work in financial services, which is below the average for all graduates (3.6%) and contradicts the widely held belief that many engineering graduates go into finance. Furthermore, of those who went to work in finance, nearly a quarter (22.7%) were working in an engineering capacity, in a financial company.

Additionally, new analysis shows the significant contribution that some other disciplines make to the engineering workforce. In every subject area, a proportion of employed graduates go into an engineering occupation, in addition, of all graduates who find employment one in nine (11.2%) actually go into an engineering occupation. Three subject areas had at least half of all their graduates going into an engineering occupation:

- architecture, building and planning – 66.6%
- engineering and technology – 64.1%
- computer science – 52.1%

Those engineering and technology graduates who didn't go into an engineering occupation tended to become photographers, audio-visual and broadcasting equipment operators and Officers in the armed forces.

Nearly three quarters (71.0%) of male engineering graduates who were in employment went into an engineering occupation, compared with over half (58.7%) of female graduates.

Finally, the importance of non-STEM subjects in providing non-engineering staff for engineering companies should be recognised. For example, nine in ten graduates in mass communication and documentation (91.4%) and languages (90.2%), eight-in-ten graduates in medicine and dentistry (82.9%), social studies (84.7%), law (81.5%), business and administrative studies (79.4%) and historical and philosophical studies (83.9%) who found employment in an engineering company went into in non-engineering roles.

The graduate earning premium is well known. Research by the Department for Business, Innovation and Skills shows that the additional lifetime earnings, net of tax and loan repayments, are on average £168,000 for men and £252,000 for women.

Graduates in engineering and technology have the second highest mean salary (within six months of graduating), at £26,536. Only medicine and dentistry has a higher mean salary (£31,853). In comparison, the mean salary for all graduates was £21,725. The UK mean salary for all those in employment was £27,174. This means that on average (and including figures for the most experience and highly paid), graduates in engineering and technology start with a salary that is almost the same as the UK national average salary. In comparison, the mean salary for physical sciences was £21,073 and for architecture, building and planning it was £23,499. It is also worth noting that the mean salary in 2012/13 for someone employed by an engineering company was £28,116, compared with £23,183 for those who did not work for an engineering company.

In terms of occupational salaries, from a set of selected STEM professions, the mean salary for all workers was £27,174. The highest mean salary for a STEM career was £78,482 for aircraft pilots and flight engineers. There was a substantial decline to the second-highest salary, which was £70,648 for medical practitioners. Also from a selected set of full-time STEM technician and craft careers in 2013, financial and accounting technicians had the highest mean salary, at £49,583, followed by rail and rolling stock builders and repairers (£39,602). The median salary for engineering technicians was £33,687.

Professionally Registered Engineers and Technicians

The *Register of professional engineers and technicians*, held by the Engineering Council, shows that there are approximately 12,500 Engineering Technicians (EngTechs), 20,600 Incorporated Engineers (IEngs) and 95,550 Chartered Engineers (CEngs) living or working in the UK. Project *MERCATOR* identifies the number of self-declared engineers and technicians working in the UK who are eligible for professional registration as significantly higher, with 1.2m eligible for EngTech, 378,000 eligible for IEng and 316,200 eligible for CEng across all occupational levels. Professionally-registered engineers enjoy enhanced salaries. Between 2010 and 2013, the mean basic annual income for Chartered Engineers increased by 10% to £68,539, for Incorporated Engineers it increased 10% to £51,227 and for Engineering Technicians average salaries rose by 32% to £52,349.

Attraction of STEM

Careers advice is a key factor in determining the future supply of young people who study STEM and go on to pursue STEM careers. It is self-evident that all young people should have access to consistent and reliable information that allows them to make informed choices about their future studies and careers. Sadly, we know that this is not the case at present. To address this, business and industry, professional engineering institutions and other third sector organisations are working in partnership with Government to play an active national role in addressing this for STEM.

We face an uphill struggle and our annual brand monitor survey clearly shows that there is more to be done. Even among STEM teachers, 17% think that a career in engineering is undesirable for their students. This rises to 19% for the 25- to 44-year-old STEM teacher group. Furthermore, only 36% of STEM teachers felt confident in giving engineering careers advice. Targeting the influencers of young people with up-to-date, accurate and non-stereotypical information about the range of engineering and STEM-related careers is essential in persuading students to persist with STEM throughout school, university, apprenticeships and employment.

The essential but often overlooked role of careers education and advice, particularly for young people still in education, is bought into sharp focus through findings from the Education and Employer Taskforce report *Nothing in Common*. Its research showed that teenagers' aspirations at age 14, 16 and 18, when mapped against projected labour demand (2010-2020), have almost "nothing in common" with the realities of the UK job market.

The Institute for Public Policy Research (IPPR) looked at interactions between schools and businesses and found that young people want more from their careers services. They want to know more about local job opportunities, more work experience to help them decide on their future career paths, and, for those careers that are strategically important, they may also need incentives to pursue them.

The Institute also determined that pupils may need help, and need it earlier than it is being provided at present. A known area of public concern is female participation in key sectors, including science. The lack of interest in post-GCSE STEM subjects and vocational education among girls is a cause for concern given that skills shortages in these sectors are looming. The survey provided evidence of insufficient knowledge among pupils of both genders about which careers did and did not have science qualifications as a prerequisite. The Institute concluded that educating young people early about careers, and the educational choices they will need to make in order to achieve their ambitions, is therefore important for pre-GCSE ages, not just those aged 16 and upwards.

Research by the University of Warwick has shown that students don't make links between curriculum knowledge and their future careers and need to know that, for some STEM careers, studying triple science is either desirable or essential. Links between the curriculum and future careers need to be made more explicit to students.

The ASPIRES study shows that while students remain positive about science as a potentially academically-rewarding subject from years 6-9 (11 to 14 years old), their enjoyment decreases year-on-year. Qualitative data suggests that the significant drop-off in enjoyment 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. This trend might explain the drop-off in numbers after the age of 16.

A large body of evidence published by King's College London shows that interest in science is formed by age 14. Those students who had an expectation of science-related careers at age 14 were 3.4 times more likely to earn a physical science and engineering degree than students without this expectation.

It is important that the role of parents should not be underestimated. Research by the Wellcome Trust and Platypus Research highlighted the association between positive parental attitudes towards science, with discussion of experiences at school and engagement in enrichment activities particularly noted. This importance was also reinforced by the Institute for Public Policy Research. Its research showed that families are the most common source of careers advice for pupils, with advice from family (again) and friends the most important factor in deciding future career for 15% of pupils surveyed. Therefore, the importance of informing parents, including through enrichment activities and the development of science capital, cannot be underestimated.

However, through The Big Bang Fair, we have shown that these perceptions can be improved. For example, when asked, 42% of parents and 43% of teachers said that their knowledge of what people who work in engineering do had increased as a result of attending the fair, while 68% of parents and 70% of teachers said that they were more likely to recommend a career in engineering to an accompanying young person.

STEM enrichment and enhancement activities

We believe that a coordinated approach to (engineering) employer engagement in schools is key to reaching the numbers of young people needed to help deliver the UK's future science, engineering and technology sectors. A pilot of the Tomorrow's Engineers employer engagement expansion project ran in the North East and South East over an eight-week period in the summer of 2014. The programme aims to coordinate the school-based careers initiatives and activities that engineering employers are delivering. Analysis also showed that, simply by coordinating efforts on a regional basis, it was possible to triple the number of young people reached and inspired to become tomorrow's engineers. National roll out is planned that provides support to business, linking local engineering employers with local schools, and helping to create the next generation of engineers.

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-achievers. In relation to KS4 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

EngineeringUK delivers The Big Bang Fair, The Big Bang Near Me Fairs, and Tomorrow's Engineers, in partnership with businesses, professional engineering institutions and third sector organisations. These careers inspiration programmes currently reach upward of 150,000 young people per year directly and over 500,000 indirectly through online and offline channels. They provide opportunities for authentic careers inspiration by enabling face-to-face interactions between STEM professionals and young people, helping to set a context for students' classroom learning.

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 NEET and earned, on average, 16% more than peers who recalled no such activities."

The Confederation of British Industry (CBI)/ Pearson Education and Skills Survey 2014 showed that 80% of UK businesses believe careers advice for young people "is not good enough to help them make informed decisions about future career options," with only 3% thinking it adequate. The CBI has therefore called for the creation of Local Brokers which would be nationally-mandated, Government-funded and help to coordinate and facilitate links – and particularly careers provision with regular work contacts – between schools, colleges and industry. Lord Young's proposed Enterprise Advisers is a similar concept.

Promoting engineering/STEM to women

Given that the number of 18-year-olds overall is due to drop by around 10% in 2022 and the number of engineering workers required in that period is set to increase, encouraging women into the STEM sector is vital to fulfilling business needs. The House of Commons Science and Technology Committee has recognised this requirement. Indeed, if women were to participate more fully in STEM employment, it could contribute an additional £2 billion to the economy.

CASE have highlighted that this may be influenced by parental perceptions of engineering, with 12% of parents stating that they would like their son to become an engineer, while only 2% said the same about their daughter. In contrast, while 16% would prefer their daughter to become a teacher, only 5% would like their son to. Despite improvements in female participation in STEM at GCSE level, the number of women taking A level physics remains low (though higher than in 2013): 23.7% of entrants in physics and 39.4% in mathematics were women in 2014. This disparity is especially prevalent in vocational routes, with just 490 (4.4%) women studying engineering apprenticeships in 2011/12 in England.

Education capacity and capability

Capacity – student supply

If we are to meet the future UK demand for skilled engineers, the fundamental challenge is to dramatically increase the numbers of students studying and progressing in STEM subjects throughout the education sector, all the way from schools, Further Education Colleges and universities. At the same time, we need to inspire them to pursue careers in engineering.

GCSEs and equivalent qualifications

The UK education qualifications system is becoming both more demanding and more fragmented across the devolved nations, making it impractical to compare accurate 'supply' figures with last year. Nevertheless, it can be determined that in 2014 there were 777,236 entrants to GCSE or equivalent mathematics and 173,958 GCSE or equivalent entrants to physics across the UK.

In addition, there were also 26,169 entries to iGCSE mathematics and 15,688 to iGCSE physics in 2012/13, contributing to the pool of GCSE and equivalent subjects. It is interesting to note that over the past three years, mathematics has grown by 39.9% and physics by 162.4%.

Looking just at GCSE mathematics and science subjects shows 736,403 entrants to mathematics in 2014 – down by 3.1%. It also shows that the three separate science subjects plus core science are the four STEM subjects with the largest percentage declines. Biology has fallen by 18.6% to 141,900, while science fell by 16.9% to 374,961 and chemistry declined by 16.8% to 138,238. Even physics fell 14.6% to 137,227, although in this case, the 21,119 students who entered further additional science will have covered the entire physics curriculum if they have also studied core and additional science. This means that the fall in physics numbers may not be as serious as the headline figure suggests.

Ofqual has commented that as science qualifications have moved from modular to linear exams, schools may have changed how they approach GCSE science subjects and the timing of exam entries. This could explain some of the variation being seen within science subjects.

Two thirds (68.8%) of all entrants in STEM subjects in 2014 achieved an A*-C grade. Six STEM subjects had an above average A*-C pass rate: mathematics (additional), statistics, physics, chemistry, biology and ICT. The highest pass rate for a STEM subject was mathematics (additional), at 93.5%. Statistics also had an above average pass rate of 70.2%. For the three separate science subjects they all had at least nine in 10 entrants achieve an A*-C grade. Physics had the highest pass rate at 91.3%, closely followed by chemistry (90.7%) and biology (90.3%).

Ofsted has shown that schools that made science interesting for pupils have raised their achievement in science. It also showed that most effect approach was through practically-based investigation.

Across all the main STEM-related subjects bar mathematics, girls achieve higher A*- C grades than males. In mathematics, the difference is now marginal, at 62.5% to 62.3%. Across all subjects, girls' A*-C achievement rates are significantly higher than boys, at 73.1% to 64.3%.

In terms of level 2 vocational supply, in 2013/14 19,632 students completed a level 2 BTec engineering course (although this was 2.4% lower than the previous year). Ofsted has said that it is likely that over the next year or two the number of vocational courses will decrease, in part because schools are responding to the new combined EBacc measure.

Finally, the Government has recognised the importance of continuing the study of maths and from September 2013, students who don't have a GCSE A*-C in maths are expected to continue their study towards this qualification as part of their 16-19 education. In 2014, 37.6% of 16 year olds studying maths failed to get an A*-C grade. Furthermore, the Government is also introducing core maths for those students who achieve a grade A*-C at GCSE level but who don't continue with advanced maths after age 16. It is estimated that the introduction of core maths could affect over 200,000 students per year post 16 who normally would have not continued to study any form of maths post-16.

AS, A levels and equivalent qualifications

In 2014, there were 114,110 entrants to A level or equivalent mathematics and 48,725 A level or equivalent entrants to physics across the UK.

Entrant numbers to all AS level STEM subjects have risen by a third (30.9%) over the 10 years to 2014 and increased by 5.0% between 2013 and 2014. In an open letter to all schools, Ofqual identified that entrants to AS level courses are higher this year compared with 2013, as a result of the removal of the January exam series which meant that students could not take a unit early and therefore had to take their full AS at the end of the academic year.

Four STEM subjects had an increase of more than the average for all subjects (5.0%): computing (30.3%), further mathematics (8.5%), mathematics (7.2%) and physics (5.9%).

The A-C achievement rate for all AS level subjects was 61.4%. Of the different STEM subjects, only two had an above-average A-C pass rate: further mathematics (80.0%) and mathematics (67.0%). Over half (58.1%) of entrants to physics got an A-C grade.

Female students had a higher A-C pass rate for all subjects than male students (64.1% against 58.4%). Looking at the different STEM subjects, in all but two – chemistry and other science subjects – female students have a higher A-C pass rate than male students.

Overall, 64,790 students were entered for physics in 2014. Of these, fewer than a quarter (23.7%) were female. The A-C pass rate for female students was 61.4%, compared with 57.1% for male students.

The number of entrants to A level mathematics increased by 0.9% to 88,816 over the past year and over the 10 years to 2014 numbers increased by 67.9%. This was the second largest increase for a STEM subject behind further mathematics, which rose by 136.4% to 14,028.

Over 10 years, the proportion of students taking physics A level has risen by 30.5% – around half the increase of mathematics. Physics had 36,701 entrants in 2014, which is below half (41.3%) of the entrants to mathematics. Therefore, one way to increase the pool of students able to study engineering would be to encourage a higher proportion of students who are studying mathematics to also study physics.

In parallel, it is interesting to note that in 2013 nearly half (45.9%) of candidates in independent schools took mathematics, compared with just over a quarter (28.6%) of students in the state sector. For physics, the proportion of candidates taking the subject was lower, but again those in independent schools (18.6%) were more likely to take the subject than those in the state sector (11.2%).

In 2014, three quarters (76.7%) of all A level entrants got an A*-C A level grade. However, looking at the different STEM subjects shows that only three had an above average A*-C pass rate. These are further mathematics (87.8%), mathematics (80.5%) and chemistry (78.0%). The pass rate for physics was just below average at 72.2%.

Female students had a higher A*-C pass rate than male students in mathematics (81.6% to 79.8%) and physics (76.4% to 71.1%) – although biological sciences was the only STEM subject where there were more female entrants (58.9%) than male entrants (41.1%).

Further Education

In 2012/13 there were approximately 10,331,900 qualifications in the FE sector. Of these, about 1,250,600 qualification aims were in engineering-related Sector Subject Areas. This means that roughly one in eight qualifications is engineering related. Of the engineering-related Sector Subject Areas, information and communication technology was the largest, with 534,700 learners. This was followed by engineering and manufacturing technologies (437,900) and construction, planning and the built environment (278,000). It has been estimated that Further Education students aged over 19 generate an extra £75 billion for the UK economy over their lifetimes.

In 2012/13, over half (247,300) of the 437,900 engineering and manufacturing technologies participants were at level 2 and around a quarter (120,600) were at level 3. For construction, planning and the built environment, levels 1 and 2 dominated (78,500 and 140,000 respectively).

Vocational qualifications

Over the 10-year period to 2013/14, completions of all level three BTec subjects increased by 390.8% to reach 350,043.

In 2013/14, there were 16,318 completions in engineering – 23.9% higher than the previous year. Two and a half percent of those completing were female.

For construction, there were 3,894 completions in 2013/14, which was only just higher than the previous year (1.3%). However, the percentage of females was higher than engineering at 7.8%.

Apprenticeships

Between 2012 and 2022, engineering enterprises will need to recruit around 56,000 engineering technicians per year. Apprentices form an important part of meeting this demand for technicians. However, the number of level 3 Apprenticeship Programme Achievements from England, Scotland and Wales, totaled 25,978 in 2012/13 – a shortfall of 30,000.

The Royal Society has also projected that between 2013 and 2022 apprenticeships in England could contribute £3.4 billion in net productivity gains.

The starts trends for all engineering-related Sector Subject Areas has increased by 43.9%, to 94,260, over the 10 years to 2012/13. It actually fell by 7.7% from 2011/12 to 2012/13.

Within these engineering-related Sector Subject Areas, starts in construction, planning and the built environment declined by a third (34.0%) over the 10 years to 2012/13, compared with a rise of 70.6% for engineering and manufacturing technologies. The largest increase was for information and communication technology (145.6%): however, it was still below the growth rate for all Sector Subject Areas (163.5%).

The 2013/14 figures for Apprenticeship Programme Starts were as follows:

- Construction, planning and the built environment – 13,730, 23.8% at advanced level.
- Engineering and manufacturing technologies – 66,410, 41.7% at advanced level and 58.3% at intermediate level. (The balance here needs to change, as the advanced level is more widely considered to be the career/ technician level.)
- Information and communication technology – 14,120, 61.5% at advanced level.

The proportion of starts for All Sector Subject Areas at Advanced level is 42.6%.

Apprenticeship Achievements in England across all Sector Subject Areas have increased by a massive 413.0% over 10 years, to reach 252,900. However, all three engineering-related Sector Subject Areas have seen below average growth. Engineering and manufacturing technologies is the largest of these three Sector Subject Areas, with a total of 37,180 achievements across all levels in 2012/13 (a rise of 258.9%). By comparison, construction, planning and the built environment had the lowest growth over 10 years (151.7%), but with 9,060 achievements in 2012/13, it is the second largest Sector Subject Area. Finally, information and communication technology grew by 206.9% to reach 7,580 achievements in 2012/13. In addition to the achievements in England, it is important to recognise the contribution of the devolved nations. In 2012/13 there were 6,334 achievements in engineering-related apprenticeship frameworks in Scotland, while Wales had 3,580 achievements in engineering-related Sector Subject Areas.

Success rates for the engineering-related Sector Subject Areas follow the same trend, with success increasing for the higher levels. The advanced level success rates for construction, planning and the built environment; engineering and manufacturing technologies and information and communication technology were 80.1%, 76.9% and 67.7% respectively.

The Institute for Employment Studies has also shown that the mean starting aged for intermediate apprentices in 2007/08 was 20.1 years. By 2011/12, this had risen to 26.8 years, while for advanced and higher level apprentices the mean age in 2007/08 was 22.3. By 2011/12, it had reached 28.8 years.

Higher Education

There are 162 Higher Education Institutions in the UK providing graduates into the UK workforce: 130 in England, 18 in Scotland, 10 in Wales and four in Northern Ireland.

In 2012/13, there was a 3.1% increase in the total number of applicants to HE courses. Applicants from the UK were slightly above this average, with an increase of 3.2%. Non-EU applicants were also above average at 3.4% but EU applicants only rose by 1.2%.

For engineering, the number of applications was 32,026, a one-year increase of 5.5%. This was almost double the 3.1% increase for all subjects. Overall, 87.1% of the applicants were male and 12.9% were female. However, production and manufacturing engineering (23.4%) and chemical, process and energy engineering (25.7%) attracted around double the proportion of female applicants than the average for all engineering sub-disciplines. Looking at applicants from the UK, the increase was 6.7%, higher than the increase for non-EU applicants (4.1%) and EU applicants (0.4%). The largest STEM subject was biological sciences, with 50,241 applicants. It is also the only STEM subject where over half (57.2%) of the applicants are female. The second-largest STEM subject was mathematical and computer sciences with 33,248 applicants – up 8.0% on the previous year.

In terms of gender, only one in five (20.0%) physics applicants in 2012/13 were female. Over a third (36.7%) of applicants to mathematics were female, compared with just over one in nine (12.1%) of applicants to computer science. The overall proportion of female applicants to engineering and technology was 13.1%, with technology (14.8%) performing slightly better than engineering (12.9%).

The closest measure of the number of degree starts in a subject area is accepted applicants. Overall, accepted applicants increased by 6.0% in the last year. Accepted applicants from the UK rose faster than average, increasing by 6.5% compared with 3.0% for non-EU students and 1.1% for EU students.

The number of accepted applicants to engineering increased by more than the average for all subjects in 2012/13, rising by 6.8%. Those from the UK increased by 8.2%, compared with a 5.7% rise from outside the EU and a decline of 4.7% from those in the EU. Over ten years, the number of accepted applicants from the UK increased by a third (33.3%), from 15,505 in 2003/04 to 20,669 in 2012/13. The total number of engineering applicants accepted increased from 21,962 in 2003/04 to 27,022 in 2012/13.

The number of First Degree qualifiers in engineering in 2012/13 was 22,265 – an increase of 6.8% on the previous year. Overall, a quarter (26.5%) of all engineering qualifiers came from outside the EU, compared with an average for all courses of 10.8%. 3,170 qualifiers were female (14.2%) – an increase of 8.5% on the previous year.

In the last year across the selected engineering sub-disciplines, the number of qualifiers has increased by 7.1%, with six of the seven sub-disciplines seeing growth:

- mechanical engineering – 14.5%
- chemical, process and energy engineering – 13.1%
- aerospace engineering – 8.5%
- electronic and electrical engineering – 8.1%
- civil engineering – 2.4%
- production and manufacturing engineering – 1.6%

General engineering, however, declined by 5.1% in 2012/13.

The number of postgraduate qualifiers in engineering declined by 10.5% in the last year to 13,985, while the number of doctorates awarded in engineering increased by 6.0% to 2,555.

Overall, in the UK, the pool of level 4+ individuals with qualifications that allow them to go into engineering occupations was 82,000 in 2012/13 – 25,000 below the demand of 107,000 per year.

Degree non-continuation rates

Analysis of non-continuation rates for 2011/12 has highlighted a major issue that further restricts an already small supply: the non-continuation rate for engineering and technology is 15.6%, which is above the average for all subjects of 14.2%.

Six subject areas had an above-average non-continuation rate. Of these, three were STEM subjects:

- computer science – 18.1%
- engineering and technology – 15.6%
- mathematical sciences – 14.6%

By comparison, the non-continuation rate for physical sciences was below average at 12.7%.

Five of the seven engineering sub-disciplines had below-average non-continuation rates, with production and manufacturing engineering (9.2%) and chemical, process and energy (9.7%) having a particularly low rate. Electronic and electrical engineering had a slightly above-average non-continuation rate (15.9%). However, the rate for general engineering was nearly double the average for all subjects at 27.1%.

Overall, 23.1% of students who did not have an A level/Higher in maths and/or physics failed to complete their course: this represents 2,779 students. Looking at general engineering specifically, it can be seen that a third (34.0%) of students without an A level/Higher in maths and/or physics failed to complete their course.

BTec Higher National Certificates (HNCs), Higher National Diplomas (HNDs) and Foundation Degrees

At HNC level, most STEM provision is in engineering and technology (4,800 out of 5,680). But for HNDs (2,185 out of 3,695) and Foundation Degrees (3,055 out of 8,710), engineering and technology makes up a smaller proportion of all STEM entrants. Only around 4-5% of entrants to HNCs and HNDs were female, regardless of study mode. By comparison, 12.2% of full-time entrants to Foundation Degrees were female. Finally, there were 5,920 completions in engineering in the last year, a decline of 4.5% on the previous year of these, 13.3% were female. However it should be noted that this decline was less than the average for all subjects.

Capability – issues

The quality and quantity of teachers is possibly the most critical issue that threatens to derail the UK's drive towards becoming a global technological powerhouse.

There is a positive correlation between teacher quality and young people's grades. It is therefore disturbing to note that:

- only 45.4% of secondary school maths teachers have a degree or higher and that only around three quarters of maths teachers (77.6%) have a relevant post A level qualification – worryingly, 22.4% do not.
- for physics, 33.5% of secondary school teachers don't have a relevant post A level qualification, 55.8% have a degree or higher, 7.9% have a PGCE and 1.8% have a BEd.

Alongside this, the Institute of Physics estimated a shortfall of between 4,000 and 4,500 specialist physics teachers out of a cohort of 10,000-11,000. This would take 15 years of recruitment at 1,000 new teachers a year to redress. At the time of reporting, this rate was 300-400 a year. The situation for mathematics is no better: Government figures show that if all maths lessons were to be taught by specialist maths teachers, 5,500 extra teachers would be needed.

The Social Market Foundation has found that physics teachers in independent schools are more likely to have a physics degree than teachers in state schools (76% compared with 50%). There is a similar pattern for maths, with 70% of teachers in independent schools having a maths degree compared with less than half of teachers in the state sector.

The impact that high quality/ inspiring teachers can have on their pupils is now well established:

- The *Maintaining curiosity* report undertaken by Ofsted, which looked at science education in schools, found that where disadvantaged pupils study academic GCSEs, they achieve as well as other pupils when teachers hold the same high expectations for all. GCSEs provide the greatest range of routes for pupils to access further science study at 16. Uninspiring teaching was one reason pupils gave to inspectors to explain why they did not wish to continue studying science. Another was not seeing a purpose to their study other than collecting examination grades.
- The National Foundation for Educational Research (NFER) found that the quality of post-16 courses in science, technology, engineering and maths (STEM) is being undermined by a lack of time for staff to develop their skills and knowledge in line with the pace of change in their subject areas. One of the key challenges relating to the capacity of the STEM education and training workforce is the difficulty of recruiting and retaining technically-skilled staff. This includes those with engineering, manufacturing, ICT and physics expertise, technicians and science assessors and, more recently, suitably qualified mathematics teachers.
- 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 grade per subject.
- Another issue of great concern to the engineering community is the fact that post-16 participation in mathematics and physics is strongly based on prior achievement. This builds a significant barrier to the supply of engineering graduates. Whilst the

overwhelming majority of those taking A level mathematics achieve grade A or A* at GCSE, participation at A level is low, with fewer than 50% of students with a grade A GCSE in mathematics going on to study AS level mathematics. By comparison, around 1% of those with grade C in GCSE mathematics continue to AS mathematics. For physics, the situation is similar but more acute, albeit from a low base size. At 23%, the A* pass rate for physics is higher than maths, but there is much lower progression to AS level. Only 43% of A* GCSE physics students' progress to AS level, compared with 79% of maths students. There is also a lower progression to A level, at 38% compared with 73% for mathematics.

Finally, despite the number of girls achieving an A*-C grade physics GCSE being almost equal to that of boys, they constitute only one fifth of A level physics students. In *It's Different for Girls (2012)* the Institute of Physics demonstrated that in almost one half (49%) of state-funded, co-educational schools, no girls at all do A level physics. The research did, however, find that a girl is four times more likely to take physics A level if she attends a single-sex, independent school than if she attends a state, mixed school. The IoP concluded that the one proven method of increasing the number and proportion of girls doing physics is to improve teaching. This is consistent with research indicating that girls are more sensitive than boys to bad teaching. It is also reflected in the results from the Schools Physics Network, which supports non-specialist teachers: the effect of improving the confidence and knowledge base of teachers is to increase progression to A level physics for both boys and girls, but with an improved gender ratio.

Research undertaken by the Institute of Education sheds some new light as to why these gender differences exist. The Institute found that girls and boys who expressed intentions to participate in physics post-16 gave similar responses towards their physics teachers and physics lessons and had comparable views about the benefits they would experience from studying physics. However, girls (regardless of intention to participate in physics) were less likely than boys to be encouraged to study physics post-16 by teachers, family and friends. Despite this, there was a subset of girls still intending to study physics post-16. The crucial differences between the girls who intended to study physics post-16 and those who did not was that girls who intend to study physics post-16 had higher physics extrinsic motivation, more positive perceptions of physics teachers and lessons and greater competitiveness.

It is claimed that the challenge that has bedeviled the UK's ability to sustain its previous pre-eminence in STEM innovation can be traced to the gradual decline in the mathematical and numerical competence of our citizens. We have seen fewer young people studying mathematics post-16, leading ultimately to fewer qualified mathematics teachers capable of encouraging and stimulating the next generation of mathematicians.

To address this poor performance and the continued paucity of participation in post-16 maths, the Government has introduced a series of measures and requirements designed to strengthen the role of mathematics. These are scaffolded by reformed qualifications:

- Those with a GCSE A*-C will be encouraged to study the subject at A level. In 2013, this was around 57.7% of the 695,050 entrants.
- Those with A*-C who do not wish to study mathematics at A level will be expected to study for a new level 3 qualification entitled core mathematics. The Department for Education expects this to affect around 200,000 of the cohort.
- Those with a grade D at GCSE will be expected to study for an improved GCSE grade. In 2013, this was 18.1% of 695,050 entrants.
- Those with lower GCSE grades will be expected to follow a Functional Skills programme to improve their mathematics and numerical competence in advance of eventually studying for a GCSE. In 2013, this 24.2% of the 695,050 entrants.

In addition, the Government's ambition is that by 2020, adults aged 19 and over and apprentices of all ages studying maths will be working towards achievement of the reformed GCSEs, taking stepping stone qualifications if necessary.

When it comes to highlighting HE supply issues, one cannot ignore the debate around immigration and overseas students. In April 2014, the House of Lords Science and Technology Select Committee noted that:

"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."

The committee highlighted that the Government is simultaneously committed to reducing net migration and attracting increasing numbers of international students (15–20% over the next five years).This contradiction could be resolved if the Government removed students from the net migration figures.

Increasing the supply chain

In the context of engagement activities, the Education & Employers Taskforce has undertaken research into the often asked but unanswered question of 'how much is enough?' Is there a difference between having one or two career talks compared with three or more career talks? The taskforce found that just over half of the 37% of respondents who'd had one or two career talks when at school said they had found these useful in finding a job, rising to 84% of the smaller proportion of young people who had experienced three or more career talks during their secondary school days.

They also noted that having one careers talk was seen as beneficial to employment prospects over the longer term by the majority of respondents; but having more career talks was seen to be even more useful. In other words, one is good, but more is better. Why might this be? The research highlights three different ways in which meeting employers at an early age can benefit young people:

1. It can help young people enhance their stock human capital, through improved employability skills and more informed decisions about the best qualifications to pursue.
2. It can increase social capital by offering the opportunity to connect with 'people in the know' who possess trustworthy information and useful ideas, and who have access to broader social networks.
3. And finally, meeting employed professionals can influence young people's cultural capital through influencing their perceptions of themselves and their understanding of professional life and the world of recruitment.

It is because of this recognised importance and need for employer engagement the Tomorrow's Engineers programme, is driving the essential coordinated approach to (engineering) employer engagement in schools which will result in eventually reaching the numbers of young people needed to help deliver the UK's future science, engineering and technology sectors.

There are two overriding messages from the report. Firstly, that engineering and skilled engineers make a vital and valued contribution to the UK economy and look set to continue to do so, and that they help mitigate 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 either the current capacity or the required rate of growth needed to meet the forecast demand for skilled engineers by 2022.

Recommendations and calls for action

This year's Engineering UK report, which presents new demand and supply analyses from previously unavailable data sets, confirms that the long-term recommendations (up to 2022) remain broadly the same as the recommendations in last year's report (up to 2020).

New analysis shows we need:

Increasing the Supply: Recommendations 1, 2 and 3

1. Either a doubling of the number of engineering graduates or a 50% increase in 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 GSCE physics as part of triple sciences 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.

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.

Provision of high quality, coordinated careers inspiration and information: Recommendations 4 and 5

4. Provision of 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 and promote the diversity of engineering careers available. It must be backed up, when required, by (face-to-face) consistent careers information, advice and guidance that highlights the subjects needed and the variety of routes to those careers.
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:

Continued improvement in the co-ordination, quality, reach and impact of engineering outreach activity by the whole engineering community and business and industry is essential. Building on 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. Through programmes such as Tomorrow's Engineers it is becoming evident that this is best achieved through ensuring coordinated support and partnerships via local, regional and national STEM employers

Government, working in partnership with business, the education sector and the engineering community, needs to ensure the provision of a national coordinated employer – led, informed and relevant approach to careers inspiration in schools and colleges, especially for 11- to 14-year-olds. Every child should have an engineering experience that is linked to careers and the curriculum. All schools and colleges should be held to account through the relevant inspection authority against appropriately agreed metrics.

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Part 1 – Engineering in Context
1.0 Capacity for growth

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Engineering enterprises have the potential to generate an additional £27 billion per year from 2022 which is equivalent to the cost of building 1,800 secondary schools or 110 new hospitals. If the UK is to benefit economically from this, we will need to meet the forecasted demand for new vacancies in engineering enterprises in the same timescale.

25 July 2014 was a significant day for the UK. It was then that the UK's economic growth finally bounced back to pre-recession levels: in Q1 2014, UK GDP was 0.2% ahead of its pre-crisis peak in Q1 2008.

Supporting this headline are a number of encouraging achievements. We have top-level cross-party endorsement of the importance of STEM education and skills and careers advice. The Industrial Strategy, Eight Great Technologies and Growth Plan are all moving in the right direction and the new devolved local agenda and role of LEPs promises to focus growth at a local level. The number of young people not in education, employment or training (NEET) is at its lowest since records began. Perceptions of engineering are up and the numbers studying engineering are increasing. Even globally we are doing well. The UK has edged up the global rankings in a major annual survey by the World Economic Forum (WEF): its *Global Competitiveness Report* saw the UK rise one spot to ninth.[1]

However despite all of this endorsement and support, the rate of change in the growth of supply is far too slow to meet the forecast UK demand for Engineering Skills. Our extension to Working futures 2012-2022 shows that over this period engineering companies will need to recruit 2.56 million people of which 257,000 will be new vacancies. Contained within this overall demand we can show that 1.82 million of these workers will need engineering skills: pro rata, that is an average of 182,000 people per year. Within this total engineering-related demand, 56,000 jobs per year are needed at level 3 and 107,000 at level 4+ (HND/C, foundation degree, undergraduate or postgraduate and euquivalent). Yet current figures show that only 26,000 people are entering engineering occupations with level 3 Advanced Apprenticeships, and only 82,000 at level 4+ The scale of the challenge is clear.

One of the issues behind this shortfall is a lack of young people studying science, technology, engineering and maths (STEM) subjects at schools and colleges – which is in turn down to a dearth of properly trained specialist STEM teachers.

Failure to meet our engineering workforce requirements damages individual prosperity for employees, economic sustainability of engineering employers and social and economic wellbeing for UK Government Indeed, meeting our forecasted demand for the 257,000 new vacancies in engineering enterprises from 2022 will generate an additional £27.0 billion per year to the UK economy in 2022.[2] This is equivalent to the cost of building 1,800 secondary schools or 110 new hospitals. It also impacts on engineering's role in providing a lasting legacy for future generations by ensuring the supply of food, clean water and energy against a backdrop of climate change and ageing populations.

Lastly, there will be some significant population challenges in the UK going forward which will affect the pool of GCSE level pupils and the pool available for progressing into the Higher Education. The number of 14-year-olds is set to fluctuate significantly, falling by 7.3% between 2012 and 2017 before jumping by 15.9% five years later, there will also be a drop in the number of 18-year-olds which will decrease by 8.9% between 2012 and 2022. To further compound the population issue, if we assume that currently people start work at 18 and stay in employment until 65 then the average number of years of employment the average person in the UK has is 24 years; this points to the fact that over the next 24 years half of the current working population will retire.

1.1 Challenges to the delivery of growth

"There is clearly a substantial demand for engineers in the UK economy. Based on my examination of the evidence in the course of this Review, I endorse the widely accepted view that it would benefit the economy to substantially increase the supply of engineers, adding flexibility and resilience to our economy, and enabling more people to take advantage of the opportunities created by technological change. I agree with Sir James Dyson that we need more engineers."[3]

Many of the challenges to the delivery of growth for the UK that we listed in last year's report[4] still remain, because they are long term in nature. This section therefore refreshes on those areas and includes some additional issues, all of which have a direct bearing on the UK's capacity and capability to deliver long term, sustainable growth.

1 http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf p13 **2** The contribution of engineering to the UK economy – A report for EngineeringUK, CEBR, October 2014 http://www.engineeringuk.com/Research/ **3** *Professor John Perkins' Review of Engineering Skills*, Department for Business Innovation and Skills, November 2013, p9 **4** *Engineering UK 2014 The state of engineering*, EngineeringUK, December 2013, p2

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1.1.1 Economic

We need to recognise that, economically at least, we are not an island. As shown last year, the UK economy is increasingly dependent on foreign investment, with manufacturing relying on 45% overseas investment compared to only 18% for the service industry.

Indeed, the UK has a strong record of attracting inward investment. The World Bank declared the United Kingdom to be the best place in the EU and G8 to do business in 2011. London has a dominant position as the leading international financial centre and is home to more European company headquarters than the rest of Europe combined. It has the largest industries in Europe for life sciences, ICT, financial services and creative industries. Data from Ernst and Young's *Investment Monitor 2011* showed the UK as having the highest share (17%) of Foreign Direct Investment (FDI) in the Eurozone, above Germany and France (both on 15%).[5]

In terms of economic standing, the World Bank's World Development Indicators[6] allow us to look at the GDP of the world's top 20 economies. Table 1.0 shows that whilst the UK's GDP was $2.5 trillion in 2013, placing it sixth in the world, we contributed only 3.37% of world GDP. This figure was significantly lower than the top three economies, which account for 41% of total world GDP between them: the United States at $18.8 trillion GDP, 22.43% of the world total; China at $9.2 trillion, 12.34% of the total; and Japan at $4.6 trillion, 6.54% of the total.

The Engineering sectors alone are vital to the UK's economy contributing an estimated £455.6 billion to Gross Domestic Product (GDP) in 2014, 27.1% of the £1,683 billion total UK GDP.[7]

Delving below the surface, Figure 1.0 usefully breaks the UK economy down by sector in terms of their respective contributions to UK Gross Value Added (GVA) and share of UK employment. It shows that 72% of UK GVA is accounted for by the services sector, of which professional services (11%) is the largest sub-sector. The remainder is accounted for by manufacturing (10%), construction (6%), other production (5%) and agriculture (1%).[8]

The figure above is 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[9] below.

The Growth dashboard provides a summary of important facts and figures on UK growth and industrial policy, including:

- an overview of UK growth, employment and productivity
- performance against the 16 growth benchmarks set out in the Plan for Growth
- important sectors and cross cutting themes from the industrial strategy
- performance across UK regions
- performance across UK business demography

The dashboard will be updated twice per year. The current version was released on 18 July 2014,[10] with the next update planned for January 2015.

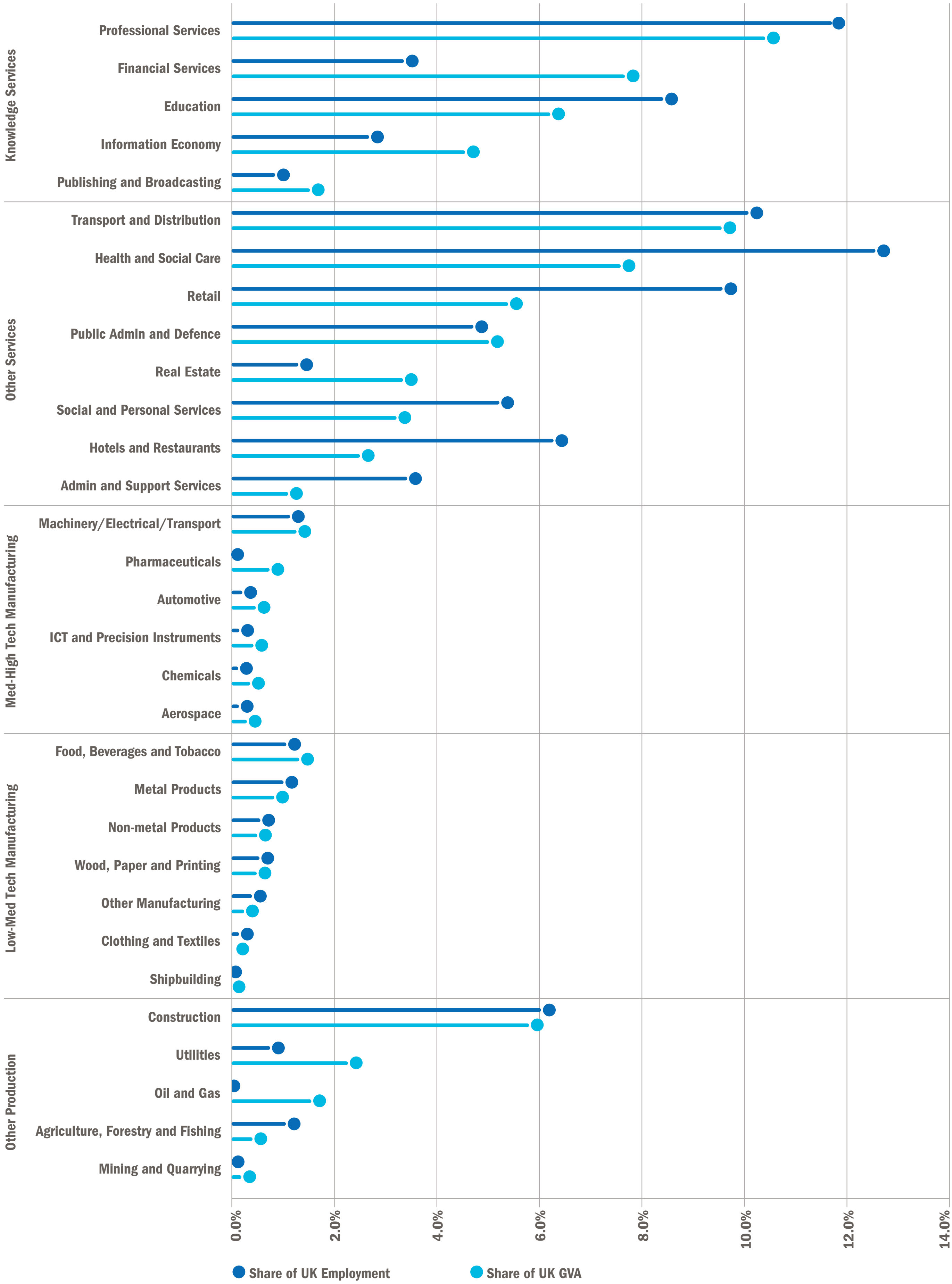
Table 1.0: Gross domestic product 2013 – world top 20 economies

Ranking	Economy	Millions US dollars	Percentage share
1	United States	16,800,000	22.43%
2	China	9,240,270	12.34%
3	Japan	4,901,530	6.54%
4	Germany	3,634,823	4.85%
5	France	2,734,949	3.65%
6	**United Kingdom**	**2,522,261**	**3.37%**
7	Brazil	2,245,673	3.00%
8	Russian Federation	2,096,777	2.80%
9	Italy	2,071,307	2.77%
10	India	1,876,797	2.51%
11	Canada	1,825,096	2.44%
12	Australia	1,560,597	2.08%
13	Spain	1,358,263	1.81%
14	Korea, Rep.	1,304,554	1.74%
15	Mexico	1,260,915	1.68%
16	Indonesia	868,346	1.16%
17	Turkey	820,207	1.10%
18	Netherlands	800,173	1.07%
19	Saudi Arabia	745,273	1.00%
20	Switzerland	650,782	0.87%
World Total		**74,899,882**	**100%**

Source: World Bank

5 *Multinational employers' perceptions of the UK workforce*, Department for Business, Innovation and Skills, March 2014, p7 6 Website accessed on the 1 July 2014 (http://data.worldbank.org/data-catalog/GDP-ranking-table) 7 The contribution of engineering to the UK economy – A report for EngineeringUK, CEBR, October 2014 http://www.engineeringuk.com/Research/ 8 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/331144/Growth_and_sector_performance_data_3.xls Figure 9.1 9 https://www.gov.uk/government/publications/growth-dashboard 10 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/337297/Growth_Dashboard_July_2014.pdf

Fig. 1.0: Structure of UK economy (2013)



Source: Office for National Statistics

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1.1.2 Skills

"Even those occupations where employment is projected to decline may still offer good career prospects, with a significant number of job openings. This is because, as long as significant numbers are employed in such jobs, employers will need to replace those workers who leave due to retirement, career moves, mortality or other reasons."[11]

Unfortunately the Manpower Group's *Global Talent Shortage Survey 2014*[12] shows that the top three shortages globally are skilled trades, engineers (second place for the third year running) then technicians.[13] We are clearly not alone in the struggle for skilled engineers and technicians. The report also points out that employers in Japan report the greatest talent shortages globally (81%) and that there were acute shortages also reported in Peru, India, Argentina, Brazil and Turkey.

In addition to shortages for existing jobs, the predicted global demand for new jobs is alarming. The International Labour Organisation (ILO) has calculated that 42.6 million jobs are needed every year until 2018 to meet the growing number of new entrants in the labour market.[14]

The UK Commission for Employment and Skills (UKCES) produced two significant reports in 2014; *Working Futures 2012-2022*[15] and the *UK Employer Skills Survey 2013* (UKCESS).[16]

Working Futures 2012-2022 provides a comprehensive and detailed picture of the UK labour market, highlighting that:

- Overall, 14.356 million job openings are predicted over the decade. Of these, 12.501 million are expected to be created by people leaving the labour market (so called replacement demand). This is much higher than the 1.855 million openings predicted from the creation of new jobs.[17]
- Private services are the main engine of jobs growth, with employment in this part of the economy projected to rise by more than 1.5m (+8%) between 2012 and 2022. Business and other services are the area where employment is expected to grow most rapidly, growing by more than 10% or 1 million jobs over the same period.

Our own engineering extension to *Working Futures 2012-2022*[18] shows that between 2012 and 2022 the UK will need 1.82 million people with engineering skills. This illuminates the scale of the challenge and, indeed, the opportunity that exists for the UK and for the engineering and manufacturing sector.

The **UK Commission's Employer Skills Survey** 2013 report provides a reliable, timely and valuable insight into the skills issues being faced by employers and the action they are taking to address these. Overall the survey reports that:

- Economic growth and recovery may be constrained by skill shortages as the labour market responds to employer requirements. While in most cases demand for skills is met through successful recruitment, almost three in ten vacancies are reported to be hard to fill, and shortages in suitably skilled, qualified and/or experienced workers are the main reason for this. Overall, such Skills Shortage Vacancies represent more than one in five of all vacancies (22%), up from one in six in 2011 (16%).[19]

Table 1.1 displays the vacancies and skills gaps between the 2011 and 2013 surveys. It shows that the number of Skills Shortage Vacancies has actually risen by 60% to 146,000. This is a serious issue for the UK, particularly when set alongside the forecast demand for jobs in 2012-2022.

Data from 2011 has been reweighted to be comparable to 2013 data.

Looking more closely at the UK by sector, the proportion of vacancies reported as hard to fill as a result of a lack of skills, qualifications or experience ranges from 10% in Financial Services to 30% in Manufacturing. Figure 1.1 shows the pattern of Skills Shortage Vacancy density by occupation, sector and occupation within sectors. It highlights in blue those occupations, sectors and occupations within each sector where the density is at least 30%. It is concerning to see several science, engineering and technology sectors highlighted in orange (density of 30% or above) across the occupational groups.[22]

Section 15[23] looks in detail at Hard-to-Fill Vacancies and shows that engineering enterprises have nearly double the proportion of Hard-to-Fill Vacancies than other professions (31.7% compared with 17.6%). In addition, the proportion of Hard-to-Fill Vacancies in the skilled trades is almost double for engineering enterprises (24.8%) than it is for all enterprises (12.6%).

Recent research by Deloittes (November 2014) into the impact of technology and automation on the labour market has highlighted that more than a third of all UK jobs are at high risk of disappearing over the next 20 years. Jobs requiring repetitive processing, clerical and support services are likely to be replaced with roles requiring digital management and creative skills. However, four out of 10 jobs were at low or no risk, reassuringly engineering and computing were within this cohort.

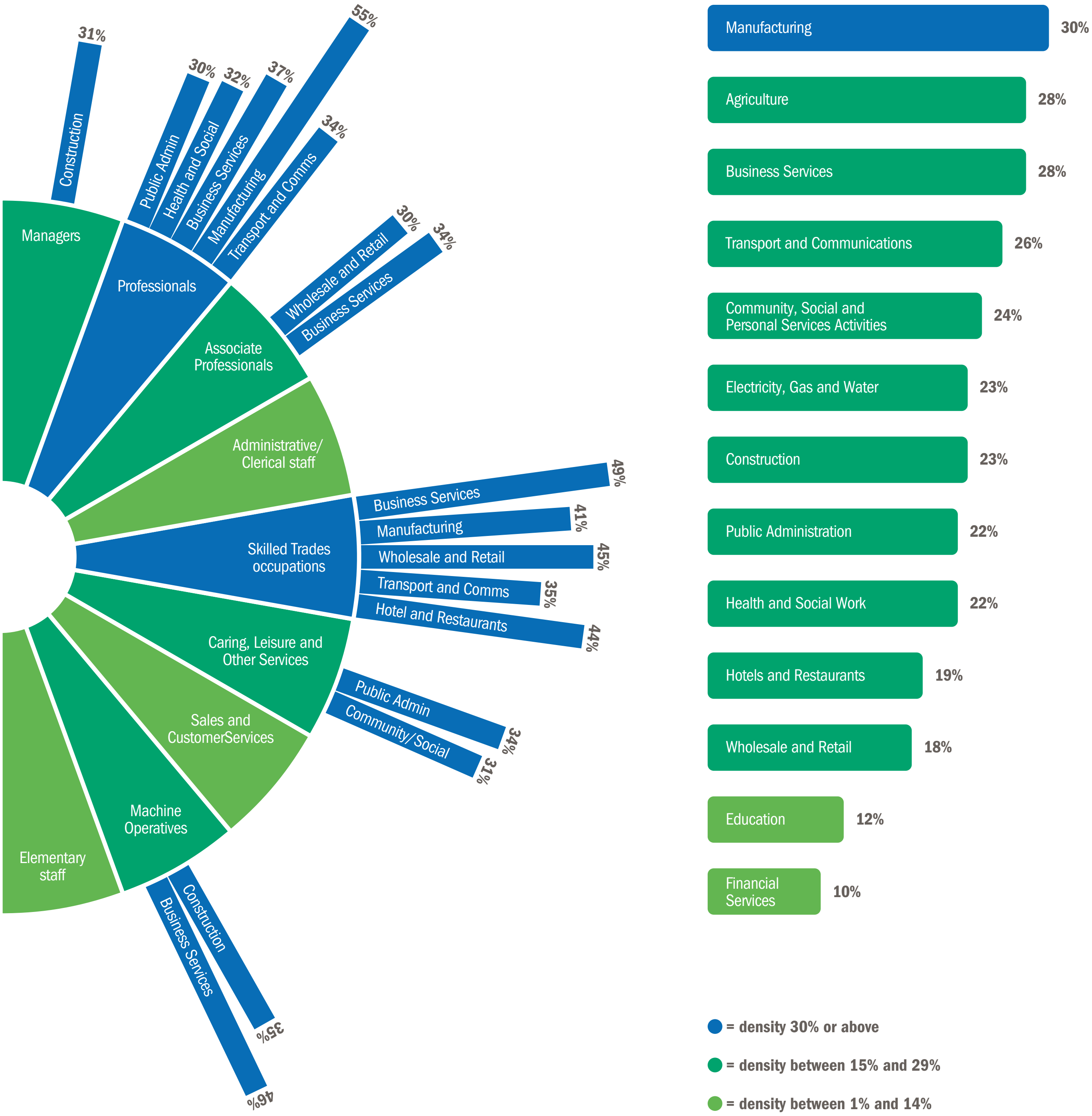
Table 1.1: UKCESS vacancies and skills gaps (2011-2013)

	UKCESS 2011	UKCESS 2013
Vacancies and Skill Shortage Vacancies (SSVs)		
Percentage of establishments with any vacancies	14%	15%
Percentage of establishments with any Hard-to-Fill Vacancies[20]	4%	5%
Percentage with SSVs[21]	3%	4%
Percentage of all vacancies which are SSVs	16%	22%
Number of vacancies	586,500	655,000
Number of Skill Shortage Vacancies	91,400	146,000
Skills gaps		
Percentage of establishments with any staff not fully proficient	17%	15%
Number of skills gaps	1,485,500	1,409,900
Number of staff not fully proficient as a percentage of employment	6%	5%

Source: UKCES

11 *Working Futures 2012-22*, UK Commission for Employment and Skills, March 2014, p78 **12** *Talent Shortage Survey Results*, Manpower Group **13** http://www.manpowergroup.com/wps/wcm/connect/manpowergroup-en/home/newsroom/news-releases/global+talent+shortage+hits+seven-year+high#.U6BaYfldVyJ **14** *Global Employment Trends 2014, Risk of a jobless recovery?* International Labour Organisation, February 2014, p9 **15** *Working Futures 2012-22, Evidence Report 83*, UK Commission for Employment and Skills, March 2014 **16** *The UK Commission's Employer Skills Survey 2013*, UK Commission for Employment and Skills, January 2014 **17** *Working Futures 2012-22*, UK Commission for Employment and Skills, March 2014, p83 **18** Section 15.2 **19** *The UK Commission's Employer Skills Survey 2013*, UK Commission for Employment and Skills, January 2014, p8 **20** Vacancies that are proving difficult to fill, as defined by the establishment (from question: "Are any of these vacancies proving hard-to-fill?"). **21** Vacancies that are proving difficult to fill due to the establishment not being able to find applicants with the appropriate skills, qualifications or experience. **22** *The UK Commission's Employer Skills Survey 2013*, UK Commission for Employment and Skills, January 2014, p33 **23** See Section 15.2 for more detail.

Fig. 1.1: Density of Skills Shortage Vacancies – occupation, occupation within sector, and sector



Source: UKCESS
Figures only shown where base is greater than 50

UKCES has looked even further ahead: its report, *The Future of Work: Jobs and skills in 2030* identifies a number of local and global trends today which point towards forthcoming *changes in business and society*. Their long-term impact on UK jobs and skills will be significant. For instance:[24]

- Emerging economies are acquiring stronger representation in global production chains
- Demographic change and migration are changing the face of the workforce
- Technological developments are slowly dissolving the boundaries between sectors and are changing traditional modes of working
- Organisational structures in business are evolving and becoming more flexible and more networked

UKCES observes that these rapid, complex shifts are affecting labour markets around the world, constantly challenging the balance of supply and demand, and labour market and education policies.

24 The Future of Work: Jobs and skills in 2030, Evidence Report 84, UK Commission for Employment and Skills, February 2014, pviii

The study adopted a 360° view, looking at societal, technological, economic, ecological and political factors to identify the 13 most influential and plausible trends impacting the jobs and skills landscape in the UK to 2030. These are detailed in Figure 1.2.[25]

Whilst it is understandable that conversations tend to centre on higher level skills and progression, we should, however, be mindful of the fact that in the UK in 2011:[26]

- 14% of 16- to 18-year-olds left school functionally illiterate (using the Government's measure of level 1 English or grades D-G at GCSE)
- 28% of 16- to 18-year-olds left school functionally innumerate (at Entry level 3 or roughly that expected of an average 9- to 11-year-old)

If the moral argument to address this is not enough then the financial one is. In the UK, raising educational attainment to match the best in Europe could add one percentage point to growth annually.[27] Raising the performance of UK schools to match that of Finland in core subjects could have a value of more than £8 trillion over the lifetime of a child born today. Few other changes could make such a powerful difference to the UK's economy.[28]

Either way this situation is untenable for the individual and for society.

1.1.3 People

Population growth and the challenges it brings – such as food, ageing, clean water and housing – remain a persistent concern for the world's governments.

The global population is expected to reach around 9.5 billion in 2050, by which stage the rate of growth will have slowed. Not all regions will grow equally, with some parts of the world, such as parts of Europe and Japan, continuing to experience population decline. An estimated 90% of population growth is expected to occur in the cities of the developing world.[29]

By 2050, around 75% of the world's population will live in cities. It is estimated that the global urban population is growing at two people per second, adding 172,800 new city-dwellers each day.[30]

With more than 20% of the world's population predicted to be 60 years old or over in 2050, compared with around 11% today, ageing populations will have an impact on the design and choice of mobility solutions. In more developed regions, 32% of the population will be 60 years old or over by 2050, and the number of older people will be nearly twice the number of children. Developing countries will also see an increase in the proportion of older people.

Much of the economic growth will be concentrated in China and South and Southeast Asia. But it is not just the likes of China and India that will be powering global growth over the next four decades. Countries as varied as Nigeria, Peru and the Philippines will also play a significant part. In 2050 there will be almost as many people in Nigeria as in the United States, and the population of many African countries will have doubled.[31] Pakistan will have the sixth-largest population in the world. Even if some of these countries remain relatively poor on a per capita basis, they could see a dramatic increase in the size of their economies thanks to population growth. In contrast, the Japanese working population looks set to contract by 37% and Russia's by 31%. The Eurozone faces similar problems with working population declines of 29% in Germany, 24% in Portugal, 23% in Italy and 11% in Spain.[32]

Finally, we have previously reported on findings that the global economy will be driven by the purchasing power of the middle classes, particularly in the BRIC countries (Brazil, Russia, India, China) and other emerging economies. A brief extract from our previous report on this phenomenon is provided below.[33]

As the BRIC and other emerging economies become richer, they will not just fuel competition for low-cost and low-value-added manufacturing. They will also provide a growing

Fig. 1.2: Trends driving the future of UK jobs and skills

Society and the individual

1. Demographic change, especially an ageing population
2. Growing diversity, increasing representation of gender and ethnic groups in the labour force
3. Growing household income uncertainty and regional inequalities
4. Growing desire for a better work-life balance
5. Changing work environments shaped by information and communications technology (ICT), outsourcing, internationalisation and the need for greater flexibility

Technology and innovation

6. Converging technologies and cross-disciplinary skills, particularly the combination of biotechnology, information and communications technology, nanotechnology and cognitive science
7. Digitalisation of production: automated and additive manufacturing processes, involving 3D printing
8. ICT development and the age of big data, the power of digital devices and the potential to capture and use vast amounts of data

Business and the economy

9. Changed economic perspectives due to globalisation and technological change, particularly volatility and uncertainty in the period post the 2008 crash
10. Shift to Asia, growing economic power and influence of countries in the East
11. New business ecosystems leading companies to be increasingly defined as 'network orchestrators'

Resources and the environment

12. Growing scarcity of natural resources and degradation of ecosystems: finite environmental resources leading to higher extraction costs and environmental decline

Law and politics

13. Decreasing scope for political action due to constrained public finances, as well as greater levels of social transfers for the ageing population, limits resources for education and skills initiatives

25 Ibid, pix 26 *Professionalism in Further Education Final Report of the Independent Review Panel*, The Lord Lingfield Kt, MEd DLitt FCGI DL, October 2012, p18 27 *First steps, A new approach for our schools*, Confederation of British Industry, November 2012, p8 28 This represents the present value (discounted at 3%) of the gains from improving educational achievement to the top performer (Finland) out to 2090. This represents a significant increase in future GDP (about 1/6 higher in present value terms). Source: http://hanushek.stanford.edu/sites/default/files/publications/Hanushek%2BWoessmann%202012%20 CESifoEStu%2058%281%29.pdf 29 *World Resources Report 1996-97*, World Resources Institute in collaboration with the United Nations Environment Programme, The United Nations Development Programme, and the World Bank, 1996, Oxford University Press, New York 30 *Como – Facts, Trends and Stories on Integrated Mobility*. The future of getting around, Issue 10, Siemens, May 2013 31 *Foresight: The Future of Rail 2050*, Arup, June 2014, p17 32 *The World in 2050 – From the Top 30 to the Top 100*, HSBC Global Research, January 2012. 33 *Engineering UK 2013 The state of engineering*, EngineeringUK, December 2013, p7

consumer market and potential market for exports. McKinsey estimates that between now and 2020, approximately 900 million people in Asia will enter the middle class, with a disposable income that will enable them to look overseas for luxury goods and services. Today, India and China account for a mere 5% of global middle class consumption, while Japan, the United States, and the European Union account for 60%. By 2025, those numbers are expected to equalise. By 2050, they will be flipped.

1.1.4 Teaching quality and quantity

"The mediocre teacher tells. The good teacher explains. The superior teacher demonstrates. The great teacher inspires."

William A. Ward

The quality and quantity of teachers is possibly the issue that most threatens the UK's drive towards becoming a global technological powerhouse. This section highlights several compelling pieces of research that underpin the validity of this categorical statement.

The **Maintaining curiosity** report undertaken by Ofsted looked at science education in schools. It found (selected relevant findings)[34] that:

- Curiosity was driven by determined subject leadership that put scientific enquiry at the heart of science teaching and coupled it with substantial expertise in how pupils learn science.
- Where disadvantaged pupils study academic GCSEs, they achieve as well as other pupils when teachers hold the same high expectations for all. GCSEs provide the greatest range of routes for pupils to access further science study at 16. However, too few 16-year-old girls continue studying physics nationally.
- Uninspiring teaching was one reason pupils gave to inspectors to explain why they did not wish to continue studying science. Another was not seeing the purpose of what they were studying, other than to collect examination grades.
- In the best schools visited, teachers ensured that pupils understood the 'big ideas' of science. They made sure that pupils mastered the investigative and practical skills that underpin the development of scientific knowledge and could discover for themselves the relevance and usefulness of those ideas.

- Timetables in a significant minority of the primary and secondary schools visited did not allow enough time for teaching science through regular, enquiry-based learning. This limited pupils' opportunities to develop the practical skills necessary for future work in science, technology or engineering. This included restricting science to irregular 'science days' in primary schools, and limiting the teaching time for the three separate science GCSEs to the same amount as for a double science award in secondary schools.

The **National Foundation for Educational Research** (NFER) found that the quality of post-16 courses in science, technology, engineering and maths (STEM) is being undermined by a lack of time for staff to develop their skills and knowledge in line with the pace of change in their subject areas.[35] The two key challenges relating to the capacity of the STEM education and training workforce were:

- difficulties related to the recruitment and retention of technically skilled staff including those with engineering, manufacturing, ICT and physics expertise, technicians and science assessors and, more recently, suitably qualified mathematics teachers
- updating the knowledge and skills of staff – it was an ongoing challenge for staff to keep their knowledge and skills up-to-date due to lack of time and difficulties in engaging employers – particularly SMEs. Staff found it difficult keeping up-to-date with the fast pace of change within industry and with new and emerging technologies

Independent analyses of data from the OECD's **Programme for International Student Assessment** (PISA) shows the importance of teacher quality. It found that if teachers are split into three equal-sized groups – below average, average and above-average – students taught by an above-average teacher make 50% more progress, and those taught by a below average teacher make 50% less progress than students taught by average teachers.[36] The most effective teachers are therefore at least three times as effective as the least effective.

This 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.[37] This plainly emphasises that the effects of high-quality teaching are especially significant for pupils from disadvantaged backgrounds.

Recruitment and teacher status obviously impinges on this issue as it is recognised within STEM subjects there are serious shortages for qualified teachers and lecturers. Consequently some of the key findings from *The Global Teacher Status Index*[38] make for interesting and illuminating reading.

34 *Maintaining curiosity – A survey into science education in schools*, Ofsted, Report Summary, November 2013 35 *Consultation on Science, Technology, Engineering and Mathematics (STEM) for the Education and Training Foundation*, National Foundation for Educational Research, July 2014, pviii; http://www.nfer.ac.uk/publications/ETFS01/ETFS01.pdf, 36 *"The economic value of higher teacher quality" in Economics of Education Review*, 30(3), E. A. Hanushek, 2011 p466–479 37 *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 38 *Global Teacher Status Index*, Varkey GEMS Foundation, October 2013

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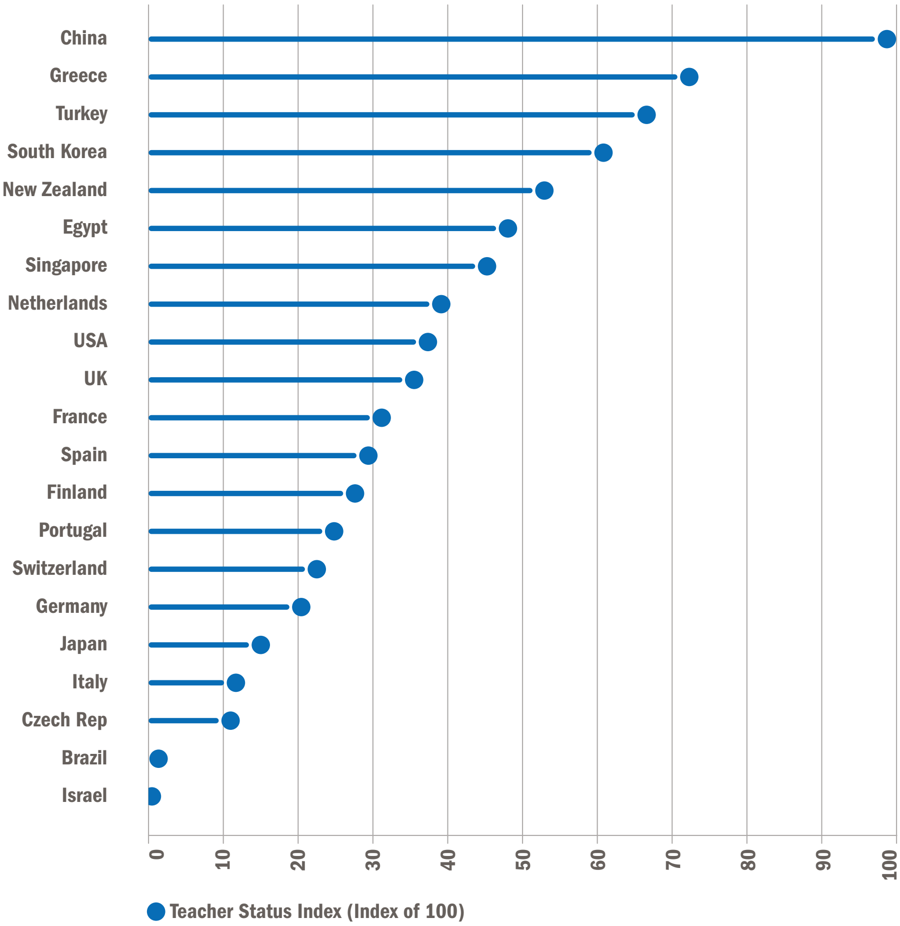
Countries in the Far East such as China and South Korea show that there are areas of the world where teaching retains its respected position (Figure 1.3). The report concludes that if we want future generations to have the right values and the best life chances, then part of the answer is simple: we need to recruit the best and brightest teachers into the profession, and look at the ways in which we can retain them. Finland, which comes top of the PISA rankings, has made teaching so well regarded that the very best graduates compete for the job – all of whom have master's degrees.

In terms of the future recruitment of teachers (which is highlighted within Section 1.1.5) the *Global Teacher Index* finds that there are significant contrasts between countries over the extent to which they would encourage younger generations to become teachers (Figure 1.4):[39]

- While 50% of parents in China provide positive encouragement, only 8% do so in Israel.
- Parents in China, South Korea, Turkey and Egypt are most likely to give encouragement to children to become teachers.
- Parents in Israel, Portugal, Brazil and Japan are least likely to provide positive encouragement.

Finally, as is shown in detail by the Institute of Physics case study,[40] the effect of improving the confidence and knowledge base of the teachers is to increase progression to A level physics for both boys and girls but with an improved gender ratio. It is possible to increase numbers of young people studying physics.

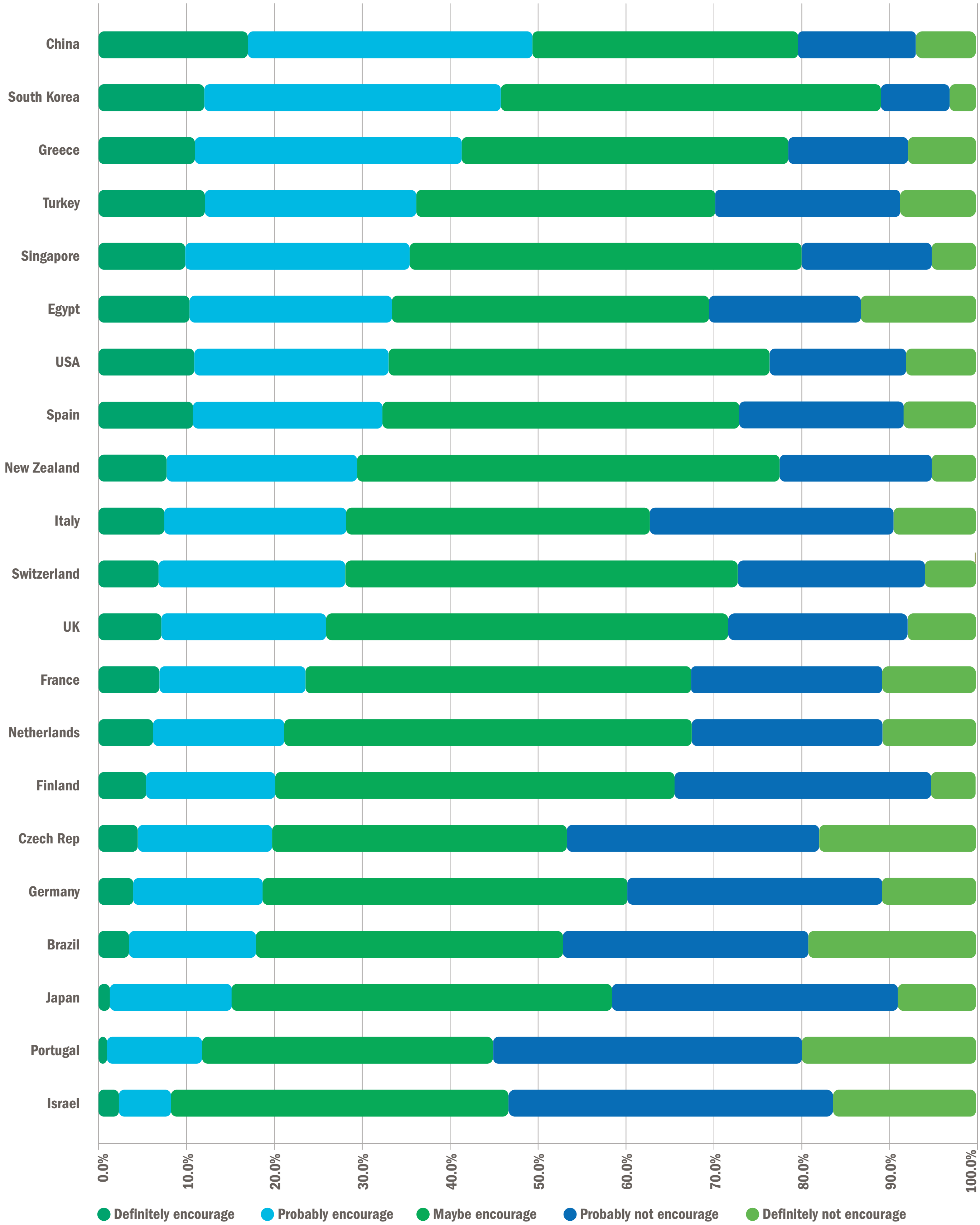
Fig. 1.3: Teacher Status Index



Source: Global Teacher Status Index

39 Varkey GEMS Foundation, Global Teacher Status Index, October 2013, p18 **40** See Section 8.6

Fig. 1.4: Would you encourage your child to become a teacher



Source: Global Teacher Status Index

1.1.5 Maths and physics

It is of great concern for the engineering community to note that post-16 participation in mathematics and physics is strongly based on prior achievement (Table 1.2) as this builds an additional barrier to the supply of engineering graduates.

The overwhelming majority of those taking A level mathematics achieved grade A or A* at GCSE. But even here, participation is low: fewer than 50% of students with a grade A GCSE in mathematics go on to study AS level mathematics. By comparison, around 1% of those with grade C in GCSE mathematics continue to AS mathematics.

For physics, the situation is similar but more acute, albeit from a low base size. At 23%, the A* pass rate for physics is higher than maths, but there is much lower progression to AS level. Only 43% of A* GCSE physics students progress to AS level, compared with 79% of maths students. There is also a lower progression to A level, at 38% compared with 73% for mathematics.

The importance of maths and physics is clearly strengthened by findings highlighted in Section 11.6.4. In particular, Table 11.28 plainly shows that in terms of students failing to complete their engineering degree courses (non-continuation), 6.9% of engineering students who were known to hold A level/higher in maths and physics failed to complete their course compared with 23.1% of students who were known not to hold an A level/higher in maths or physics.

We mentioned in the previous section that there is a positive correlation between teacher quality and young people's grades. It is therefore disturbing to note the following findings:[47]

- Only 45.4% have a degree or higher but around three quarters of maths teachers (77.6%) have a relevant post A level qualification which is up from 72.9% last year. 22.4% do not have a relevant post A level qualification.
- For physics, 33.5% of teachers don't have a relevant post A level qualification. 55.8% have a degree or higher, while 7.9% have a PGCE and 1.8% have a BEd.

Furthermore, the Institute of Physics estimated a shortfall of between 4,000 and 4,500 specialist physics teachers out of a cohort of 10,000–11,000. This would require 15 years of recruitment at 1,000 new teachers a year to redress. At the time, the rate was 300-400 a year.[48]

The situation for mathematics is no better: Government figures show that if all maths lessons were to be taught by specialists maths teachers, 5,500 extra teachers would be needed.

Finally, we show that although the number of girls achieving an A*-C physics GCSE was almost equal to that of boys (Table 7.6), only one fifth of A level physics students were girls (Table 8.11). The study by the Institute of Education (IoE)[49] sheds some new light on these gender differences. It found that girls and boys who expressed intentions to participate in physics post-16 gave similar responses towards their physics teachers and physics lessons and had comparable views about the benefits they would experience from their studying physics. However, girls (regardless of intention to participate in physics) were less likely than boys to be encouraged to study physics post-16 by teachers, family and friends. Despite this, there was a subset of girls still intending to study physics post-16. The crucial differences between the girls who intended to study physics post-16 and those who did not was that girls who intend to study physics post-16 had higher physics extrinsic motivation, more positive perceptions of physics teachers and lessons and greater competitiveness.

Table 1.2: Progression from GCSE mathematics and physics to AS/A level mathematics and physics (2012)

	A*	A	B	C
Percentage of entries resulting in each GCSE mathematics grade (2007/08)[41]	5%	11%	17%	26%
Percentage of entries resulting in each GCSE physics grade (2007/08)[42]	23%	29%	26%	15%
Progression rate from GCSE to AS mathematics by mathematics grade[43]	79%	48%	15%	1%
Progression rate from GCSE to AS physics by physics grade[44]	43%	30%	21%	5%
Progression rate from GCSE to A level mathematics[45]	73%	34%	6%	0%
Progression rate from GCSE to A level physics[46]	38%	22%	8%	1%

Source: Department for Education, National Pupil Database

1.1.6 Careers advice

Careers advice is a key factor in determining the future supply of young people who study STEM and go on to pursue STEM careers. We believe that it is self-evident that all young people should have access to consistent and reliable information that allows them to make informed choices about their future studies and careers. We know that this is not the case at present and in partnership with Government, business and industry, professional engineering institutions and other third sector organisations are playing an active national role in addressing this for STEM.[50]

We do, however, face an uphill struggle. Our annual Brand Monitor survey clearly shows that there is more to be done: 17% of all STEM teachers think that a career in engineering is undesirable for their students, rising to 19% for the 25- to 44-year-old STEM teacher group. Additionally, when asked to name an engineering development from the past 50 years that has had an impact on their lives, only two out of five (41%) of the general population (aged 20+) could name one – despite this being a survey carried out via the internet.

The essential but often overlooked role of careers education and advice, particularly for young people still in education, is bought into sharp focus through findings from the Education and Employer Taskforce report ***Nothing in Common***. Its research showed that teenagers' aspirations at age 14, 16 and 18, when mapped against projected labour demand (2010-2020), have almost "nothing in common" with the realities of the UK job market.[51]

41 *Subject progression from GCSE to AS level and continuation to A level,* Department for Education https://www.education.gov.uk/publications/eOrderingDownload/DFE-RR195.pdf Figures taken from Table B; note that these proportions are based on the number of entries (731,900 for mathematics for the 2007/08 cohort) rather than the number of students attempting (609,700). The former includes attempts by these pupils in previous years, but is relevant in assessing the progression of this cohort **42** Ibid **43** Ibid, Table 1.1 – based on the progression of the 2007/08 cohort in the following two years **44** Ibid, Table 1.1 **45** Ibid, Table 3.1 **46** Ibid **47** Discussed more fully in Section 7.9.1 and Table 7.12 **48** *Engineering UK 2013 The state of engineering*, EngineeringUK, December 2012, Section 1.1.3, p5; Section 7.6, p61 and Section 8.11, p75. **49** See Section 7.11 **50** Through co-ordinated programmes such as The Big Bang Fair, Big Bang Near Me Fairs, Tomorrow's Engineers activities and careers resources. **51** *Nothing in Common: Career Aspirations of Young Britons Mapped Against projected Labour Demand (2010-2020)*, UKCES, March 2013, p8

However, today's secondary school pupils are being let down by careers services that are not up to scratch. A review conducted by **Ofsted** in 2013[52] reported that three-quarters of schools are not executing their statutory careers duties satisfactorily. In particular, the review highlighted the poor links that exist between schools and businesses. We are making a difficult transition even harder than it should be for young people.

The **Institute for Public Policy Research** (IPPR) looked at interactions between schools and businesses and found that young people want more from their careers services: they want to know more about local job opportunities, more work experience to help them decide on their future career paths, and, for those careers that are strategically important, they may need incentives to pursue them.

The survey also determined that pupils may need help, and need it earlier than it is being provided at present. A known area of public concern is female participation in key sectors, including science. The lack of interest in post-GCSE STEM subjects and vocational education among girls is a cause for concern given that skills shortages in these sectors are looming. The survey provided evidence of insufficient knowledge among pupils of both genders about which careers did and did not have science qualifications as a prerequisite.

IPPR concluded that educating young people early about careers, and the educational choices they will need to make in order to achieve their ambitions, is therefore important for pre-GCSE ages, not just those aged 16 and upwards.[53]

The **International Centre for Guidance Studies'** (iCeGS) research into school organisation and STEM career-related learning concluded that the support of school senior leaders and their organisation of STEM within the school is highly significant in determining the success of STEM in an individual school.[54] The key findings were that:[55]

- Schools that had made a clear commitment to enhancing their STEM learning alongside a programme of career-related learning were able to articulate a perceived improvement in their students' attainment of qualifications, their ability to both articulate and demonstrate employability skills (such as team skills, planning, communication) and an improved or sustained popularity in terms of subscription to places.
- A clear commitment from the headteacher to integrating career-related learning within STEM learning can provide a fertile context for developing interesting and engaging learning opportunities for students in secondary schools. Where headteachers clearly identify STEM subjects and STEM careers as a priority, schools are more likely to have a range of activities operating across different subjects and for all year groups.
- Career-related learning (Figure 1.5) is one way to help young people to consider taking their STEM studies further. It can help to give them the information they need to make subject and career choices and the skills they need to make sure they are on appropriate paths to fulfil their ambitions. It includes three areas of activity which have tended to be seen as discrete aspects of the curriculum and to have been managed separately within schools: career education; work-related learning; and career information, advice and guidance (CIAG).

Two key recommendations (out of seven) worthy of note from our perspective were:[56]

1. Extra-curricular activities should be designed to integrate STEM with career-related learning, and this should be a clear expectation of their delivery and their success.
2. STEM career-related learning should be undertaken for all young people in secondary school.

Finally, other related reports around the underpinning importance of careers advice are: A large body of evidence[57] published by **King's College London**, shows that interest in science is formed by age 14 and that those students who had an expectation of science related careers at age 14 were 3.4 times more likely to earn a physical science and engineering degree than students without this expectation.

Research by the **University of Warwick**[58] has shown that students don't make links between curriculum knowledge and their future careers and need to know that, for some STEM careers, studying triple science is either desirable or essential. Links between the curriculum and future careers need to be made more explicit to students.

Finally, the work of **Brinkley et al**[59] should be noted. Their warning that careers advice and opportunities for work experience often fail to challenge gender stereotypes[60] should be taken seriously. They found that whilst there have been some attempts to address gender stereotypes through non-traditional work experience and careers guidance, such projects are often small scale, time limited, and do not reach all pupils.[61]

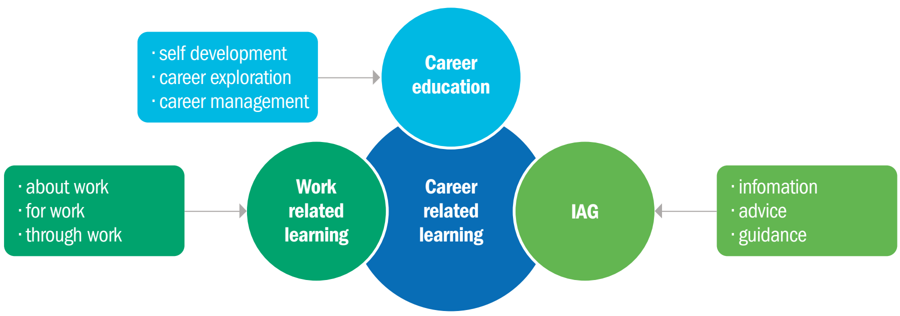
1.1.7 International students immigration

"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."[62]

Why has this appeared as an issue? It is because despite the actual realities of immigration legislation, we are seeing palpable declines in overseas (non-EU) students particularly in STEM disciplines.

We have shown[63] that the UK needs 1.82 million people with engineering skills over the period 2012-2022, highlighted the shortage of STEM teachers[64] and shown that the supply of

Fig. 1.5: Career related learning



Source: iCeGs

52 *Going in the right direction?: Careers Guidance in Schools from September*, 2012, Ofsted, 2013 http://www.ofsted.gov.uk/filedownloading/?file=documents/surveys-and-good-practice/g/Going%20in%20the%20right%20direction.pdf&refer=1 **53** *Driving a generation: Improving the interaction between schools and businesses*, Institute of Public Policy Research North, January 2014, p22 **54** *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 **55** *School organisation and STEM career-related learning,* International Centre for Guidance Studies, August 2013, p36 **56** *School organisation and STEM career-related learning,* International Centre for Guidance Studies, August 2013, p38 **57** *What shapes children's science and career aspirations age 10-13?*, King's College London, 2013, p3 **58** *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 **59** *The Gender Jobs Split: how young men and women experience the labour market,* Ian Brinkley, Katy Jones and Neil Lee, Touchstone Extras, August 2013, p7 **60** "Gendered Identities and Work Placement: why don't boys care?", Osgood, J., Francis, B. and Archer, L., in *Journal of Education Policy, 21(3)*, 2006, pp305–321 **61** *Gender equality in work experience placements for young people*, Francis, B., Archer, L., Osgood, J., Dalgety, J., Equal Opportunities Commission, 2004 **62** *International Science, Technology, Engineering and Mathematics (STEM) students*, House of Lords Science and Technology Select Committee, 11 April 2014, p6 **63** See Section 15.3.1 **64** Section 1.1.5

graduate level people (UK domiciled and international) is not going to be sufficient to meet this demand.[65] In addition, we highlighted last year that there are many engineering-related job titles listed on the Migration Advisory Committee (MAC) shortage list.[66] This is why any such decline is of concern.

The Lords report, entitled *International Science, Technology, Engineering and Mathematics (STEM)* students,[67] calls on the Government to rethink immigration policy, which it calls contradictory. The inquiry looked specifically at the numbers of international students in STEM subjects, and whether the UK's immigration policy has had any impact. The Lords are concerned by the fact that international STEM student enrolments have fallen by more than 10% in the last two years (by 8% in 2011/12 and a further 2% in 2012/13).[68]

They highlight that the Government is simultaneously committed to reducing net migration and attracting increasing numbers of international students (15–20% over the next five years). This contradiction could be resolved if the Government removed students from the net migration figures. Students comprise a majority of non-EU immigrants, so it follows that the net migration target can only be met by reducing the number of international students coming to the UK – contrary to the Government's stated policy to grow numbers of international students. Despite repeated invitations, however, the Government has refused to remove students from the net migration figures, arguing that it is complying with the international standard approach as set out by the United Nations. Given that only 22% of the general public thinks international students should be counted as migrants[69] we recommend, at the very least, that when the Government presents net migration figures, it should clearly state what proportion of the sum is students. It should not include student numbers for immigration policy making purposes.

International students make a huge contribution to the academic, intellectual and cultural vibrancy of UK universities, also enriching the experience for domestic students. International students also contribute very significantly to university finances, often partly subsidising courses for domestic students. Some courses, particularly taught Masters, are made viable by international student enrolments, and a fall in international student numbers poses a real threat. In terms of the labour market, UK plc is missing out on highly skilled workers.

UK work and student VISAs

People from outside the EU who wish to enter the UK to work or study must apply for a visa. Different types of visas are available, depending on the purpose of coming to the UK. Applicants must meet specified criteria, which vary depending on the type of visa. The types of visas, which are most relevant to international STEM students or recent graduates are briefly described below.

Tier 1: Highly Skilled Migrants. There are several different categories of Tier 1 visa.[70] The category most likely to apply to recent graduates is the Graduate Entrepreneur visa, which was introduced in 2012. This applies to graduates who have "been officially endorsed as having a genuine and credible business idea,"[71] by UK Trade and Investment (UKTI) and their Higher Education Institution. The Post Study Work visa used to operate under Tier 1, but this has now been closed.

Tier 2: Skilled Worker. The Tier 2 General Visa applies to those who have been offered a skilled job in the UK by a licensed employer. The total number of Tier 2 visas is capped at 20,700 places a year. Recent graduates can switch to a Tier 2 General Visa[72] and do not count against the 20,700 limit, provided they remain in the country. They must earn a salary of at least £20,300.

Tier 4: Student Visa. All international students require a Tier 4 visa. To qualify for a Tier 4 General Visa, prospective students need to provide: a valid Confirmation of Acceptance for Studies (CAS) from a fully licensed Tier 4 sponsor; evidence that they have enough money to cover course fees and monthly living costs; evidence that they have a specified level of competency in the English language. Visas are usually limited to a maximum of five years, with some exceptions. PhD students can now apply for a 12 month extension to their Tier 4 visa to stay in the UK after their course has ended under the Doctorate Extension Scheme, which was introduced in 2013.[73]

Tier 5: Temporary Worker Visa. There are several types of Tier 5 visa. People who wish to come to the UK for a short period of time to do work experience, training, research or a fellowship through an approved Government authorised exchange scheme can apply for a Tier 5 visa.[74] Recent graduates can switch to a Tier 5 visa in order to do a "period of professional training relating to their degree." There is no minimum salary requirement.

The report recommended that:

- The Government should treat student numbers separately for immigration policy making purposes.
- The Government should review its package for international students every two years to ensure it is globally competitive.
- The Government should reinstate the previous post study work route, which was simple and effective.
- The Government should establish a working group to determine the impact of decreasing international taught Masters students on the sustainability of courses.
- The Home Office should improve the way information is provided to prospective students to ensure welcoming and clear language is used.

Separately, the IPPR also investigated this issue, arriving at similar conclusions in its report *Britain wants you, Why the UK should commit to increasing international student numbers:*[75]

- The Government needs to commit to increasing the number of international students studying at British education institutions.
- 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.

Rather than rehearsing the points previously made in the Lords report, the following supplementary points/statistics are worth recording:

- In its July 2013 international export strategy, the Department for Business, Innovation and Skills (BIS) announced that it aims to secure an extra £3 billion worth of contracts for the UK's education providers overseas, and envisages attracting almost 90,000 extra overseas university students by 2018 (an increase of around 20%). In January 2013, a new Education UK Unit was set up within the

65 See Section 15.3.1 **66** *Engineering UK 2014 The state of engineering*, EngineeringUK, December 2013, p27 **67** http://www.parliament.uk/business/committees/committees-a-z/lords-select/science-and-technology-committee/news/international-stem-student-report/ **68** *International Science, Technology, Engineering and Mathematics (STEM) students*, House of Lords Science and Technology Select Committee, 11 April 2014, p5 **69** *International students and the UK immigration debate*, British Futures and Universities UK, August 2014, p6 **70** *Work Visas,* gov.uk; https://www.gov.uk/browse/visas-immigration/work-visas **71** *Tier 1 (Graduate Entrepreneur)* Visa, gov.uk; https://www.gov.uk/tier-1-graduate-entrepreneur-visa **72** *Tier 2 (General) Visa*, Gov.uk; https://www.gov.uk/tier-2-general/switch-to-this-visa **73** *Tier 4 of the Points Based System. Policy Guidance*, Home Office, 2013 **74** *Approved Tier 5 Government Authorised Exchange Schemes*, UK Border Agency, 2013; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/270320/gaelist.pdf **75** *Britain wants you, Why the UK should commit to increasing international student numbers*, Institute of Public Policy Research, November 2013

UK Trade and Investment department to help UK business take advantage of high value opportunities overseas, with the aim of securing contracts worth £3 billion by 2020.[76]

- Most international students in the UK are in higher education. The number of international students in UK universities and other Higher Education Institutions has grown significantly in recent decades. Fifty years ago the number of international students in UK universities was just over 20,000, but by the academic year 2011/12 there were 435,235.[77]
- International students are concentrated in postgraduate courses. Non-UK students account for 46% of all taught postgraduates and 41% of all research postgraduates. International students are also concentrated in particular subjects – especially business or STEM – and often comprise a high proportion of students in those subjects. For example, non-UK students made up 84% of new entrants in electronic and electrical engineering postgraduate courses in 2011/12.[78]
- International students often study courses in subject areas in which the UK has recognised skills gaps. For example, almost half (46%) of international students at the University of Sheffield were studying STEM degrees during the 2012/13 academic year.[79]
- Finally the Government is also looking to boost the number of UK students who study overseas. Under the Erasmus+ scheme there is a fund of £793 million to encourage overseas study, teaching and volunteering.[80] The Government is also looking to double the number of UK exchange students who visit China, in order to boost trade links.[81]

Employers are also concerned – In its evidence,[82] the manufacturers' organisation EEF criticised the Government's decision to abolish the Tier 1 post-study work route. It argued that this decision is restricting employers' ability to attract STEM graduates from outside of Europe, many of whom are left with no choice but to leave the UK after completing their studies.

Under the defunct Tier 1 rule, non-European Economic Area graduates who had studied in the UK were able to seek employment here for two years after completing their studies.

EEF recommends that Government restores the Tier 1 post-study work route and makes the process of recruiting non-EEA graduates easier and simpler, giving manufacturers access to a wider talent pool when skills shortages are rife.

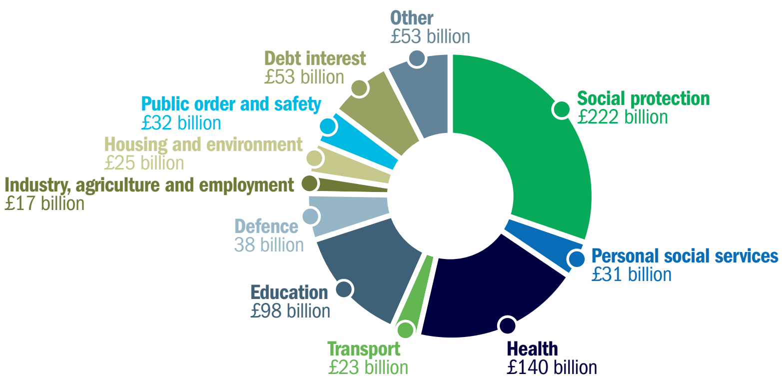
1.2 Government ambition and intent

Figure 1.6 presents public spending by main function at a national level and shows that the total managed expenditure for 2014-15 will be £732 billion.[83]

Major announcements in terms of science, innovation, education and skills from the Budget 2014

- A package of measures designed to support energy intensive industries, including extending the existing compensation scheme for them until 2019-20; introducing new compensation worth £1 billion to protect them from rising costs of the Renewable Obligation and Feed-In Tariff; and exempting from the carbon price floor the electricity generated from Combined Heat and Power plants – which hundreds of manufacturers use.
- Capping the Carbon Price Support mechanism at £18 per tonne of carbon – ensuring that the difference in the price of carbon between the UK and Europe will never rise above £18. This will save a mid-size manufacturer almost £50,000 on its annual energy bill.
- Extending the Apprenticeship Grant for Employers scheme by providing £85 million in the financial years 2014/15 and 2015/16. This will fund over 100,000 additional incentive payments for employers to take on young apprentices, in particular small and medium sized businesses.
- New support for employer investment in apprenticeships up to postgraduate level, which will provide apprentices with the technical skills that employers need. It will also give employers greater control over the content of courses to ensure that they equip apprentices with the right skills.
- £106 million investment over five years to develop new Centres for Doctoral Training which bring together business and academia for cutting edge research. The centres will train over 750 new students developing the engineers, physical scientists and mathematicians who will be central to our future economic growth.
- £74 million investment in the Catapult network, which bridges the gap between research and development and the market, turning innovative ideas into reality. This new investment will ensure the UK can remain at the forefront in two of our rapidly growing new industries: graphene and cell therapies. Catapult centres are closely aligned to Government industrial strategy sectors.
- £42 million investment towards the creation of a world-class research institute dedicated to Second World War code breaker Alan Turing, which will specialise in big data science. This will enable the UK to lead the way and capitalise on the benefits of big data.
- UK Export Finance is doubling its lending to businesses to £3 billion, and cutting interest rates on this funding by a third, supporting businesses looking to trade their products overseas and making it the most competitive export finance scheme in Europe.
- 174 new free schools and 3,486 academies have been opened across England since 2010, providing places for two million pupils.[84] Over 130,000 two-year-olds are now eligible for 15 hours of free early education a week.
- 50 University Technical Colleges and 46 studio schools have been approved.

Fig. 1.6: Government spending (2014/15)



Source: Office for Budget Responsibility. 2014-15 estimates. Allocations to functions are based on HM Treasury analysis

76 https://www.gov.uk/government/news/new-push-to-grow-uks-175-billion-education-exports-industry **77** *Students in Higher Education Institutions 2011/12,* Higher Education Statistics Agency, 2013. https://www.hesa.ac.uk/component/option,com_pubs/task,show_pub_detail/pubid,1/Itemid,286/ **78** *Students in Higher Education Institutions 2011/12,* Higher Education Statistics Agency, 2013 https://www.hesa.ac.uk/component/option,com_pubs/task,show_pub_detail/pubid,1/Itemid,286/ **79** *The economic costs and benefits of international students,* Oxford Economics, 2013 http://www.shef.ac.uk/polopoly_fs/1.259052!/file/sheffield-international-students-report.pdf **80** Website accessed on the 18 June (https://www.gov.uk/government/news/800-million-to-help-uk-students-study-overseas) **81** Website accessed on the 18 June 2014 (https://www.gov.uk/government/news/80000-uk-students-to-visit-china-to-boost-trade-links) **82** http://www.theengineer.co.uk/channels/policy-and-business/news/employers-should-be-able-to-recruit-non-european-skilled-graduates-says-eef/1018062.article **83** *Budget 2014,* HM Treasury, March 2014 **84** http://www.gleeds.com/worldwide/getfile.cfm?f=127

Other major on-going strands: Industrial Strategy,[85] Eight Great Technologies[86] and regional Growth[87] Fund previously mentioned in Engineering UK 2014 – updates:

The **industrial strategy** builds on the Government's Plan for Growth and the Growth Review which looked at how the Government is addressing the barriers faced by industry.[88] On-going progress reports are available on-line.[89]

The significant contribution of these Industrial Strategy sectors by Gross Value Added and employment[90] is shown in Table 1.3. These sectors embrace circa 10.9 million people – approximately 39% of the workforce.

Following the announcement of **The Eight Great Technologies** in 2012, funds are being allocated on an on-going basis[91] against each of the 'eight'[92] technologies: big data, satellites, robots, modern genetics, regenerative medicine, agricultural technologies, advanced materials and energy storage. Current reports investigating the eight great technologies as identified by UK Government can be found on-line.[93]

The **Regional Growth Fund** (RGF), according to the national audit office, is working.[94] Over £2.6 billion of RGF investment has now been allocated to 400 local projects and programmes, unlocking nearly £15 billion of private investment and delivering 550,000 jobs. RGF programmes amongst these awards have supported over 3,000 SMEs.

RGF is a flexible and competitive £3.2 billion fund operating across England from 2011 to 2017. Updates are available on-line.[95]

Other significant examples of action and spending:

Over the past year Government has allocated more than £2 billion to industrial strategy objectives. Whilst in some instances the true impact of industrial strategy may not be seen for a decade or more, progress has been made already. In particular:[96]

- The Aerospace Technology Institute is operational, thanks to £2 billion joint funding commitment by Government and industry between 2013 and 2020. It exists for research and development of the technologies needed for quieter, more energy efficient and environmentally friendly planes.
- The Advanced Propulsion Centre was established with up to £75 million available, initially from Government, for pilot projects to develop a new generation of low carbon powertrain technologies. This kick-started a £1 billion joint investment by Government and industry over 10 years. The APC's first projects were announced on 23 April 2014.
- The £70 million Agri-Tech Catalyst was launched to support industry-led 'proof of concept' development of near-market agricultural innovations. In the first phase, announced on 28 March 2014, eleven projects across the UK benefitted from £2.8 million from Government, alongside £1.4 million from industry.
- The ambition to support £1 billion of education exports by 2015 was met. This is contributing to an overall target to increase the value of all UK exports to £1 trillion by 2020.
- Dedicated funding at £100 million per year was put aside to support projects to grow skills in key sectors and technologies, through co-funding with employers.
- Seven catapult centres are now open for business, with £1.5 billion of public and private funding over their first five years, helping businesses bring innovative ideas to commercial reality.
- The British Business Bank launched in interim form. Its programmes made £660 million of finance available to small and medium sized enterprises (SMEs) in 2013 – a 73% year-on-year increase from 2012.
- £100 million funding[97] was made available to provide support for the increasing trend of 'reshoring', as companies bring manufacturing back to the UK from abroad. This will be delivered through the Advanced Manufacturing Supply Chain Initiative (AMSCI). The scheme aims to rebuild Britain's manufacturing prowess.
- The Technology Strategy Board (TSB) 2014-15 Delivery Plan outlines an ambitious £400 million plan for developing and nurturing the very best of British entrepreneurial talent.[98]

Table 1.3: Economic contribution of industrial strategy sectors

	Output (GVA billion)	% of UK Total	Employment	% of UK Total
Aerospace	£7.3	0.50%	118,000(I)	0.40%
Automotive(II)	£11.2	80.00%	129,000	0.40%
Construction(III)	£90.0	6.70%	2.98 million	10.00%
Education(IV)	£88.2	6.40%	2.77 million	8.70%
Information economy(V)	£58.0	4.20%	885,000	4.80%
Life sciences(VI)	£11.8	0.90%	160,000	0.50%
Nuclear(VII)	N/A	N/A	ca. 40,000	10.00%
Offshore wind(VIII)	N/A	N/A	ca. 4,000	1.00%
Oil and gas	£24.8	1.80%	35,000(IX)	0.10%
Professional business services(X)	£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. See notes below.
Notes: Direct sector comparisons should be made with some caution as they may be based on different data sources and time frames.
(i) Includes direct jobs only. The Aerospace Strategy identified about 230,000 direct and indirect jobs in the aerospace sector.
(ii) Source: ONS *Annual Business Survey 2011* provisional results.
(iii) 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).
(iv) Education statistics include economic contribution of domestic and foreign students but exclude educational products and services.
(v) 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.
(vi) Source: ONS *Annual Business Survey* (2011) and BIS *Bioscience and Health Technology* database.
(vii) Source: Industrial Strategy: *UK's Nuclear Future* (2013). There are no GVA stats available. Commercial turnover estimated at £4 billion.
(viii) Source: Industrial Strategy and RenewableUK; 2012 data.
(ix) *The Oil and Gas Industrial Strategy* identified that some 400,000 jobs are supported directly and indirectly by the upstream oil and gas industry.
(x) Source: *Industrial Strategy for Professional and Business Services* based on ONS statistics. GVA data for 2011 and employment data for 2012.

85 *Engineering UK 2014 The state of engineering, EngineeringUK,* December 2013, Section 1.3.1, p8 **86** *Engineering UK 2014 The state of engineering,* EngineeringUK, December 2013, Section 3.6, p28 **87** *Engineering UK 2014 The state of engineering, EngineeringUK,* December 2013, Section 1.2, p7 **88** https://www.gov.uk/government/collections/industrial-strategy-government-and-industry-in-partnership **89** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf **90** *Industrial Strategy Conference 2013: Securing Jobs and a Stronger Economy,* Department for Business, Innovation and Skills, September 2013, p58 **91** http://www.theguardian.com/science/2013/jan/25/government-technology-science-funding **92** https://www.gov.uk/government/publications/eight-great-technologies-infographics **93** https://www.gov.uk/government/publications/eight-great-technologies-satellites **94** https://www.gov.uk/understanding-the-regional-growth-fund#regional-growth-fund-national-audit-office-nao-report-update **95** https://www.gov.uk/understanding-the-regional-growth-fund **96** *Progress report:* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf **97** *£100 million to support domestic supply chains and create new jobs,* Department for Business, Innovation and Skills, 11 April 2014; https://www.gov.uk/government/news/vince-cable-100-million-to-support-domestic-supply-chains-and-create-new-jobs **98** *Delivery Plan: Financial Year 2014/15,* Technology Strategy Board, June 2014; https://www.innovateuk.org/documents/1524978/2138994/Delivery%20Plan%202014-15;jsessionid=1CE7EC9A3973EB3290E77ED00E54722C.1

1.3 UK industry strengths

A major influence on the UK's industrial strengths and growth has been Government focus: on public spending on science and innovation, and on industrial strategy and the Eight Great Technologies (previously mentioned in Section 1.2). Whilst not picking winners, this does provide a scale of support for sectors.

1.3.1 Strengths and opportunities

Below is a compilation from a variety of sources intended to highlight areas where the UK has proven strength in a sector of technology and is demonstrating either potential or actual capacity for growth.

Automotive

The automotive sector continues to be a success, building 1,597,433 vehicles in 2013 and generating exports of £30.7 billion – 10% of UK trade in goods. Additionally, it:[99]

- employs 731,000 people
- generates £59.3 billion turnover
- accounts for 3% of UK GDP
- invested £1.7 billion in R&D
- builds more than 70 models of vehicle

Aerospace

The UK has a 17% global market share in aerospace industry revenues, making it the largest in Europe and second only to the US worldwide. In 2012, the industry had a turnover of some £20 billion.[100] Furthermore:[101]

- The sector supports more than 3,000 companies distributed across the UK, directly employing 100,000 people and supporting an additional 130,000 jobs indirectly.
- UK aerospace revenue was £24.2 billion in 2011, a real terms increase of 2.5% compared with 2010.
- It is estimated that there will be global demand for 27,000 new passenger aircraft, worth around $3.7 trillion, by 2031. In addition, global demand for commercial helicopters is expected to be in excess of 40,000 and worth circa $165 billion by 2031.

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.

The global construction market is forecast to grow by over 70% by 2025, concentrated primarily in emerging economies.[102]

In July 2013, the Government published Construction 2025, which summarises the industrial strategy for the construction sector in the coming decade.[103]

Biosciences

Biosciences are vital to develop the integral products and processes in our lives, from the food we eat to our medical care. Between them, the UK biosciences sectors of pharmaceuticals and industrial biotechnology represent over 13,000 companies, generate over £134 billion in turnover and contribute £41 billion to the economy.[104]

Space

Space technology provides the basis for much of modern life, with services supporting communications, environmental monitoring, navigation and security. The UK space sector contributes £9.1 billion a year to the UK economy and directly employs 28,900 people.[105] It is also one of the UK economy's fastest growing sectors, with an average growth rate of almost 7.5%.[106] The sector has the potential to be a great success story for the UK economy, with ambitions to increase its annual turnover from 9.1 billion in 2013 to £40 billion by 2030. The worldwide space market was worth £160 billion in 2008 and is forecast to grow to £400 billion in 2030.[107]

Chemicals

Whether in household products, in food or medicines, or in advanced materials, fuels and process technologies, supporting the UK chemicals sector is fundamental to our economy and quality of life. In 2012, the UK chemicals sector generated annual sales of nearly £31 billion, accounting for 11% of all manufacturing exports by value, and employed over 111,000 people directly. The sector generated £8.6 billion in GVA in 2012, and contributed a total of £591 million in R&D investment.[108]

Creative industries

Government analysis shows the sector punches above its weight for the economy, generating £8 million an hour, contributing £71.4 billion GVA and providing 1.68 million jobs (or 2.2 million if we count creative jobs in other sectors) in 2012.[109]

Advanced materials

Advanced materials underpin many sectors including manufacturing, construction, cleantech and transport. The interdependency of advanced materials and high value manufacturing in particular offers a large opportunity for UK innovation and growth. Businesses that produce, process, fabricate and recycle materials form a critical element in high value manufacturing. They have an annual turnover of around £197 billion and contribute £53 billion to the economy.[110]

Electronic, sensors and photonics

Electronics, sensors and photonics underpin many industrial sectors. The UK's electronics sector generates approximately £29 billion a year in revenues, contributing over £12 billion to GVA and employing an estimated 850,000 people in the UK.[111]

Agri-tech

Agri-tech underpins our food and drink manufacturing sector, which is the UK's largest manufacturing sector, worth £25 billion. The entire agri-food supply chain – from farm to table – is worth £96 billion. A UK Strategy for Agricultural Technologies defines this new industrial sector for the first time.[112]

Renewables

Generation from renewables, including wind, wave and tidal, currently makes up around 15% of the UK's electricity supply. The largest contributor to this is the combination of onshore and off-shore wind power.[113] Wind, wave and tidal power currently provide employment for 34,500 people in the UK, and have the potential to create 70,000 more jobs over the next decade.[114]

The UK has made a firm commitment to cut carbon emissions by at least 80% by 2050.[115] Between 2010 and 2020, the UK is expected to cut greenhouse emissions by 29%, and must then reduce this amount by a further 85% by 2030.

Rail

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.[116]

99 http://www.smmt.co.uk/wp-content/uploads/sites/2/SMMT_Facts-Guide_May.pdf **100** http://www.google.co.uk/url?sa=t&rct=j&q=uk%20aerospace%20key%20facts&source=web&cd=2&ved=0CCoQFjAB&url=http%3A%2F%2Fwww.parliament.uk%2Fbriefing-papers%2FSN00928.pdf&ei=dtLoU-zLCceP0AW6rYCIBg&usg=AFQjCNGqyGvaG4sAWL26MVGdeFEort0jpg&bvm=bv.72676100,d.d2k&cad=rjt **101** *Industrial Strategy: government and industry in partnership, Lifting Off – Implementing the Strategic Vision for UK Aerospace*, HM Government, March 2013 **102** Global Construction Perspectives and Oxford Economics (2013) Global Construction 2025. Construction output is estimated to grow from about $8.7 trillion in 2012 to $15 trillion in 2025. www.globalconstruction2025.com **103** https://www.gov.uk/government/publications/construction-2025-strategy **104** *Delivery Plan: Financial Year 2014/15*, Technology Strategy Board, June 2014 **105** http://www.bis.gov.uk/ukspaceagency **106** UK Space Agency Civil Space Strategy 2012-16, foreword, http://www.bis.gov.uk/assets/ukspaceagency/docs/uk-spaceagency-civil-space-strategy.pdf **107** *Work of the European and UK Space Agencies*, House of Commons Science and Technology Committee, 14 October 2013 **108** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf **109** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf **110** *Delivery Plan: Financial Year 2014/15*, Technology Strategy Board, June 2014 **111** *Delivery Plan: Financial Year 2014/15*, Technology Strategy Board, June 2014 **112** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf **113** *Energy Trends*, Department of Energy and Climate Change, March 2014 **114** *Working for a Green Britain and Northern Ireland 2013-23*, RenewableUK, 2013 **115** www.theccc.org.uk/tackling-climate-change/the-legal-landscape/global-action-on-climate-change/ **116** https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf

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Retail

Retail turnover is around £320 billion per year in the UK and despite the economic climate the sector has continued to show growth. Retail employs three million people (1/10 of the workforce) across 180,000 businesses, operating in every postcode in the country. It also underpins local economies, and is a key partner in delivering Government policy in a number of areas.[117]

Oil and gas

The UK oil and gas supply chain is well positioned across the value chain, with 1,100 companies achieving combined revenues of £27 billion in 2011.[118] Currently, oil and gas provide some 73% of the UK's total primary energy, with oil for transport and gas for heating being dominant in these markets. The industry supports some 450,000 jobs, many highly skilled, across the whole economy.[119] In 2013, its capital investment of £14.4 billion in the UK's oil and gas reserves was the highest it has been for 30 years.[120]

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.[121] 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 $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%.[122]

Universities

In 2011–12, the Higher Education sector made a substantial contribution to economic activity,[123] and generated over £73 billion of output (both direct and indirect effects). In addition it:

- contributed 2.8% of UK GDP, up from 2.3% in 2007
- generated significant employment opportunities across the economy, accounting for 2.7% of all UK employment, up from 2.6% in 2007. This was equivalent to 757,268 full-time jobs
- Universities directly employed 378,250 people, which equated to approximately 319,474 full-time equivalent jobs. This was equivalent to just over 1% of all UK employment in 2011
- generated an estimated £10 billion of export earnings for the UK in 2011/12

Cities

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. But as well as being important in terms of scale, they are also important in terms of efficiency. Cities in the UK produce 15% more output for every worker than non-city areas, while they produce 32% fewer carbon dioxide emissions than non-city areas.[124]

The UK's future prosperity depends on them as (selected):[125]

- Cities host 73% of all highly skilled jobs
- 64% of unemployment is in cities

Intangible assets

Latest figures published show that UK business is building success through 'knowledge' and 'creative assets'. Investment in 'intangible' assets has increased by more than 5% to £137.5 billion from 2009 to 2011 and nearly half of this investment was protected by formal Intellectual Property Rights. Of this, 46% was protected by copyright, 21% by unregistered design rights and 21% by trademarks.[126]

Data shows investment in intellectual property and 'intangible' assets is growing. It continues to outstrip investment in tangible assets, such as buildings and machinery, which fell slightly from £93 billion to £89.8 billion. These figures signal the growing value UK businesses attach to knowledge, innovation and creativity.[127]

Professional and business services

We are among the world leaders in most of the highly skilled services which make up the professional and business services (PBS) sector.[128]

The PBS sector generates 11% of UK gross value added and provides nearly 12% of UK employment.[129] It also contributes strongly to economic growth and productivity: despite the economic downturn, PBS has seen growth of nearly 4% a year in the last decade. Export performance is strong, totalling £47 billion in 2011[130] and with a trade surplus of £19 billion (a third of the UK's total services sector surplus).[131]

Information economy

The information economy is transforming the way we live and work. It enables process, product and service innovation across all sectors, leading to increased competitiveness and sustainability.[132] It is crucial to our success on the global stage, our competitiveness and our connectedness – to our whole economy.[133]

The UK ICT sector comprises more than 116,000 companies with revenues of more than £137 billion and contributes £66 billion to the UK economy. The overwhelming majority of information economy businesses – 95% of the 120,000 enterprises in the sector – employ fewer than ten people. There were 1.3 million jobs in the ICT sector in 2011.

Within this overarching sector **software, IT and telecoms** together generated 4.2% of UK gross value added in 2011 and provided 885,000 jobs. There are 107,000 software businesses, and the UK is the world's number two exporter of telecoms services (£5.4 billion) and number three in computer services (£7.1 billion) and information services (£2 billion).[134]

Big data

"We live in a world where the volume, velocity and variety of data being created and analysed each day is ever increasing. It is estimated that 90% of the world's data was created in the last two years,[135] and each day 2.5 billion gigabytes of data is created – enough to fill over 27,000 iPads per minute."[136]

One of the greatest opportunities and challenges facing policymakers today is the ever increasing significance of data. Data underpins our businesses and our economy, providing new insights into consumer needs and enabling new products and services to be developed. The next generation of scientific discovery and innovation will be data-driven, from modelling and simulation, to handling massive data traffic.[137] This is why 'big data' has become in vogue the past year.

Big data refers to ways of handling data sets so large, dynamic and complex that traditional techniques are insufficient to analyse their content.

117 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf **118** *Review of the UK oilfield Services Industry*, Ernst & Young, 2012 http://www.ey.com/Publication/vwLUAssets/Review_of_the_UK_oilfield_services_industry_2012/$FILE/EY_Review_of_the_UK_oilfield_services_industry_2012.pdf **119** http://www.oilandgasuk.co.uk/2013-economic-report.cfm **120** http://www.oilandgasuk.co.uk/economics.cfm **121** http://www.telegraph.co.uk/finance/newsbysector/energy/10072029/Shale-gas-could-be-a-new-North-Sea-for-Britain.html **122** http://www.bbc.co.uk/news/business-21453393 **123** *The impact of universities on the UK economy*, UniversitiesUK, April 2014, p2 **124** *Cities Outlook 2014,* Centre for Cities, January 2014, p6 **125** *Cities Outlook 2014,* Centre for Cities, January 2014, p2 **126** https://www.gov.uk/government/news/uk-knowledge-investment-continues-to-grow **127** http://www.ipo.gov.uk/ipresearch-intangible.pdf **128** *Industrial Strategy: government and industry in partnership, Growth is Our Business: A Strategy for Professional and Business Services*, HM Government, July 2013 **129** Office for National Statistics *National Accounts* data and Department for Business, Innovation and Skills calculations **130** Office for National Statistics *Pink Book* **131** OECD Trade in Services data **132** *UK Business: Activity, Size and Location*, Office for National Statistics, 2011. **133** *Industrial Strategy: government and industry in partnership, Information Economy Strategy*, HM Government, June 2013 **134** *Delivery Plan: Financial Year 2014/15*, Technology Strategy Board, June 2014 **135** *What is big data?*, IBM, http://www-03.ibm.com/software/products/en/category/bigdata **136** Calculation based on IBM figures and 64GB iPad **137** *Seizing the data opportunity A strategy for UK data capability*, HM Government, October 2013

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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,[138] whilst 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.[139]

1.3.2 All change for manufacturing?

"Manufacturing in 2050 will look very different from today, and will be virtually unrecognisable from that of 30 years ago. Successful firms will be capable of rapidly adapting their physical and intellectual infrastructures to exploit changes in technology as manufacturing becomes faster, more responsive to changing global markets and closer to customers."[140]

Due to changes in the nature of global manufacturing, this sector deserves a sub-section all of its own.

Manufacturing is and must continue to be an essential part of the UK economy. It contributes £6.7 trillion to the global economy, and the UK is the 11th largest in the world's top manufacturers.[141] Manufacturing makes up 10% of UK gross value added and 54% of UK exports, and directly employs more than 2.5 million people.[142] Its benefits include:[143]

- Absolute value: The contribution of manufacturing to UK Gross Domestic Product (£139 billion in 2012) is still significant and increasing over the long term.[144]
- Research and Development (R&D): Manufacturing businesses are more likely to engage in R&D. 41% of manufacturing businesses with ten or more employees allocated resources to R&D in 2010, compared with an average of 23% of businesses in other sectors. Throughout 2000-2011, 72-79% of total UK R&D expenditure was associated with manufacturing.[145]
- Innovation: Manufacturers are more likely to innovate. In 2010, 26% of manufacturing businesses with ten or more employees carried out process innovation compared with less than 14% for non-manufacturers, and 44% undertook product innovation (less than 26% for non-manufacturers).[146]
- Productivity: The growth in total factor productivity for manufacturing has been 2.3% per year between 1980 and 2009, compared with 0.7% per year for the UK as a whole.[147]
- Exports: Manufacturing businesses are more likely to engage in exporting. UK exports of goods produced by the manufacturing sector totalled £256 billion in 2012, accounting for around 54% of all UK exports.[148] In 2010, 60% of manufacturing businesses with ten or more employees exported products and services compared with 26% of non-manufacturers.[149]
- Highly skilled jobs: In 2011, remuneration in UK manufacturing was 10% higher in comparable occupations compared with the average across all industries,[150] reflecting the high levels of skills required in modern manufacturing roles.

We should not forget that this success is dependent upon people. People are our key resource – the quality and skills of the workforce will therefore be a critical factor in capturing competitive advantage. It is essential that UK policy makers focus on the supply of skilled workers, including apprenticeship schemes, support for researchers, and the supply of skilled managers. Firms will need to pay much more attention to building multidisciplinary teams to develop increasingly complex products, and also innovative business models.[151]

It should be noted that a small number of products account for a large proportion of the value of UK manufacturing exports, with 10 products out of a total of around 4,500 accounting for over a quarter of the total.[152]

Table 1.4 shines a light on the top ten UK export products in 2011, providing a better understanding of what UK manufacturing is good at.[153]

Table 1.4: Top 10 UK export products in 2011

Rank	Description	Exports in US$ BN	Share of total US Exports
1	Petrolium oils and oils from bituminous minerals, crude	27.3	5.8%
2	Medicaments consisting of mixed/unmixed products for therapeutic/prophylactic uses	18.4	3.9%
3	Petroleum oils and oils obtained from bitumnious minerals (other than crude) & preparations not elsewhere specified	15.6	3.3%
4	Light petroleum oils & preparations	13.3	2.8%
5	Vehicles principally designed for the transport of persons with spark-ignition internal combustion reciprocating piston engine, of a cylinder capacity >1500cc but not >3000cc	10.0	2.1%
6	Vehicles principally designed for the transportation of persons with spark-ignition internal combustion reciprocating piston engine, of a cylinder capacity >3000cc	9.4	2.0%
7	Parts of the turbo-jets/turbo-propellers	8.7	1.8%
8	Turbo-jets, of thrust >25 kN	7.1	1.5%
9	Diamonds, non-industrial, unworked,/simply sawn/cleaved/bruten	7.0	1.5%
10	Whiskies	6.9	1.5%

Source: Kneller, R. (2013)

138 CEBR, Data equity: Unlocking the value of big data, 2012 http://www.sas.com/offices/europe/uk/downloads/data-equity-cebr.pdf **139** 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 **140** *Foresight – The Future of Manufacturing: A new era of opportunity and challenge for the UK Summary Report*, The Government Office for Science, London, 2013 **141** Website accessed on the 16th June 2014 (http://unstats.un.org/unsd/snaama/dnllist.asp) **142** Technology Strategy Board- Driving Innovation, Delivery Plan Financial Year 2014/15 **143** *Foresight – The Future of Manufacturing: A new era of opportunity and challenge for the UK Summary Report*, The Government Office for Science, London, 2013, p14 **144** PriceWaterhouseCoopers (2009) *The Future of UK Manufacturing: reports of its death are greatly exaggerated.* Available from: http://www.pwc.co.uk/assets/pdf/ukmanufacturing-300309.pdf **145** Office for National Statistics (2010) *Measuring investment in intangible assets in the UK: results from a new survey. Economic and Labour Market Review* p4 **146** Department for Business, Innovation and Skills (2012c) Community Innovation Survey, 2011. London. Available from: http://webarchive.nationalarchives.gov.uk/+/http://www.bis.gov.uk/policies/science/science-innovationanalysis/cis **147** O'Mahony, M. and Timmer, M. (2009) *Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database. The Economic Journal.* 119. p.374 – 403. Available from: http://onlinelibrary.wiley.com/doi/10.1111/j.1468-0297.2009.02280.x/abstract **148** Office for National Statistics (2012) Trade in Goods classified by Industry (MQ10). Available from: http://www.ons.gov.uk/ons/rel/uktrade/uk-trade/april-2012/tsd-tradein-goods-mq10-dataset--sb---april-2012.html In: Office for National Statistics (2012b) United Kingdom Balance of Payments – The Pink Book, 2012. Available from: http://www.ons.gov.uk/ons/rel/bop/united-kingdom-balance-ofpayments/2012/index.html **149** Harris, R. and Moffat, J. (2013) Investigation into trends in export participation among UK firms. London. Available from: www.ukti.gov.uk/download/file/524940.html **150** Office for National Statistics (2012) Annual Survey of Hours and Earnings – 2011 Revised results. UK. Available from: http://www.ons.gov.uk/ons/rel/ashe/annual-surveyof-hours-and-earnings/index.html **151** *Foresight – The Future of Manufacturing: A new era of opportunity and challenge for the UK Summary Report*, The Government Office for Science, London, 2013, p6 **152** Kneller, R. (2013) *What are the constraints on potential UK exporters? Foresight*, Government Office for Science, London. **153** *Foresight – The Future of Manufacturing: A new era of opportunity and challenge for the UK Full Report*, The Government Office for Science, London, 2013, p102

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1.3.2.1 Manufacturing services

As we have stated before,[154] the manufacturing paradigm is undergoing a shift from the traditional production process to the new manufacturing services offering.

The Foresight report on *The Future of Manufacturing* exemplifies this by reporting that manufacturing has traditionally been understood as the production process in which raw materials are transformed into physical products through processes involving people and other resources. It goes on to state that it is now clear that physical production is at the centre of a wider manufacturing value chain.[155] This this shift is visualised in Figure 1.7.[156]

Manufacturers are increasingly using this wider value chain to generate new and additional revenue, with production playing a central role in allowing other value creating activities to occur.[157] For example, 39% of UK manufacturers with more than 100 employees derived value from services related to their products in 2011, compared with 24% in 2007. What this means is the provision of services to clients by manufacturing firms,[158] with services typically supporting or complementing products and helping manufacturers to establish long-term relationships with consumers.[159] This is likely to be an important trend for manufacturers to embrace, by exploiting synergies that can arise when offering both products and services.

Fig. 1.7: Five trends supporting the shift to manufacturing services

Service business models are becoming more complex

From a world of...	To a world including...
Products	Solutions
Outputs	Outcomes
Transactions	Relationships
Suppliers	Network partners
Elements	Eco-systems

Source: Neeley, A. et al. (2011)

1.3.2.2 Technological drivers

In addition to the aforementioned changes, it is crucial to look to the future to be prepared for underpinning technological changes that will undoubtedly drive how products are designed, manufactured, used and recycled. In turn, this will have a direct bearing upon the competitiveness of businesses.

The pace of technological change means that it is not always possible to exactly predict the consequences of developments, or when they will occur. However, technological developments will ultimately lead to new ways of doing business, for example using new sources of data to make products more tailored or personalised, or to sell complementary services. It will also bring new challenges in the protection of intellectual property, skills requirements and cyber- and biosecurity.

Nevertheless, the Foresight report (along with Figure 1.8) on *The Future of Manufacturing*[160] provides a very useful overview of the key drivers for change:

- Primary or underpinning technologies such as information and communications technology (ICT), sensors, advanced and functional materials, biotechnology and sustainable or green technologies are likely to become increasingly pervasive in products and processes.
- The secondary or underpinning technologies are relevant to the Eight Great Technologies (big data, space, robotics and autonomous systems, synthetic biology, regenerative medicine, agri-science, advanced materials and energy) receiving current Government investment.[161]

The report describes that the developments in these technologies are likely to be either derivative (including advances in technologies already in place); novel (immediately offering new capabilities, for example medical biotechnology and additive manufacturing); or disruptive (currently unknown and highly innovative technologies that offer unpredictable implications, with the potential to revolutionise an industry).[162]

154 *Engineering UK 2013 The state of engineering*, EngineeringUK, December 2012, p10 **155** *The New Industrial Revolution: Consumers, Globalisation and the End of Mass Production*. Yale University Press, 2012 **156** *Foresight – The Future of Manufacturing: A new era of opportunity and challenge for the UK Full Report*, The Government Office for Science, London, 2013, p51 **157** *Foresight – The Future of Manufacturing: A new era of opportunity and challenge for the UK Summary Report*, The Government Office for Science, London, 2013, p17 **158** Tether, B. Servitization: *The extent and motivations for service provision amongst UK based manufacturers. Economic and Social research Council, 2011.* Available from: http://www.esrc.ac.uk/my-esrc/grants/RES-598-28-0001/outputs/read/01ae838a-5e76-44ec-813c-01c845452634 **159** Neely, A., Benedetinni, O. and Visnjic, I. *The servitization of manufacturing: Further evidence. 18th European Operations Management Association Conference.* Cambridge, UK, 2011. Available from: http://www.cambridgeservicealliance.org/uploads/downloadfiles/2011-The%20servitization%20of%20manufacturing.pdf **160** *Foresight – The Future of Manufacturing: A new era of opportunity and challenge for the UK Full Report*, The Government Office for Science, London, 2013 **161** For further details see: https://www.gov.uk/government/news/600-million-investment-in-the-eight-great-technologies **162** Bower, J. and Christensen, C. (1995) *Disruptive Technologies: Catching the Wave.* Harvard Business Review, January–February 1995. Available from: http://hbr.org/1995/01/disruptive-technologies-catching-the-wave

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Fig. 1.8: Primary, underpinning and secondary technological trends and the consequences for products design, manufacture, use and recycling

Primary/ underpinning technologies	Secondary/ technological developments	Impacts and consequences
ICT	**Mobile internet**	**Product personalisation**
Advanced materials	**Knowledge-based automation**	**Sustainability and the 'circular economy'**
Biotechnology	**The 'internet of things'**	**Intellectual property mobility & protection**
Sustainable/green technologies	**Big data**	**Cyber security & counterfeiting**
Numerical modelling & algorithms	**Cloud computing**	**Changing skills requirements**
Mechatronics	**Autonomous robotics**	Supply chain volatility
Photonics	**Energy intelligence**	Export control
Knowledge systems	**Additive manufacturing**	Standardisation
Micro electronics	**Printable electronics**	Communication protocols
Tribology	**Integrated safety systems**	Medical ethics
Nanotechnology	Virtual product creation	Continous quality verification of products
Networks	Low impact transportation	
Artificial intelligence	Virtual manufacturing	
Human-machine interfaces	Adaptive systems	

Source: Foresight

1.3.2.3 Reshoring

Reshoring is an idea that's time has come. Over the past two years, reshoring has added £600 million to the UK economy and created approximately 10,000 new jobs. Moreover, reshoring has been identified as an important part of the Government's overall growth and industrial strategies.[163] The facts certainly suggest that reshoring is starting to gain traction.[164]

- 15% of UK manufacturers have brought production back from overseas during the past year or are in the process of doing so, compared with only 4% that off-shored in the past year – suggesting that reshoring is starting to gain traction.
- The number of companies returning production from countries such as China is outstripping those moving output overseas, according to a survey of more than 500 small and medium-sized manufacturers.
- Reshoring is picking up in some sectors of the economy driven by shifting consumer preferences, a reduction of the wage gap with emerging economies, volatile international transport costs and a desire by management to better control quality and supply chain risks.
- In order of magnitude terms, we estimate that this trend could create around 100-200,000 extra UK jobs over the next decade and boost annual national output by around £6-12 billion at today's values (c.0.4-0.8% of GDP) by the mid-2020s.[165]

We are all well versed with **offshoring**, which has been a growing trend since at least the late 1990s. This was driven by a variety of factors[166] including:

- cheap labour
- lower trade barriers
- growing local markets
- variations in social and environmental regulation
- better and cheaper global communications

However, according to the data listed above, the tide appears to be turning towards **reshoring**. So what are the main drivers behind this emerging new trend?[167] PWC's investigation indicates:

- **Declining wage gaps**
  One key factor has been the declining wage gap between developing and developed economies, which has reduced a key cost benefit from offshoring activities to low-wage economies.
- **Technological changes**
  New technologies may also be eroding some of the benefits of relocating to low wage economies. One example is 3D printing, which reduces the role of labour in the production process.
- **Security of supply chains**
  In the light of extreme climate events, political unrest and theft of intellectual property (particularly in countries where IP protection is difficult), management of UK companies may have a greater desire to keep their supply chains secure by bring more of them onshore.
- **Rising or volatile transport costs**
  Another factor which is encouraging reshoring has been the cost of transporting freight over long distances.
- **Quality of products and services**
  Quality is one of the major reasons cited by UK businesses considering whether to reshore parts of their overseas operations back to their home country. This suggests that businesses have often found it difficult to monitor and guarantee the quality of the goods and services produced by off-shored operations.
- **Need to respond quickly to changing consumer preferences in a digital world**
  Offshoring has made businesses less agile to changes in customer preferences, which may themselves shift more quickly in a world where online shopping is increasingly prevalent. Even though management teams may have been quick to recognise changing preferences, distances have made communication and changes in production runs more difficult. This could lead to higher inventory costs and lower profit margins.
- **Cost of managing overseas operations.**
  Finally, even if it is now cheaper and easier to communicate with off-shore offices, companies continue to spend significant sums of money in deploying management and purchasing teams abroad to monitor performance and improve processes. So, in some cases, the cost gain from offshoring parts of the businesses has been eroded by the incremental cost of travel and overseas accommodation.

These drivers for reshoring are complemented by new research undertaken by The Boston Consulting Group (BCG),[168] which finds that **manufacturing cost competitiveness** around the world has changed dramatically over the past decade – so dramatically that many old perceptions of low-cost and high-cost nations no longer hold.

BCG reports that in manufacturing Brazil is now one of the highest-cost countries, for example, and the UK is the cheapest location in Western Europe. Mexico now has lower manufacturing costs than China, while costs in much of Eastern Europe are basically at parity with the US.

163 Briefing and Q and A *Reshore UK Challenges and opportunities*, All-Party Parliamentary Manufacturing Group, 27th February 2014 **164** Manufacturing Advisory Service, November 25, 2013 **165** Reshoring – a new direction for the UK economy? http://www.pwc.co.uk/the-economy/publications/uk-economic-outlook/reshoring-a-new-direction-for-the-uk-economy-ukeo-march14.jhtml **166** Reshoring – a new direction for the UK economy? http://www.pwc.co.uk/the-economy/publications/uk-economic-outlook/reshoring-a-new-direction-for-the-uk-economy-ukeo-march14.jhtml, p25 **167** Reshoring – a new direction for the UK economy? http://www.pwc.co.uk/the-economy/publications/uk-economic-outlook/reshoring-a-new-direction-for-the-uk-economy-ukeo-march14.jhtml, p27-30 **168** *The Shifting Economics of Global Manufacturing: An Analysis of the Changing Cost Competiveness of the World's Top 25 Export Economies*, Boston Consulting Group, April 2014 – selected highlights. http://www.slideshare.net/TheBostonConsultingGroup/bcg-global-mfg-cost-competitiveness-index-final

Through studying the world's 25 largest goods-exporting nations, which account for nearly 90 percent of global exports of manufactured goods, the firm has developed a new tool – BCG's Global Manufacturing Cost-Competitiveness Index. This tracks changes in production costs over the past decade in the world's 25 largest goods-exporting nations.

The research has identified four distinct patterns of change in manufacturing cost competitiveness over the past decade that involve most of the 25 economies studied:

- **Under Pressure.** Five economies traditionally regarded as low-cost manufacturing bases – China, Brazil, the Czech Republic, Poland, and Russia – have seen their cost advantages erode significantly since 2004. The erosion has been driven by a confluence of sharp wage increases, lagging productivity growth, unfavourable currency swings, and a dramatic rise in energy costs. China's manufacturing-cost advantage over the US has shrunk to less than 5%. Costs in eastern European nations are at parity or above costs in the US.
- **Losing Ground.** Several countries that were already relatively expensive a decade ago, primarily in Western Europe, have fallen even further behind. Relative to the costs in the US, average manufacturing costs in Belgium rose by 6%; in Sweden by 7%; in France by 9 %; and in Switzerland and Italy by 10 %. Higher energy costs and low productivity growth – or even productivity declines – are the chief reasons.
- **Holding Steady.** A handful of countries held their manufacturing costs constant relative to the US from 2004 to 2014 and have significantly improved their competitiveness within their regions. Declining currencies along with productivity growth that largely offset wage hikes, helped keep overall costs in check in Indonesia and India. The UK and the Netherlands, on the other hand, have kept pace thanks to steady productivity growth. As a result, the cost structures of Indonesia and India have improved relative to Asia's other major exporters, while the UK and the Netherlands have boosted their cost competitiveness relative to other exporters in Western and Eastern Europe.
- **Rising Stars.** The overall manufacturing-cost structures of Mexico and the US have significantly improved relative to nearly all other leading exporters across the globe. The key reasons were stable wage growth, sustained productivity gains, steady exchange rates, and a big energy-cost advantage that is largely driven by the 50% fall in natural gas prices since large-scale production of US shale gas began in 2005. Mexico now has lower average manufacturing costs than China. Overall costs in the US, meanwhile, are 10-25% lower than those of the world's ten leading goods-exporting nations other than China.

To take advantage of this opportunity, UK Trade and Investment (UKTI) has joined forces with the Manufacturing Advisory Service (MAS) to launch **Reshore UK**, a new one-stop-shop service to help companies bring production back to the UK.[169]

Reshore UK will provide a matching and location service, access to advice and support and a named individual to help each company. MAS's role is to help support small and medium sized businesses to be globally competitive and to ensure there is capacity in the UK supply chain to take advantage of the reshoring opportunities. UKTI will use its global networks to attract foreign companies to invest.

In addition it has also launched a scheme for companies so that they can bid for a share of £100 million from a Government scheme to help them strengthen their domestic supply chains and help bring manufacturing back to the UK.[170]

1.3.2.4 Remanufacturing

Remanufacturing is a series of manufacturing steps acting on an end-of-life part or product in order to return it to like-new or better performance, with warranty to match.[171]

It is a trend that has come to the fore and presents a huge financial and environmental opportunity for the UK.[172] Estimates suggest that the value of remanufacturing in the UK is £2.4 billion,[173] with the potential to increase to £5.6 billion[174] alongside the creation of thousands of skilled jobs.

For example, the United States is the largest remanufacturer in the world and between 2009 and 2011 the value of US remanufactured production grew by 15% to at least $43 billion (£26 billion). This supported 180,000 full-time US jobs in over 70,000 remanufacturing firms.[175]

In addition to economic and employment benefits, there are also environmental benefits related to remanufacturing. Remanufacturing typically uses 85% less energy than manufacturing.[176] Studies conducted at the Fraunhofer Institute in Stuttgart, Germany have estimated that the energy savings by remanufacturing worldwide equals the electricity generated by five nuclear power plants. This equates to 10,744,000 barrels of crude oil or a fleet of 233 oil tankers. Estimates for resource impact suggest remanufacturing also saves in excess of 800,000 tonnes of carbon dioxide emissions each year,[177] roughly equivalent to 1% of emissions from cars.[178] The Fraunhofer Institute estimates that raw materials saved by remanufacturing worldwide each year could fill 155,000 railroad cars forming a train 1,100 miles long.[179]

Remanufacturing is often confused with other aspects related to refurbishment and reuse, so in the interests of clarity, it is not:

- **Repairing** – The fixing of a fault but with no guarantee on the product as a whole.[180]
- **Reusing** – The simple reuse of a product with no modifications.
- **Refurbishing** – The largely aesthetic improvement of a product which may involve making it look like new, with limited functionality improvements.
- **Reconditioning** – The potential adjustment to components bringing an item back to working order, although not necessarily to an 'as new' state.
- **Recycling** – The extraction of a product's raw materials for use in new products. This is a good option for products which are easily constructed and have minimal numbers of components.

169 https://www.gov.uk/government/news/new-government-support-to-encourage-manufacturing-production-back-to-the-uk **170** https://www.gov.uk/government/news/vince-cable-100-million-to-support-domestic-supply-chains-and-bring-manufacturing-back-to-the-uk 9 June 2014 **171** *Centre for Remanufacturing and Reuse, An Introduction to Remanufacturing*, 2007, p3 **172** *Remanufacturing – Towards a Resource Efficient Economy*, A report by the All-Party Parliamentary Sustainable Resource Group, March 2014, p1 **173** Parker,: *Remanufacturing in the UK: A snapshot of the UK remanufacturing industry in 2009*; Oakdene Hollins for the Centre for Remanufacturing and Reuse and the Resource Recovery Forum, 2010 **174** Lavery et al, The Next Manufacturing Revolution: Non-Labour Resource Productivity and its Potential for UK Remanufacturing, 2013, p75-96 **175** United States International Trade Commission Report October 2012, p21 **176** Steinhilper, *Remanufacturing: The Ultimate Form of Recycling*, Fraunhofer IRB Verlag,2006, p6 **177** Charter, M and Gray, *Remanufacturing and Product design: Designing for the 7th generation* **178** UK Greenhouse Gas Emissions, Final Figures, Department of Energy and Climate Change, 2012 **179** Steinhilper, *Remanufacturing: The Ultimate Form of Recycling*, Fraunhofer IRB Verlag,2006 p6 **180** Ijomah, Winifred L., Childe, Steve and McMahon, Chris 2004: R*emanufacturing: a key strategy for sustainable development. Proceedings of the 3rd International Conference on Design and Manufacture for Sustainable Development.* Cambridge University Press. ISBN 1-86058-470-5

Part 1 – Engineering in Context
2.0 Engineering in the UK

The number of engineering enterprises in the UK has grown by 2.0% over the 12 month period to March 2013. However, growth in enterprises has not been even across the country, with London growing by 5.3%. Engineering enterprises employ 5.4 million workers – a fifth (19.3%) of people employed in VAT/PAYE registered enterprises. Engineering enterprises had a collective turnover of £1.17 trillion – up 6.7% from the previous 12 months – and represented a quarter (24.9%) of the turnover of all VAT/PAYE registered enterprises. In terms of its importance to the UK economy in 2014, the engineering sector alone contributed an estimated £455.6 billion to Gross Domestic Product (GDP), 27.1% of the £1,683 billion total UK GDP.[181]

The UK economy has finally recovered all the growth lost during the recession, and is now at a higher point than its previous peak of Q1 in 2008.[182] In addition, at the time of the budget in March, the Office for Budget Responsibility predicted growth of 2.7% in 2014.[183]

This section examines the size and contribution of the engineering sector based on EngineeringUK's footprint of engineering.[184 185] The data comes from the Inter-Departmental Business Register (IDBR)[186 187] and is split by home nations and the different English regions.

2.1 Number of engineering enterprises in the UK

Table 2.0 shows the trend in the number of engineering enterprises over a five year period. It shows that as of March 2013 the total number of enterprises in the UK had grown by 1.3% over the five year trend period to reach 576,440. However, looking at the data by the different home nations of the UK shows that Scotland has grown by 10.3% while England has grown by 1.2%. By comparison, the number of engineering enterprises has declined by nearly one in 10 (9.5%) in Northern Ireland and by 4.0% in Wales.

Although England's engineering base has grown by 1.2% in five years, only three of its nine regions have grown:

- London – up 12.4%
- South East – up 1.8%
- North East up 0.8%

All of the other six regions have seen a decline in the number of engineering enterprises, with the West Midlands falling by 3.6% and the East Midlands by 3.3%.

Specifically in the last 12 months, the number of engineering enterprises in Scotland grew by 3.5% while England grew by 2.1%. However, in Wales there was a slight decline of 0.1%, while Northern Ireland fell by 2.4%. Northern Ireland has 14,355 engineering enterprises – fewer than every region of England and each of the home nations.

181 The contribution of engineering to the UK economy – A report for EngineeringUK, CEBR, October 2014 http://www.engineeringuk.com/Research/ 182 *Gross Domestic Product Preliminary Estimate*, Q2 2014, Office for National Statistics, 183 *Budget 2014,* HM Treasury, March 2014, p2 184 The engineering footprint is defined in SIC 2007. For further details see Table 17.5 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf 185 Data was purchased from the ONS, using IDBR, based on the engineering footprint. 186 The IDBR collects data on VAT and/or PAYE registered businesses 187 The IDBR is the official Government statistics on the number of businesses

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In the 12 months up to March 2013, there was growth in every region of the UK. At 5.3%, London had the strongest growth, followed by the North West at 2.6%. Weakest was the South West with just 0.9% growth.

Finally looking at the absolute number of engineering enterprises shows that although London grew strongly over five years, from 81,680 to 91,775, it still has fewer engineering enterprises than the South East (99,800). The English region with the lowest number of engineering enterprises is the North East, with 15,675. Of the home nations, Scotland has the most engineering enterprises (39,840), while Wales has 20,525 and Northern Ireland has 14,355.

The IDBR database only records businesses that are VAT and/or PAYE registered. It is therefore possible that there are some very small businesses which are not recorded in Table 2.0.

Table 2.1 shows the total number of enterprises in the UK. Only two of the home nations have increased their number of enterprises over five years: Scotland by 3.7% and England by 1.0%. By comparison, the number of enterprises declined by 5.6% in Northern Ireland and 4.7% in Wales.

Only two UK regions have grown their number of enterprises in the last year: London by 9.8% and the South East by 0.8%. It is also worth noting that over the last 12 months, Northern Ireland and Wales were the only parts of the UK to show a decline in the number of enterprises, down 1.2% and 1.0% respectively.

Table 2.0: Number of VAT and/or PAYE registered engineering enterprises (2009-2013) – UK

Home nation/ English region	2009	2010	2011	2012	2013	Change over one year	Change over five years
North East	15,545	15,010	14,545	15,275	15,675	2.6%	0.8%
North West	55,315	53,240	51,365	53,065	53,895	1.6%	-2.6%
Yorkshire and The Humber	40,080	38,825	37,770	38,855	39,330	1.2%	-1.9%
East Midlands	40,600	39,050	38,075	38,850	39,280	1.1%	-3.3%
West Midlands	48,380	46,415	44,945	46,105	46,625	1.1%	-3.6%
East	63,625	61,930	60,495	62,415	63,040	1.0%	-0.9%
London	81,680	78,640	79,190	87,175	91,775	5.3%	12.4%
South East	98,005	95,500	94,535	98,020	99,800	1.8%	1.8%
South West	52,415	51,105	50,355	51,825	52,300	0.9%	-0.2%
England	495,645	479,715	471,275	491,585	501,720	2.1%	1.2%
Wales	21,375	20,595	20,115	20,540	20,525	-0.1%	-4.0%
Scotland	36,125	35,920	36,180	38,490	39,840	3.5%	10.3%
Northern Ireland	15,860	15,290	14,870	14,705	14,355	-2.4%	-9.5%
UK total	569,005	551,520	542,440	565,320	576,440	2.0%	1.3%

Source: ONS/IDBR

Table 2.1: Number of VAT and/or PAYE registered enterprises (2009-2013) – UK

Home nation/ English region	2009	2010	2011	2012	2013	Change over one year	Change over five years
North East	57,425	55,865	54,770	56,420	56,430	0.0%	-1.7%
North West	211,915	204,990	201,060	205,690	206,815	0.5%	-2.4%
Yorkshire and The Humber	152,475	148,855	146,605	150,060	150,715	0.4%	-1.2%
East Midlands	147,980	143,310	140,940	144,510	145,295	0.5%	-1.8%
West Midlands	177,195	171,410	167,585	171,200	171,750	0.3%	-3.1%
East	217,925	213,635	210,845	216,595	217,605	0.5%	-0.1%
London	339,185	331,535	334,395	359,880	372,380	3.5%	9.8%
South East	337,380	330,375	328,015	337,810	339,965	0.6%	0.8%
South West	202,550	197,935	196,605	200,500	201,145	0.3%	-0.7%
England	1,844,030	1,797,910	1,780,820	1,842,665	1,862,100	1.1%	1.0%
Wales	92,005	89,370	87,430	88,575	87,685	-1.0%	-4.7%
Scotland	145,745	144,565	144,650	150,455	151,105	0.4%	3.7%
Northern Ireland	70,620	68,525	67,960	67,490	66,690	-1.2%	-5.6%
UK total	2,152,400	2,100,370	2,080,860	2,149,185	2,167,580	0.9%	0.7%

Source: ONS/IDBR

Overall, just over a quarter (26.6%) of VAT and/or PAYE registered enterprises are engineering enterprises. Both England (26.9%) and Scotland (26.4%) are close to this UK average, while Wales (23.4%) and Northern Ireland (21.5%) have the lowest proportion of engineering enterprises. The South East has the highest proportion of engineering enterprises of all the English regions, at 29.4%. Perhaps surprisingly, given its strong growth in the number of engineering enterprises (Table 2.2), London has the lowest proportion of engineering enterprises at 24.6%.

Table 2.2: Number of VAT and/or PAYE registered engineering enterprises as a proportion of all enterprises (2013) – UK

Home nation/ English region	Engineering enterprises	All enterprises	Proportion of enterprises that are engineering enterprises
North East	15,675	56,430	27.8%
North West	53,895	206,815	26.1%
Yorkshire and The Humber	39,330	150,715	26.1%
East Midlands	39,280	145,295	27.0%
West Midlands	46,625	171,750	27.1%
East	63,040	217,605	29.0%
London	91,775	372,380	24.6%
South East	99,800	339,965	29.4%
South West	52,300	201,145	26.0%
England	501,720	1,862,100	26.9%
Wales	20,525	87,685	23.4%
Scotland	39,840	151,105	26.4%
Northern Ireland	14,355	66,690	21.5%
UK total	**576,440**	**2,167,580**	**26.6%**

Source: ONS/IDBR

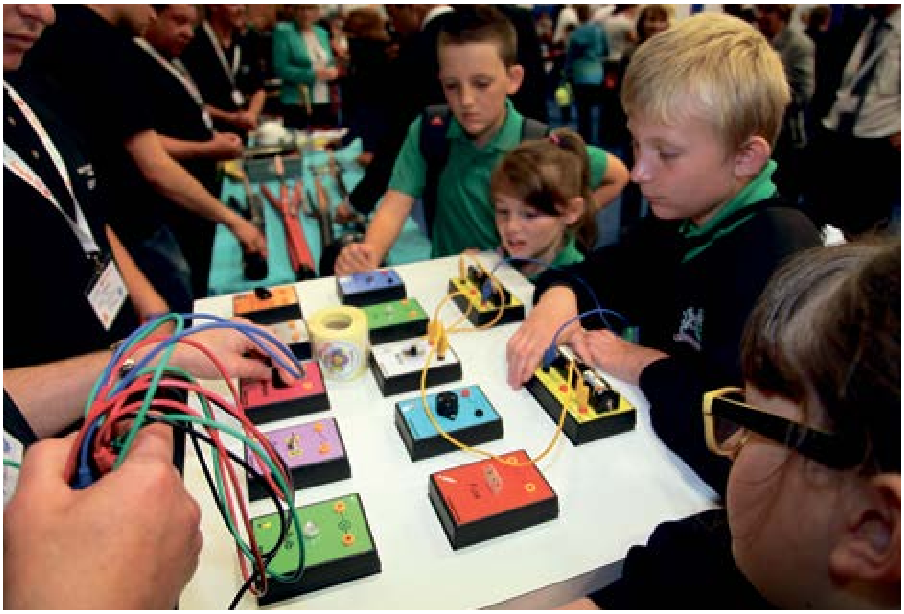

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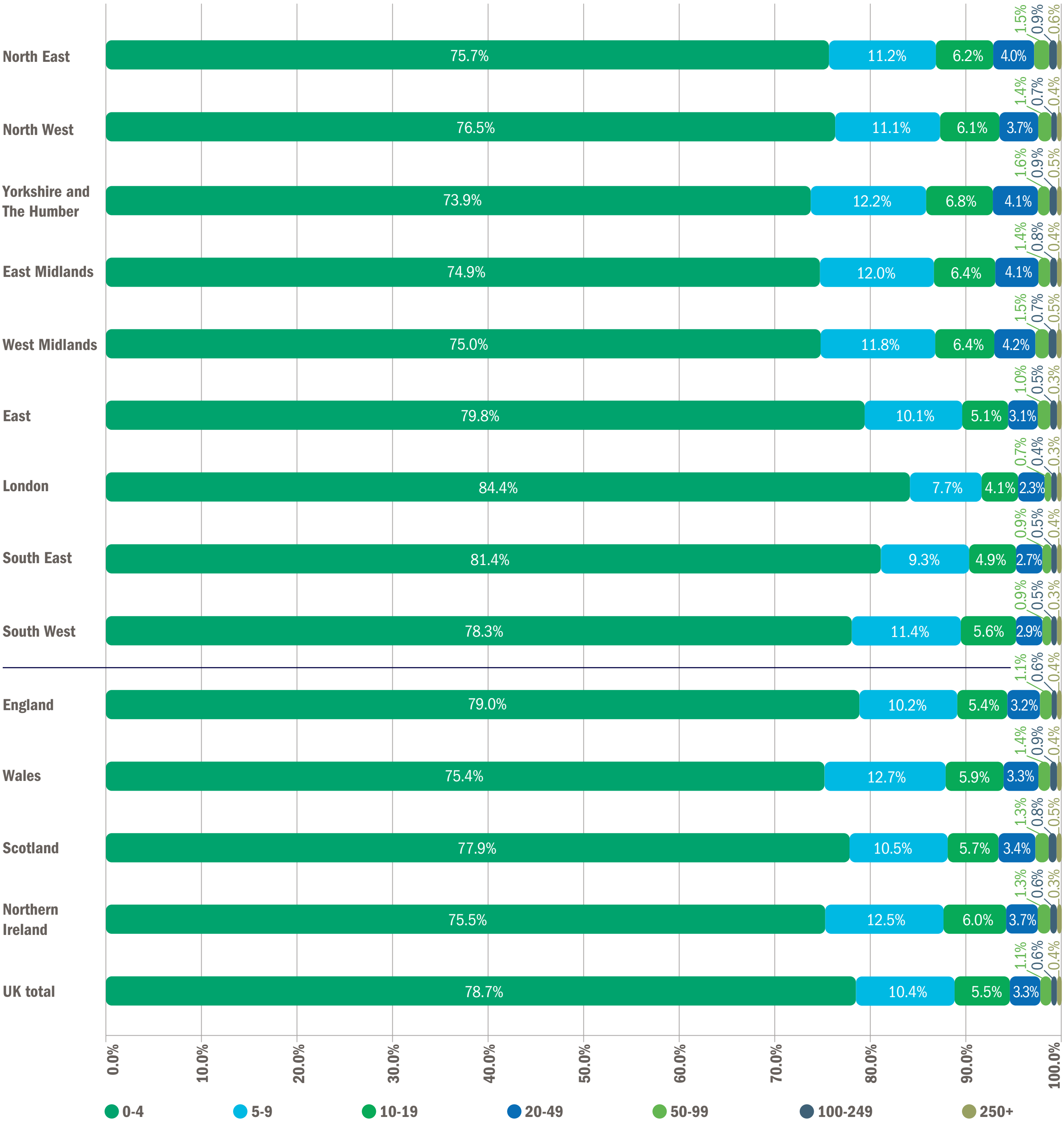
Figure 2.0 shows the proportion of engineering enterprises by the number of people they employ. The Figure shows that most (97.1%) engineering enterprises are either small[188] or micro[189] and that overall 86.9% of engineering enterprises have fewer than 10 employees.

Over three quarters (78.7%) of engineering enterprises have 0-4 employees. Across the different nations and regions of the UK, London has the highest proportion (84.4%) of micro enterprises, followed by Yorkshire and The Humber with 73.9%. At the other end of the scale, only 0.4% of enterprises have at least 250 employees. In the North East this rises to 0.6%.

The proportion of engineering enterprises in different industrial groups is shown in Table 2.3. Just over a quarter (27.7%) are in information and communication while construction accounts for 26.5% and manufacturing for 21.6%. Mining and quarrying only represents 0.2% of all engineering enterprises and all other industrial groups comprise the remaining 24%.

Fig. 2.0: Share of VAT and/or PAYE registered engineering enterprises by number of employees and by home nation and English region (2013) – UK



Source: ONS/IDBR

188 10-49 employees **189** 1-9 employees and turnover less than £2 million

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Table 2.3: Number of engineering enterprises by selected industrial groups (2013) – UK

Home nation/ English region	Overall	Manufacturing	Mining and quarrying	Construction	Information and communication	All other industrial groups
North East	15,675	3,820	50	4,175	2,335	5,290
North West	53,895	13,710	80	13,790	11,345	14,970
Yorkshire and The Humber	39,330	11,195	85	11,270	7,280	9,505
East Midlands	39,280	11,265	85	11,345	7,310	9,275
West Midlands	46,625	13,680	65	12,090	9,650	11,140
East	63,040	13,215	95	19,050	16,495	14,185
London	91,775	12,060	160	16,740	46,335	16,480
South East	99,800	17,500	110	25,805	34,115	22,270
South West	52,300	11,395	100	15,750	12,750	12,305
England	501,720	107,840	830	130,015	147,615	115,420
Wales	20,525	4,995	65	6,780	3,385	5,300
Scotland	39,840	7,710	310	9,650	7,590	14,585
Northern Ireland	14,355	3,705	85	6,285	1,315	2,965
UK total	**576,440**	**124,250**	**1,290**	**152,730**	**159,905**	**138,270**
Share of total UK engineering enterprises		21.6%	0.2%	26.5%	27.7%	24.0%

Source: ONS/IDBR

2.2 Employment in engineering in the UK

In March 2013, 5.4 million people were working in engineering enterprises:[190] 1,000 fewer than in 2012. Over five years, the number of people employed in engineering enterprises has declined by 7.9% from 5,895,000 in 2009 to 5,431,000 in 2013.

This five year decline is common for every nation and region of the UK. In the home nations, engineering employment has fallen by a fifth (21.6%) in Northern Ireland and a tenth (9.9%) in Wales. The percentage decline in England was slightly below the UK average at 7.6% while Scotland had the smallest decline at 6.0%.

Regionally, everywhere in England saw a decline over five years in the number of people employed in engineering enterprises – albeit with a large degree of variation. The largest decline was in Yorkshire and The Humber, which fell by 12.6%. This was closely followed by the North West (11.8%) and the North East (11.6%). By comparison, employment in engineering enterprises in London only declined by 1.8%.

Looking at the change in employment over one year also shows an interesting pattern. Employment has declined for engineering enterprises in Wales (down 1.0%) and Northern Ireland (down 0.8%). In England, although the number of engineering enterprises increased by 2.1% in the last year (Table 2.0), employment has remained unchanged. In Scotland, employment has increased by 0.2%, which is less that the increase in engineering enterprises (3.5%).

Within England there is a combination of both growth and decline, over the last 12 months. The largest decline was in the South West where employment fell by 3.2%. The other two regions which showed decline were Yorkshire and The Humber (down 1.5%) and the South East (down 0.9%). Both the North East and West Midlands had employment growth of 1.8%, while London grew by 1.3%.

One possible explanation for this variance between growth in the number of engineering enterprises and growth in the number of people employed could be changes in the number of people who are self-employed. There are currently 4.6 million workers (15% of those in work) who are self-employed in their main job: this is the highest percentage for four decades.[191] Similarly, the Office for National Statistics has identified that there are 167,000 people working in construction who can be classed as self-employed.[192] Finally a poll by Ipsos Mori shows that over a quarter (28%) of those who are self-employed would rather be working for a company.[193]

Looking at the total number of employees of engineering enterprises by nation and region shows that there are 4.7 million in England, followed by 409,000 in Scotland. Wales has 201,000 people employed by engineering enterprises and Northern Ireland has 120,000. Within the regions of England, the South East has the most people employed by engineering enterprises, with 960,000, followed by London on 704,000 and the East of England on 607,000. By comparison, there are only 164,000 people employed by engineering enterprises in the North East.

Overall, 19.3% of employed people were working in engineering enterprises. However, there is some variation. Wales had the highest proportion of the home nations, with a fifth (20.0%) working in engineering enterprises. This compares with 19.4% in England, 18.9% in Scotland and 18.0% in Northern Ireland.

190 The IDBR dataset is not the official source of statistics on employment and these figures are indicative. The Business Register Employment Survey is the official statistics on employment. Employment statistics have been rounded to the nearest thousand. **191** *Self-employed workers in the UK – 2014*, Office for National Statistics, 20 August 2014, p1 **192** *Self-employed workers in the UK – 2014*, Office for National Statistics, 20 August 2014, p7 **193** Website accessed 11 June 2014 (http://www.independent.co.uk/news/uk/politics/report-450000-recently-selfemployed-brits-would-rather-just-have-a-normal-job-9262913.html)

Within the regions of England there is also a wide degree of variation. Table 2.4 shows that the South East had both the largest number of people working in engineering enterprises (960,000) and the highest proportion (24.8%). By comparison, London had the second highest number of people working in engineering enterprises (704,000). However, it also had the lowest proportion (13.3%).

Table 2.4: Employment in VAT and/or PAYE registered engineering enterprises (2009-2013) – UK

Home nation/ English region	2009	2010	2011	2012	2013	Change over one year	Change over five years
North East	189,000	175,000	159,000	164,000	167,000	1.8%	-11.6%
North West	559,000	540,000	489,000	489,000	493,000	0.8%	-11.8%
Yorkshire and The Humber	462,000	423,000	403,000	410,000	404,000	-1.5%	-12.6%
East Midlands	427,000	399,000	382,000	385,000	388,000	0.8%	-9.1%
West Midlands	550,000	519,000	497,000	491,000	500,000	1.8%	-9.1%
East	657,000	633,000	607,000	604,000	607,000	0.5%	-7.6%
London	717,000	661,000	668,000	695,000	704,000	1.3%	-1.8%
South East	1,018,000	1,000,000	961,000	969,000	960,000	-0.9%	-5.7%
South West	505,000	497,000	491,000	493,000	477,000	-3.2%	-5.5%
England	5,084,000	4,848,000	4,657,000	4,700,000	4,700,000	0.0%	-7.6%
Wales	223,000	208,000	206,000	203,000	201,000	-1.0%	-9.9%
Scotland	435,000	408,000	403,000	408,000	409,000	0.2%	-6.0%
Northern Ireland	153,000	144,000	125,000	121,000	120,000	-0.8%	-21.6%
UK total	5,895,000	5,608,000	5,391,000	5,432,000	5,431,000	0.0%	-7.9%

Source: ONS/IDBR

Table 2.5: Employment in engineering enterprises as a proportion of employment in all enterprises (2013) – UK

Home nation/ English region	Engineering enterprises	All enterprises	Proportion of enterprises that are engineering enterprises
North East	167,000	954,000	17.5%
North West	493,000	2,614,000	18.9%
Yorkshire and The Humber	404,000	2,262,000	17.9%
East Midlands	388,000	2,016,000	19.2%
West Midlands	500,000	2,302,000	21.7%
East	607,000	2,862,000	21.2%
London	704,000	5,306,000	13.3%
South East	960,000	3,867,000	24.8%
South West	477,000	2,090,000	22.8%
England	4,700,000	24,274,000	19.4%
Wales	201,000	1,004,000	20.0%
Scotland	409,000	2,166,000	18.9%
Northern Ireland	120,000	668,000	18.0%
UK total	5,431,000	28,113,000	19.3%

Source: ONS/IDBR

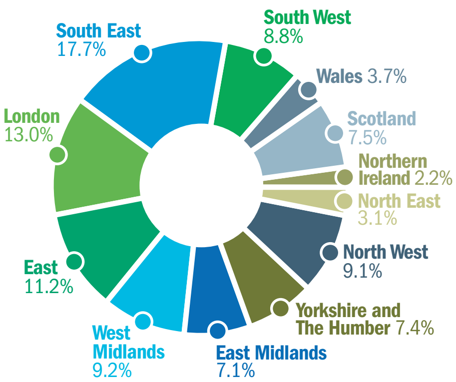
Figure 2.1 shows the proportion of staff in engineering enterprises by number of employees. In Figure 2.0, we showed that companies with at least 250 employees represented 0.4% of all engineering enterprises. But these companies employ over two fifths (42.4%) of those working in engineering enterprises.

The importance of companies with at least 250 employees is not consistent across the nations and regions of the UK. Nationally, in Northern Ireland only 29.2% of employees work in enterprises with at least 250 employees. In Wales it is just over a third (36.3%). While England (42.9%) and Scotland (43.5%) are slightly above average.

Regionally, in the South East over half (50.7%) of employees worked for engineering enterprises with at least 250 employees. This compares with around a third in the North West (33.5%), Yorkshire and The Humber (34.7%) and the East Midlands (35.3%).

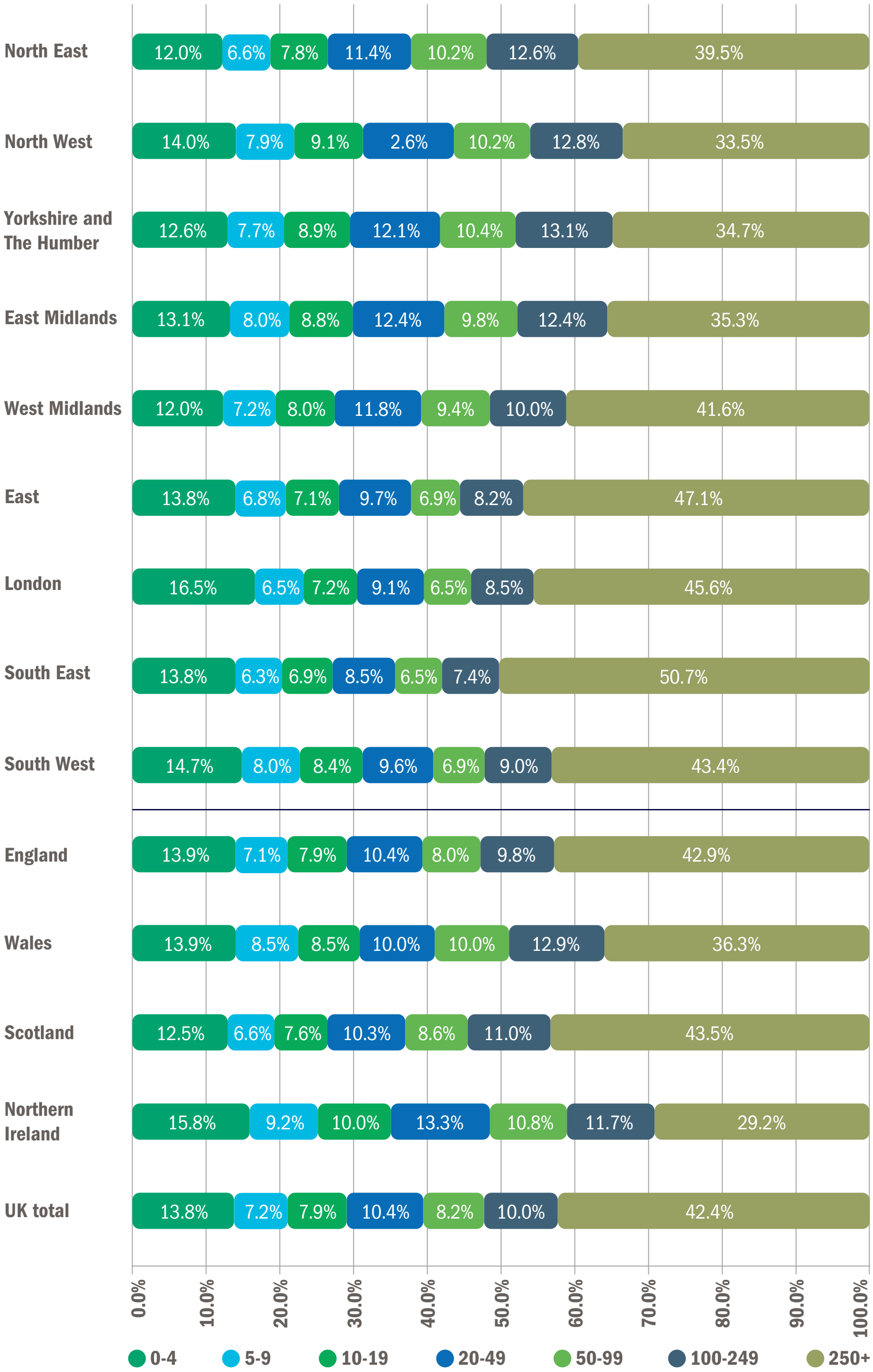
Figure 2.2 shows the proportion of employees working by devolved nation and English region. Nearly one in five (17.7%) of those working for engineering enterprises work in the South East, followed by 13% in London. By comparison, 3.1% work in the North East and 2.2% work in Northern Ireland.

Fig. 2.2: Share of employment for VAT and/or PAYE registered enterprises by devolved nation and English region (2013)



Source: ONS/IDBR

Fig. 2.1: Share of employment in VAT and/or PAYE registered enterprises by enterprise size, home nation and English region (2013) – UK



Source: ONS/IDBR

Manufacturing enterprises comprise a fifth (21.6%) of all engineering enterprises, yet are responsible for over two fifths (43.8%) of all employment (Table 2.6). Nearly a fifth of those employed in engineering enterprises work in information and communication (18.4%) and construction (17.5%).

Mining and quarrying enterprises account for 58,000 people: 28,000 in Scotland, 26,000 in England, 2,000 in Wales and 1,000 in Northern Ireland. This is the only instance where engineering enterprises in England employ fewer workers than those in a devolved nation. In fact, for manufacturing, construction and information and communication, the largest English region employs more people than any of the devolved countries.

Table 2.6: Employment in VAT and/or PAYE registered engineering enterprises by selected industrial groups (2013) – UK

Home nation/ English region	Overall	Manufacturing	Mining and quarrying	Construction	Information and communication	All other industrial groups
North East	167,000	88,000	2,000	32,000	12,000	33,000
North West	493,000	270,000	1,000	86,000	46,000	88,000
Yorkshire and The Humber	404,000	233,000	2,000	75,000	34,000	60,000
East Midlands	388,000	235,000	4,000	63,000	37,000	49,000
West Midlands	500,000	279,000	1,000	90,000	39,000	90,000
East	607,000	235,000	1,000	113,000	163,000	95,000
London	704,000	167,000	8,000	114,000	269,000	146,000
South East	960,000	339,000	4,000	152,000	269,000	197,000
South West	477,000	194,000	3,000	80,000	61,000	140,000
England	4,700,000	2,040,000	26,000	806,000	930,000	898,000
Wales	201,000	118,000	2,000	37,000	14,000	31,000
Scotland	409,000	160,000	28,000	75,000	42,000	103,000
Northern Ireland	120,000	62,000	1,000	31,000	13,000	13,000
UK total	5,431,000	2,381,000	58,000	949,000	998,000	1,045,000
Share of total UK engineering enterprises turnover		43.8%	1.1%	17.5%	18.4%	19.2%

Source: ONS/IDBR

2.3 Turnover of engineering enterprises in the UK

Table 2.7 shows that in the year ending March 2013 UK engineering enterprises turned over £1.17 trillion – 6.7% more than the previous year.[194] It should also be noted that turnover is 9.0% higher than it was in the year ending March 2009.

Nationally over five years, the highest growth in turnover was in Scotland, up a fifth (20.3%). However, in the last year Scotland's turnover rose by just 0.1%. Wales had the reverse picture, with strong growth of 4.0% in the last year, but a disappointing 0.7% over five years. Northern Ireland declined by 7.9% over five years and 0.7% in the last year. Only England had strong growth over one year and five years (7.7% and 8.5% respectively).

Every region in England experienced growth in the last year too, although not all regions grew over the five year period. London had the highest growth in turnover, up a fifth over five years (19.3%) and 11.2% in the last year. In the last year, strongest growth was in the West Midlands (13.2%), although this was still 0.5% below the level registered in 2009.

Turnover in the North East fell by a quarter (24.6%) over five years, making it the region with the largest decline. However, it did grow by 4.0% in the last year.

Table 2.8 shows the turnover of engineering regions in each nation and region of the UK as a proportion of the turnover of all enterprises. It shows that overall engineering enterprises produce a quarter (24.9%) of the turnover of all enterprises. This is a slight increase on 2012's figure of 24.5%.[195]

Nationally, engineering enterprises in England had the lowest turnover as a proportion of all turnover, at just under a quarter (24.0%). By comparison, engineering turnover accounted for 29.0% of all turnover in Northern Ireland, 30.4% in Scotland and 42.2% in Wales.

Of the English regions, London has the highest absolute turnover for engineering enterprises at £237,333 million. However, it has the lowest percentage as a proportion of all enterprises (13.2%). The South East has the second highest turnover for engineering enterprises (£235,763 million) and it also has the highest turnover as a proportion of all enterprises (40.3%).

194 The IDBR dataset is not the official source of statistics on turnover and these figures are indicative. The official statistics on turnover are the Annual Business Survey. **195** *Engineering UK 2014 The state of engineering*, EngineeringUK, December 2013, p19

Table 2.7: Turnover (millions) in VAT and/or PAYE registered engineering enterprises (2009-2013) – UK

Home nation/ English region	Turnover (millions) 2009	Turnover (millions) 2010	Turnover (millions) 2011	Turnover (millions) 2012	Turnover (millions) 2013	Change over one year	Change over five years
North East	38,171	35,807	27,065	27,694	28,790	4.0%	-24.6%
North West	82,209	85,323	77,817	81,790	89,851	9.9%	9.3%
Yorkshire and The Humber	64,580	62,709	56,371	60,684	62,974	3.8%	-2.5%
East Midlands	60,270	62,046	58,742	59,817	62,315	4.2%	3.4%
West Midlands	93,612	82,572	77,024	82,262	93,161	13.2%	-0.5%
East	109,521	117,366	109,177	115,142	122,467	6.4%	11.8%
London	198,958	232,880	207,274	213,518	237,333	11.2%	19.3%
South East	211,568	237,578	230,367	223,813	235,763	5.3%	11.4%
South West	65,936	69,162	67,289	66,811	70,427	5.4%	6.8%
England	924,826	985,443	911,125	931,530	1,003,080	7.7%	8.5%
Wales	35,082	35,412	32,139	33,997	35,344	4.0%	0.7%
Scotland	94,329	107,388	98,805	113,339	113,503	0.1%	20.3%
Northern Ireland	19,357	19,377	18,082	17,939	17,819	-0.7%	-7.9%
UK total	1,073,594	1,147,619	1,060,151	1,096,806	1,169,747	6.7%	9.0%

Source: ONS/IDBR

Table 2.8: Turnover (millions) in VAT and/or PAYE registered engineering enterprises as a proportion of turnover in all enterprises (2013) – UK

Home nation/ English region	Engineering enterprises (turnover millions)	All enterprises (turnover millions)	Proportion of enterprises that are engineering enterprises
North East	28,790	99,059	29.1%
North West	89,851	296,746	30.3%
Yorkshire and The Humber	62,974	317,083	19.9%
East Midlands	62,315	219,911	28.3%
West Midlands	93,161	256,347	36.3%
East	122,467	364,960	33.6%
London	237,333	1,792,944	13.2%
South East	235,763	585,075	40.3%
South West	70,427	254,159	27.7%
England	1,003,080	4,186,283	24.0%
Wales	35,344	83,715	42.2%
Scotland	113,503	373,740	30.4%
Northern Ireland	17,819	61,368	29.0%
UK total	1,169,747	4,705,106	24.9%

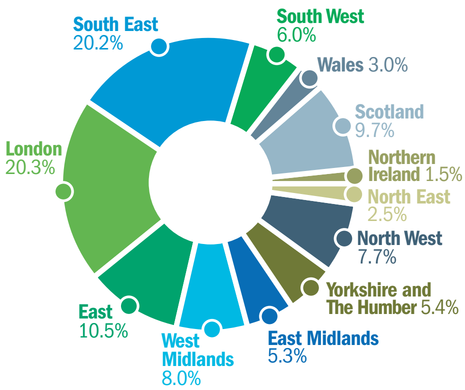
Source: ONS/IDBR

Figure 2.3 shows that a fifth of the entire turnover for engineering enterprises comes from those based in London (20.3%), with a further fifth from enterprises in the South East (20.2%). The English region which generates the lowest proportion of turnover is the North East, at 2.5%.

Although Table 2.8 shows us that engineering enterprises in Wales generate 42.2% of the turnover all Welsh enterprises, they generate only 3.0% of the turnover of all engineering enterprises. Engineering enterprises in Northern Ireland generate 1.5% of the turnover of all engineering enterprises, while those in Scotland generate 9.7%.

According to the Annual Business Survey,[196] the retail sector[197] had a turnover of £348,825 million in 2012 and employed 3.1 million workers. This means that the turnover of the retail sector is less than a third (30%) of the engineering sector while employing 56% of the workforce employed by engineering enterprises.

Fig. 2.3: Share of turnover of VAT and/or PAYE registered engineering enterprises by home nation and English region (2013)



Source: ONS/IDBR

196 Data from the Annual Business Survey can be accessed at http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-323688 **197** The retail sector has been defined as Sector 47 retail trade, except of motor vehicles and motorcycles

Table 2.9 shows that nearly half (45.5%) of the turnover from all engineering enterprises comes from manufacturing. Although engineering enterprises in mining and quarrying only represent 0.2% of all engineering enterprises (Table 2.3) and employ 1.1% of people working (Table 2.6), they generate 7.5% of the turnover. By comparison, engineering enterprises in construction and information and communication generate a lower percentage of turnover than their share of employment. Construction generated 12.4% of turnover and information and communication generated 15.1%. However, their share of employment was 17.5% and 18.4% respectively.

Table 2.9: Turnover (millions) in VAT and/or PAYE registered engineering enterprises by selected industrial groups (2013) – UK

Home nation/ English region	Overall (millions)	Manufacturing (millions)	Mining and quarrying (millions)	Construction (millions)	Information and communication (millions)	All other industrial groups (millions)
North East	28,790	17,581	619	4,062	1,077	5,450
North West	89,851	54,948	311	10,185	6,629	17,779
Yorkshire and The Humber	62,974	36,124	367	11,663	3,643	11,178
East Midlands	62,315	41,157	843	10,764	3,708	5,843
West Midlands	93,161	54,248	384	13,661	4,851	20,017
East	122,467	63,770	91	20,498	25,004	13,103
London	237,333	68,457	60,985	22,275	52,747	32,869
South East	235,763	94,204	3,164	25,853	60,202	52,339
South West	70,427	33,163	346	8,891	12,531	15,496
England	1,003,080	463,650	67,109	127,853	170,392	174,075
Wales	35,344	25,000	250	4,026	1,781	4,288
Scotland	113,503	34,331	19,881	9,032	2,902	47,358
Northern Ireland	17,819	9,077	146	4,568	1,178	2,850
UK total	**1,169,747**	**532,059**	**87,386**	**145,479**	**176,254**	**228,569**
Share of total UK engineering enterprises turnover		45.5%	7.5%	12.4%	15.1%	19.5%

Source: ONS/IDBR

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

"Promoting new sources of growth has become a global policy priority. Science, technology, innovation and entrepreneurship – which foster competitiveness, productivity, and job creation – are important mechanisms for encouraging sustainable growth."[198]

The UK punches above its weight as a research nation:[199] while it represents just 0.9% of global population, 3.2% of R&D expenditure, and 4.1% of researchers, it accounts for:

- 9.5% of downloads
- 11.6% of citations and 15.9% of the world's most highly-cited articles
- 30 of the top 200 universities in the world
- 85 Nobel prizes

Amongst its comparator countries, the UK has overtaken the US to rank first by field-weighted citation impact (an indicator of research quality). Moreover, with just 2.4% of global patent applications, the UK's share of citations from patents (both applications and granted) to journal articles is 10.9%.

3.1 Importance of research and innovation

As well as its economic impact, innovation plays a critical role in addressing society's future challenges. The world's population is projected to rise from approximately seven billion now to nine billion by 2050.[200] The age structure of the UK's population is changing as people live longer, there are challenging and legally-binding carbon reduction targets to meet, and food supply is always an issue. These are all threats that the UK is well placed to change into opportunities by applying new scientific knowledge and emerging technologies. This includes the Eight Great Technologies,[201, 202] fields where the UK has the depth of research expertise and the business capability to develop a range of applications, potentially putting us at the forefront of commercialisation which has received investment of £600 million.

The UK is also working to maximise opportunities for UK companies and organisations to access EU funding for research and innovation, focusing on the forthcoming Horizon 2020 programme[203] for 2014 to 2020. With a budget of over €70 billion, Horizon 2020[204] aims to raise the level of excellence in Europe's science base and ensure a steady stream of world class research to secure Europe's long-term competitiveness. It also aims to make Europe a more attractive location to invest in research and development. Through both of these activities, there will be a focus on emerging and enabling technologies, such as information and communication technologies, and developing European e-infrastructure, which will support growing data capability.

This EU funding is important as currently the UK benefits directly from £1.2 billion annually in European research funding. It is the largest beneficiary of EU research funds to universities, receiving nearly a quarter of all European Research Council funding during the course of fp7, the seventh framework programme for research and technological development.[205]

198 OECD Science, Technology and Industry Scoreboard 2013, p13 **199** 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, p2 **200** Department for Business, Skills and Innovation (2001), *The Future of Food and Farming: Challenges and Choices for Global Sustainability*, Foresight Final Project Report Government Office for Science, Accessed at: http://www.bis.gov.uk/assets/foresight/docs/food-and-farming/11-546-future-of-food-and-farming-report.pdf **201** Willets. D (2013), Eight Great Technologies, Policy Exchange, Accessed at: http://www.policyexchange.org.uk/images/publications/eight%20great%20technologies.pdf **202** Descriptions of the Eight Great Technologies at *Engineering UK 2014 The state of engineering*, EngineeringUK, December 2013, p28 **203** European Commission, Research and innovation, Horizon 2020 http://ec.europa.eu/programmes/horizon2020/en/ **204** https://www.h2020uk.org/ **205** *Agenda 2030: One Nation Labour's Plan for Science*, Green Paper, June 2014, p15

If a similar performance is maintained, UK universities, research centres and businesses could expect to receive £2 billion in the first two years of Horizon 2020. Such an allocation would equate to just over a fifth of the total British Government spend on science (Table 3.0).

This long history of attracting R&D finance from overseas is also converting into Foreign Direct Investment (FDI). In 2012 we performed particularly well, with nearly 300 UKTI-involved FDI projects linked to R&D – an increase of 84% from the previous year.[206]

3.2 UK Government interventions

At a time of tight control over public spending, the Government continues to offer strong support for science and research. Recognising that world class research plays a key role in economic growth and the continued improvement to health and wellbeing of society, the Government continues to protect the cash ring-fenced for science for the financial year 2015/16. In addition, the Chancellor has previously announced a long term commitment to an investment in science infrastructure of £1.1 billion in real terms to 2021, as well as increasing funding for Quantum Technologies and collaboration with emerging powers. This brings the overall investment in science and research to £5.8 billion in 2015/16 – an increase on recent years.[207]

For information, Table 3.0 shows an abbreviated historic 11-year trend for UK Government spending on science, engineering and technology.[208] The latest figures, from 2012, show that this was running at around £10 billion per annum.

The Department for Business, Innovation and Skills (BIS) describes the UK innovation system as a range of interacting elements delivered by different institutions, firms and individuals working in collaboration. It encompasses:[209]

- **The innovation infrastructure:** the institutions supporting the development and management of intellectual property, standards, measurement, accreditation and design, including the Intellectual Property Office, Design Council, the National Measurement System and the British Standards Institution (BSI).
- **The knowledge base:** a range of organisations providing education, training and research, including Higher Education Institutions (HEIs) and Public Sector Research Establishments (PSREs).
- **The business community:** those engaged in innovation across the economy and bodies supporting them in commercialising innovation. These include the Technology Strategy Board (TSB) – the UK's innovation agency, with the remit to accelerate economic growth by stimulating and supporting business-led innovation – and the intermediate sector organisations such as Research and Technology Organisations (RTOs). The UK also provides an attractive tax environment for companies carrying out R&D.

Finally at the time of publishing, the Government's new Science and Innovation Strategy[210] is still awaited. However, the input from the UK 'academies'[211] provides a useful insight as to fundamental components of the new strategy.

Table 3.0: UK Government net expenditure on science, engineering and technology (SET) by department: (2001-2012)

Current prices												£ million
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Research Councils												
TOTAL	**1,707**	**1,947**	**2,259**	**2,408**	**2,871**	**3,014**	**2,742**	**3,024**	**3,196**	**3,280**	**3,286**	**3,201**
Higher Education Funding Councils (HEFCs):												
TOTAL	**1,474**	**1,626**	**1,665**	**1,804**	**1,928**	**2,085**	**2,252**	**2,247**	**2,403**	**2,328**[r]	**2,285**[r]	**2,212**
Civil Departments												
TOTAL	**1,776**	**2,043**	**2,140**	**1,866**	**1,965**	**1,918**	**1,896**	**2,073**	**2,236**	**2,261**[r]	**2,352**[r]	**2,392**
Ministry of Defence (MoD) of which:												
	557	516	524	639	598	632	635	584	575	532	553	565
	1,500	2,218	1,609	1,552	1,645	1,492	1,505	1,406	117	1,159	953	895
TOTAL	**2,057**	**2,734**	**2,133**	**2,191**	**2,243**	**2,124**	**2,139**	**1,991**	**1,752**	**1,693**	**1,306**	**1,460**
TOTAL SET	**7,014**	**8,351**	**8,196**	**8,270**	**9,008**	**9,141**	**2,029**	**9,334**	**9,586**	**9,461**[r]	**9,228**[r]	**9,226**
Indicative UK contributions to EU R&D expenditure	391	440	390	325	365	374	374	593	668	647	661[r]	718
GRAND TOTAL	**7,404**	**8,791**	**8,586**	**8,595**	**9,373**	**9,515**	**9,403**	**9,927**	**255**	**10,108**[r]	**9,889**[r]	**9,984**

Source: Office for National Statistics

r = revised data

206 *Innovation Report 2014, Innovation, Research and Growth*, Department for Business Innovation and Skills, March 2014, p9 207 *Science and research budget allocations for financial year 15/16*, Department for Business Innovation and Skills, February 2014 208 UK Government Expenditure on Science, Engineering and Technology, 2012, Published on 11 July 2014 209 *Innovation Report 2014, Innovation, Research and Growth*, Department for Business, Innovation and Skills, March 2014, p8 210 https://bisgovuk.citizenspace.com/digital/science-and-innovation-strategy-2014 211 The Academy of Medical Sciences, the British Academy, the Royal Academy of Engineering and the Royal Society

The academies support the Government's efforts to develop a strategy to shape the future of UK research up to 2020 and beyond, and recommend that the strategy should:[212]

- Provide a flexible long-term framework that enables the UK to collaborate and compete internationally by supporting a broad research base across all disciplines. This should sit at the heart of Government's industrial strategy and plans for growth.
- Be broad in scope to encompass the UK's richly diverse and integrated research and innovation system, including Government, industry, charities and other organisations nationally and internationally.
- Place excellence at the heart of decision making about research investment.
- Be ambitious in its vision and deliver effective results.

3.2.1 UK funding examples

"An investment in knowledge pays the best interest."

Benjamin Franklin

As we find every year, trying to capture the full extent of Government announcements on research and innovation is like trying to capture lightning in a bottle and then show it to the world.

The BIS *Innovation Report 2014*[213] therefore provides a welcome source for providing a selected top level indication of support and funding in pursuit of the Government's growth commitments. On **science and innovation**, it reports the following:

- Since 2010, Research Councils have invested £1.69 billion in research capital.
- Over this Parliament, Government has invested £21.5 billion in science, including over £600 million in the Eight Great Technologies,[214] fields where the UK has the depth of research expertise and business capability to develop a range of applications, and the potential to be at the forefront of commercialisation.
- There is a commitment to develop a network of research centres in quantum technologies, with a £270 million investment over five years to improve high-level skills and to reinforce the UK's position as a global leader in this cutting-edge field of research.
- Over £1 billion of public and private investment has been made in 22 research infrastructure projects through the Research Partnership Investment Fund.[215]
- Seven Catapult centres[216] are being funded, providing access to the specialist capability and expertise required to transform innovative ideas and technologies rapidly into commercial products and processes. These are High Value Manufacturing, Cell Therapy, Off-shore Renewable Energy, Satellite Applications, Connected Digital Economy, Future Cities and Transport System. A further two Catapults in Energy Systems and Precision Medicine are under development and due to open in 2015.
- In 2013 the Government announced that £185 million will be provided to the Higher Education Funding Council for England (HEFCE) over four years to support the additional expense of teaching high-cost subjects such as **science and engineering**. In addition, £200 million of capital investment will be made in 2015/16 to fund such high-cost subjects. This capital funding will be matched by equal investment from institutions, meaning some £400 million[217] will be invested in the creation and upgrading of teaching facilities to ensure students receive a high quality experience that fully equips them for the economy of the future.

That said, the **March 2014 Budget**, recognising that science and innovation are key drivers of long-term economic growth, stated that "the Government will continue its drive to help commercialise research and ensure the UK economy benefits from its world leading science base." It included the following announcements:[218]

- Government will provide £42 million funding over five years for the Alan Turing Institute. This national institute will undertake new research in ways of collecting, organising and analysing large sets of data (big data). Big Data[219] analysis can allow businesses to enhance their manufacturing processes, target their marketing better, and provide more efficient services.
- Government will invest £74 million over five years in a Cell Therapy manufacturing centre and a graphene innovation centre as part of the UK's Catapult network. These will enable large-scale manufacturing of cell therapies for late-stage clinical trials and will provide SMEs with access to cutting-edge equipment for research and development of novel graphene products.
- It will provide £106 million funding over five years for around 20 additional Centres for Doctoral Training – partnerships between universities, businesses and Government to research new technologies and train postgraduate students.
- The Government recently announced a new five-year £375 million Newton Fund[220] for programmes that will focus on supporting the development of 15 emerging economies.[221]
- The Government has recognised the value of educational exports and has published a strategy to increase these exports.[222] BIS is promoting growth in the international education sector and estimates that numbers of international students in HE can grow by 15-20% in the next five years.[223] Education UK will support the education sector by focusing on high value overseas opportunities. The unit aims to generate contracts worth £1 billion by 2015 and £3 billion by 2020.[224] To support the important role that Higher Education plays in economic development and to strengthen the UK's strategic partnerships with emerging markets, the Government will triple the number of Chevening Scholarships from 2015-16. It will also expand the 'Education is GREAT' campaign to help attract more international students to the UK, and build on its reputation as a world-leading place to study.[225]

Science Industrial Partnerships (SIP)

A new scheme worthy of mention is the SIP.[226] This clearly highlights the growing trend for Government to secure, over the long term, sustainable employer ownership (resources) across education and skills, particularly within the STEM sphere.

This £52 million investment in new and emerging science talent will create more than 7,800 education and skills opportunities over a two-year period. Funding will be delivered through the SIP, which will be made up of a consortium of around 100 leading science sector employers. The consortium will be led by GlaxoSmithKline, which will design the vocational training and skills programmes that the life sciences, chemicals and industrial science sectors need to thrive and compete in the global economy. The SIP will deliver:

- 1,360 apprenticeships: based on a new, simple employer-owned system delivering work-ready apprentices
- 240 Traineeships: a new work experience programme for young people pursuing science-based careers
- 150 Industry Degrees: a radical new approach to graduate development, focused on employer skills needs and graduate employability
- 230 Modular Masters Modules: a new modular route to deliver high-tech post-graduate skills in the workplace

212 https://royalsociety.org/policy/publications/2014/submission-on-science-innovation-strategy/ **213** *Innovation Report 2014, Innovation, Research and Growth*, Department for Business Innovation and Skills, March 2014, p32 **214** Descriptions of the Eight Great Technologies at Engineering UK 2014 The state of engineering, EngineeringUK, December 2013, p28 **215** http://www.hefce.ac.uk/whatwedo/rsrch/howfundr/ukrpif/ **216** https://www.catapult.org.uk/ **217** *Innovation Report 2014, Innovation, Research and Growth*, Department for Business Innovation and Skills, March 2014, p28 **218** *Budget 2014*, HM Treasury, p38 **219** See Section 1.3.1 for further details on Big Data **220** https://www.gov.uk/government/news/375m-fund-to-promote-development-though-science-and-innovation-announced **221** China, India, Brazil, Turkey, South Africa, Colombia, Chile, Mexico, Eqypt, Kazakhstan, Indonesia, Malaysia, Vietnam, Thailand, Philippines. **222** The strategy can be accessed at https://www.gov.uk/government/news/new-push-to-grow-uks-175-billion-education-exports-industry **223** *Britain wants you – why the UK should commit to increasing International Students Numbers*, Institute of Public Policy Research, November 2013, p2 **224** *Industrial Strategy: government and industry in partnership*, HM Government, July 2013, p11 **225** *Budget 2014*, HM Treasury, p37 **226** https://www.gov.uk/government/news/52-million-boost-for-skills-and-training-in-uk-science-sectors 8 July 2014

- 5,900 workforce development opportunities: increasing technical and management capability of the workforce
- STEM careers: a cross-sectorial proposal to attract young people into STEM jobs

Finally, to give some material examples of what Government funding is intending to achieve, we list below a selection of developments announced by Research Councils UK. These exemplify areas where the UK is breaking new ground and leading the world:[227]

- **Advanced manufacturing:** the world's first flexible imaging sensor has been unveiled, with the potential for application in smart packaging, biomedical diagnostics, and surface scanners
- **Advanced manufacturing:** tiny LED lights with Wi-Fi-like internet communication capability have been developed to deliver information into a range of domestic, commercial and public spaces
- **Regenerative medicine:** scientists have bioengineered the first tooth produced from human gum cells, offering hope that missing teeth may one day be replaced using a person's own gum cells
- **Regenerative medicine:** a degradable polymer that can be inserted into broken bones to encourage real bone to regrow is being developed by scientists using a pioneering technique called 'solvent blending'
- **Satellites and space:** a software tool, based on software for the European Space Agency's Envisat satellite, was used to create a program that analyses human brain scans and a simple method for wide-scale screening for Alzheimer's disease.

3.2.2 Local Enterprise Partnerships (LEPs) and innovation

LEPs are now worthy of a sub-section in their own right. They are the key players in steering support for innovation at the local level (as well as focusing on education and skills and those Not in Education, Employment or Training – see Section 6.3), and their role is growing.[228] In 2013, BIS announced notional allocations to each LEP from the £5.3 billion European Structural and Investment Funds (ESIF) for the period 2014-2020. At least £660 million will be directed towards supporting innovation.

Currently, BIS is working with LEPs to improve the effectiveness of local innovation systems through Growth Hubs and local strategies.[229] This is being reinforced by the implementation of the key recommendations from the Witty Review,[230] (which called for an even closer relationship between universities and LEPs that will drive growth, with a focus on the genuinely competitive strengths of our local economies), on the role of universities in driving growth and on the EU Smart Specialisation approach to identifying areas of comparative advantage.

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. At the time of writing, LEPs were in the process of finalising their Strategic Economic Plans with Government. These will be the basis on which they will negotiate a "Growth Deal," providing them with the opportunity to compete for Local Growth Funds.

Finally, LEPs are also developing activities that will target those innovative SMEs that have growth potential,[231] and are simplifying access to support through establishing Growth Hubs. They are in discussions with the Growth Accelerator programme, the Manufacturing Advisory Service and the UKTI export service with the aim of increasing the number of SMEs receiving support and increasing the intensity of this support. LEPs are also engaging with TSB on how they might work together on this agenda, to enable more world class innovation to be commercialised.

3.3 Research on the world stage

It was evident from last year's report[232] and the public statements on research and innovation from heads of state or ministers of science that the genie is out of the bottle. Many nations have not only identified the value of a strong science, engineering and innovation base for economic growth but have developed, funded and instigated plans intended to place them at a global competitive advantage. The race is on.

3.3.1 UK

A key indicator of a country's appetite and commitment to long term investment is its Gross Domestic Expenditure on Research and Development (GERD) or its GERD as percentage of Gross Domestic Product (GDP). The latter is also known as R&D intensity and is a relative indicator of national investment in the research base.

Table 3.1 presents the 2012 (latest available) estimates as a means of placing the UK into an international context with regards to GERD as a percentage of GDP.[233] It shows the individual EU-28 countries' GERD as a percentage of GDP, as well as the average for the EU-28 compared with the Europe 2020 target of 3%. The UK's GERD represented 1.72% of GDP in 2012, the joint 12th highest percentage. This indicates that we risk falling behind the competition even though we do still punch above our weight when it comes to research and innovation output.[234]

Table 3.1: GERD as a percentage of GDP (R&D intensity) (2012) – EU countries

Rank	Country	GERD as a percentage of GDP
1	Finland	3.55%
2	Sweden	3.41%
3	Denmark	2.99%
4	Germany	2.92%
5	Austria	2.84%
6	Slovenia	2.80%
7	France	2.26%
8	Belgium	2.24%
9	Estonia	2.18%
10	Netherlands[235]	2.16%
–	**EU (28 countries)**	**2.06%**
11	Czech Republic	1.88%
12	**United Kingdom**	**1.72%**
12	Ireland	1.72%
14	Luxembourg	1.51%
15	Portugal	1.50%
16	Spain	1.30%
17	Hungary	1.30%
18	Italy	1.27%
19	Poland	0.90%
20	Lithuania	0.90%
21	Malta	0.84%
22	Slovakia	0.82%
23	Croatia	0.75%
24	Greece	0.69%
25	Latvia	0.66%
26	Bulgaria	0.64%
27	Cyprus	0.47%
28	Romania	0.42%
–	**Europe 2020 target**	**3%**
–	**Europe 2002 average**	**1.87%**

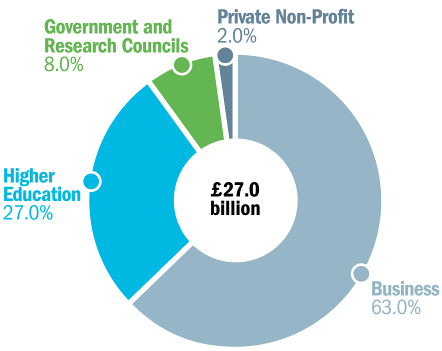
Source: Eurostat

227 Research Councils UK (2013), *Timelines of Research.* http://www.rcuk.ac.uk/research/timelines/ 228 *Innovation Report 2014, Innovation, Research and Growth*, Department for Business Innovation and Skills, March 2014, p14 229 *Innovation Report 2014, Innovation, Research and Growth*, Department for Business Innovation and Skills, March 2014, p15 230 *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-british-invention-revolution-andrew-witty-review-R1.pdf 231 see Section 3.3.2.2 for more details 232 *Engineering UK 2014 The state of engineering*, EngineeringUK, December 2013, p24 233 http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2012/index.html 234 See Section 3.3.3 for further details 235 Data for 2011

Figure 3.0 portrays how the £27 billion UK GERD is broken down by the four significant contributing sectors.[236] It shows the following:

- The business sector performs the most R&D of any sector in the UK. In 2012 it accounted for £17.1 billion expenditure, representing 63% of total expenditure on R&D. This is a decrease of 2% in current prices from £17.5 billion in 2011.
- The Higher Education sector, which includes universities and Higher Education Institutes, represented 27% of total UK R&D expenditure in 2012. At £7.2 billion, this was an increase of 1% in current prices, from £7.1 billion in 2011.
- In 2012, R&D expenditure in the UK by the Government and research councils sector decreased by 8% in current prices, from £2.4 billion in 2011 to £2.2 billion in 2012. This sector accounted for 8% of total expenditure on R&D performed in the UK in 2012.
- The private non-profit sector includes registered charities and trusts. Those performing R&D in this sector specialise mainly in health and medical research. It is the smallest R&D performing sector in the UK. In 2012, it is estimated that £0.5 billion was spent by these organisations, which contributed 2% to total UK R&D expenditure.

Fig. 3.0: Composition of UK GERD by performing sector (2012)



Source: Office for National Statistics

In terms of comparisons within the EU 28 countries, other notable facts[237] from the latest Office for National Statistics (ONS) statistical bulletin relating to GERD are:

- In 2012, the UK's gross domestic expenditure on research and development (GERD) in current prices decreased by 2% to £27 billion compared with 2011. Adjusted for inflation, in constant prices, research and development (R&D) expenditure decreased by 3%.
- In constant prices, R&D expenditure has increased by 56% from the 1985 estimate of £17.3 billion. Expenditure peaked in 2011 at £27.9 billion.
- Total R&D expenditure in the UK in 2012 represented 1.72% of GDP, a decrease from 1.77% in 2011.
- International comparisons show that UK R&D expenditure in 2012 was below the EU 28 provisional estimate of 2.06% of GDP.

Finally in the absence of the R&D scoreboard it is of interest to note the global top 20 publicly-traded companies worldwide that spent the most on R&D in each of the past nine years ranked by the amount they spent on R&D[238] (Table 3.2).

Table 3.2: Top 20 world ranking by R&D spending (2013)

Rank	Company
1	Volkswagen
2	Samsung
3	Roche
4	Intel
5	Microsoft
6	Toyota
7	Novartis
8	Merck
9	Pfizer
10	Johnson & Johnson
11	General Motors
12	Google
13	Honda
14	Daimler
15	Sanofi
16	IBM
17	GlaxoSmithKline
18	Nokia
19	Panasonic
20	Sony

Source: Strategy&

3.3.1.1 The Research Excellence Framework (REF)

The Research Excellence Framework (REF) is the revised system for assessing the quality of research in UK HEIs and includes an assessment of the impact of excellent research for the first time.[239] In 2013, all 155 institutions that intended to participate in the REF successfully made their submissions by the deadline on 29 November 2013, submitting the research of 52,077 staff. The REF expert panels have begun to assess submissions, and the outcomes will be published in December 2014.

Overall, 52,077 Category A[240] full-time equivalent (FTE) staff submitted to the 2014 REF.[241] This is a similar number to the 52,401 who submitted to its predecessor, the 2008 Research Assessment Exercise. Around 10,000 staff (headcount) were submitted in the REF as early career researchers.

REF Main Panel[242] B saw the greatest increase in the numbers of FTE researchers submitted (up 9%). This panel is made up of the following subject areas:[243]

- Earth systems and environmental sciences
- Chemistry
- Physics
- Mathematical sciences
- Computer science and informatics
- Aeronautical, mechanical, chemical and manufacturing engineering
- Electrical and electronic engineering, metallurgy and materials
- Civil and construction engineering
- General engineering

Main Panel D saw the greatest falls in numbers of FTE staff submitted (down 5%). This panel is made up of the following subject areas:[244]

- Area studies
- Modern languages and linguistics
- English language and literature
- History
- Classics
- Philosophy
- Theology and religious studies
- Art and design: history, practice and theory
- Music, drama, dance and performing arts
- Communication, cultural and media studies, library and information management

236 http://www.ons.gov.uk/ons/dcp171778_355583.pdf p4 **237** http://www.ons.gov.uk/ons/dcp171778_355583.pdf **238** http://www.strategyand.pwc.com/global/home/what-we-think/global-innovation-1000/top-20-rd-spenders-2013 Strategy& (formerly Booz & Company) **239** *Innovation Report 2014, Innovation, Research and Growth*, Department for Business Innovation and Skills, March 2014, p32 **240** Category A staff are defined as academic staff with a contract of employment of 0.2 FTE or greater and on the payroll of the submitting HEI on the census date (31 October 2013), and whose primary employment function is to undertake either 'research only' or 'teaching and research' **241** *Higher Education in England 2014: Analysis of latest shifts and trends*, HEFCE, April 2014, p59 **242** The REF will be a process of expert review. Expert sub-panels for each of 36 units of assessment (UOAs) will carry out the assessment, working under the leadership and guidance of four main panels A-D. **243** *Higher Education in England 2014: Analysis of latest shifts and trends*, HEFCE, April 2014, p59 **244** ibid, p60

From the perspective of EngineeringUK and its stakeholders, the rise in science and engineering subjects areas (+9%) compared with the decline in humanities type subjects (-5%) is interesting to note.

3.3.2 International comparative performance

As previously mentioned Research and Innovation is seen by all developed and aspiring nations to be a key determinant in a nation's economic future well-being. This is particularly evident with the focus of global research continuing to shift to rising research nations such as China and Brazil who now compete on a global stage with long-standing research powerhouses such as the UK, Germany, France and the US.[245]

In addition to the usual references on UK R&D spend (Section 3.2.1), two particular areas of interest are highlighted in the following sub-sections: the supply of students, and SMEs as drivers of innovation.

3.3.2.1 Supply (students)

In the final analysis, the research and innovation success – or not – of a nation depends on its ability to grow, recruit and retain bright young people, whether home grown or from overseas.

Table 3.3 shows that the UK ranks seventh among countries by percentage of students earning first university degrees in science and engineering.[246] However, it should be noted that the UK sits within a cohort of six countries whose percentage span is 31-38%.

Degrees in science and engineering are most popular in Japan and South Korea. UK students are less likely to study science and engineering, although the proportion of graduates leaving university with science and engineering degrees has been relatively stable since 2001, while decreasing for many countries included in the sample.

Table 3.3: Percentage of students earning first university degrees in science and engineering

Rank	Country	Percentage of total first university degrees in science and engineering
1	**Japan**	61%
2	**South Korea**	41%
3	**Canada**	38%
4	**Germany**	37%
5	**Finland**	37%
6	**France**	35%
7	**United Kingdom**	**34%**
8	**United States**	31%
9	**Australia**	27%

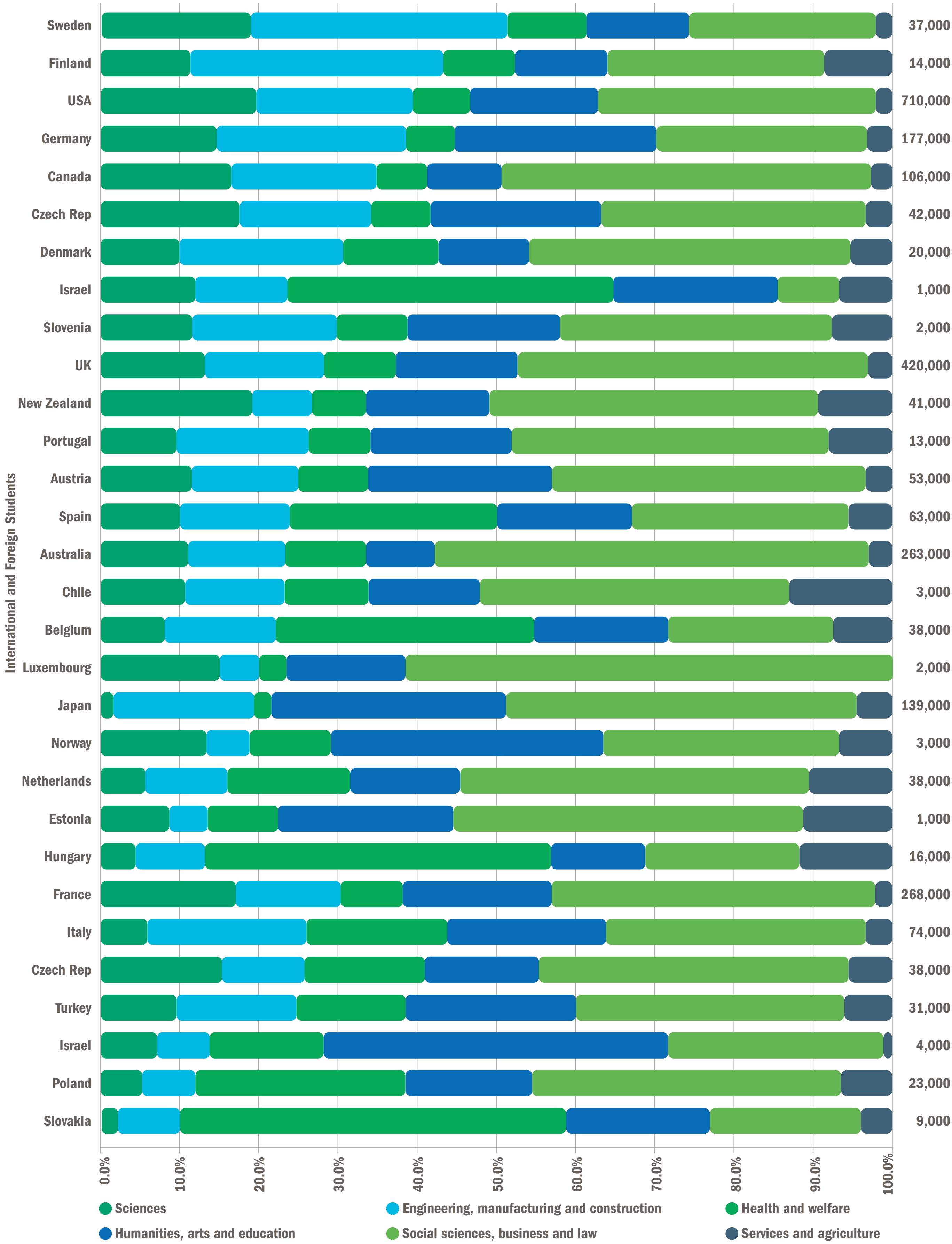
Source: IMD (2013) World Competitiveness Yearbook

In addition to home grown students, students moving abroad to study are also an important source of knowledge flows between countries.[247] High-quality tertiary education[248] attracts skilled individuals in search of training and career opportunities, some of whom later return to their home countries. The United States is the main recipient of international students, followed by the United Kingdom, Australia, France and Germany (Figure 3.1).[249] The distribution of international students by subject reveals key strengths in a country's knowledge base. Science and engineering attract a sizeable share – around 38% to 50% of international students – particularly in Sweden, Finland, the United States and Germany. The UK only accounts for 28%. In most OECD countries, the share of international students in this field exceeds that of domestic students.

It must, however, be noted that the current furore around reducing UK immigration numbers risks damaging the esteemed international standing of the UK.[250]

245 *International Comparative Performance of the UK Research Base – 2013*, A report prepared by Elsevier for the UK's Department for Business, Innovation and Skills, November 2013, p2 **246** *Insights from international benchmarking of the UK science and innovation system*, A report by Tera Allas, Department for Business, Innovation and Skills Analysis Paper Number 03, Annexes, January 2014, p51 **247** *OECD Science, Technology and Industry Scoreboard 2013, OECD, 2013*, p130 **248** Tertiary education comprises Levels 5 and 6 of the ISCED classification. **249** OECD Indicators, OECD Publishing. 1 2 http://dx.doi.org/10.1787/888932891454 **250** See Section 1.1.7 for more details

Fig. 3.1: International and foreign students enrolled in tertiary education, totals and breakdown by field of education (2011)



Source: OECD calculations based on OECD (2013), Education at a Glance

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3.3.2.2 SMEs (small and medium enterprises) as drivers of innovation

Traditionally, R&D/Innovation has been synonymous with multi-nationals. However, more recently the spotlight has focused upon SMEs.[251]

It has been accepted that the sophistication and complexity of various fields of science and knowledge, and collaboration with Higher Education or public research institutions could be an important source of knowledge transfer. This aspect has now been measured using the proportion of innovative SMEs that collaborate with Higher Education or public research institutions.

It was found that the extent of collaboration[252] varied a lot across the countries included in the sample (Table 3.4). Finland had the highest proportion of SMEs collaborating with Higher Education/public research institutions, substantially ahead of all other comparator economies. The UK came ranked in the middle (fourth of seven).

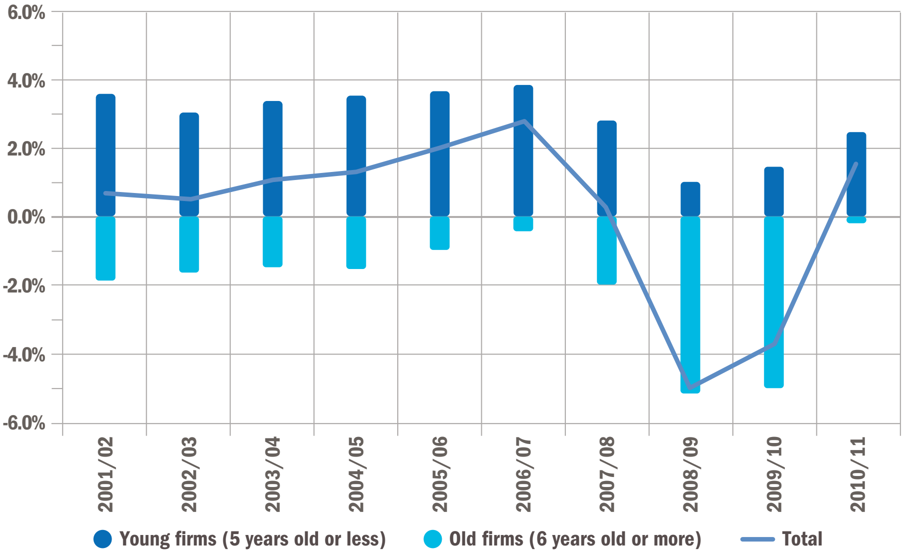
Table 3.4: SME collaboration with Higher Education Institutions

Country	Rank
Finland	1
Japan	2
South Korea	3
United Kingdom	**4**
Germany	5
France	6
Australia	7

Source: OECD (2013) Science, Technology and Industry Scoreboard

This is all well and good. However, the tangible outcomes of SME collaboration can be seen in Figure 3.2[253] which shows the net job growth of younger vs older firms over the period 2001 to 2011. This new evidence from 15 OECD countries shows that young businesses play a crucial role in employment creation. During the financial crisis, the majority of jobs destroyed in most countries reflected the downsizing of old businesses, while net job growth in young firms (usually SMEs) remained positive.[254]

Fig. 3.2: Net job growth, younger versus older firms, average over 15 countries (2001/02-2010/11)



Source: OECD calculations based on the OECD DYNEMP data collection, July 2013

251 *Insights from international benchmarking of the UK science and innovation system*, A report by Tera Allas, BIS Analysis Paper Number 03, Annexes, January 2014, p82 **252** Collaboration involves "active participation in joint innovation projects with other organisations" but excludes pure contracting out of innovation-related work. **253** http://dx.doi.org/10.1787/888932889383 **254** OECD Science, Technology and Industry Scoreboard 2013, p20

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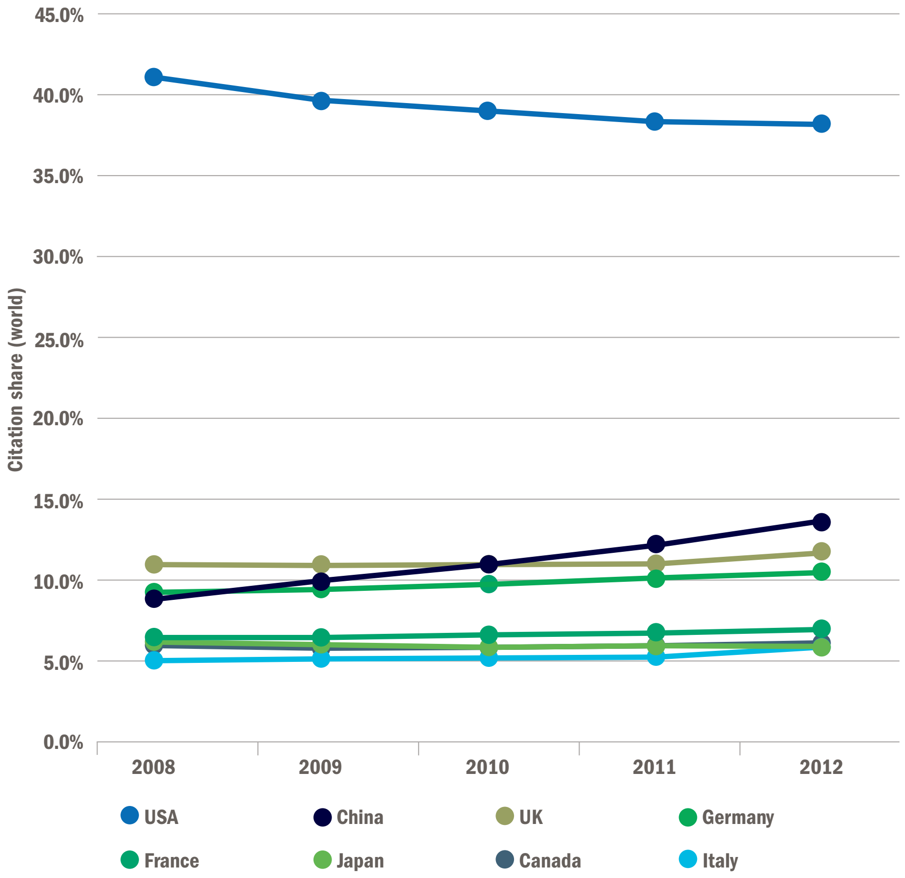
3.3.3 International citations – UK and comparator countries

The most recent *International Comparative Performance of the UK Research Base* report[255] shows that, despite the UK having far fewer researchers than larger countries such as the US and China, as a country it is far more efficient in terms of output per researcher. To exemplify this we have abstracted four charts related to citations. The rationale behind using citations is that it is widely accepted that *the number of citations of an article is a measure of its quality and the significance of the work.*[256]

Figures 3.2 to 3.5 show that for:

- the world share of citations, the UK ranks third in the G8 and is first in the EU 27 (Figure 3.3)[257]
- the world share of citations for UK **engineering**, the UK ranks third in the G8 and second in EU 27 (Figure 3.4)[258]
- the number of citations per billion dollars GDP, the UK ranks first in the G8, showing excellent value for money (Figure 3.5)[259]
- 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 (Figure 3.6)[260]

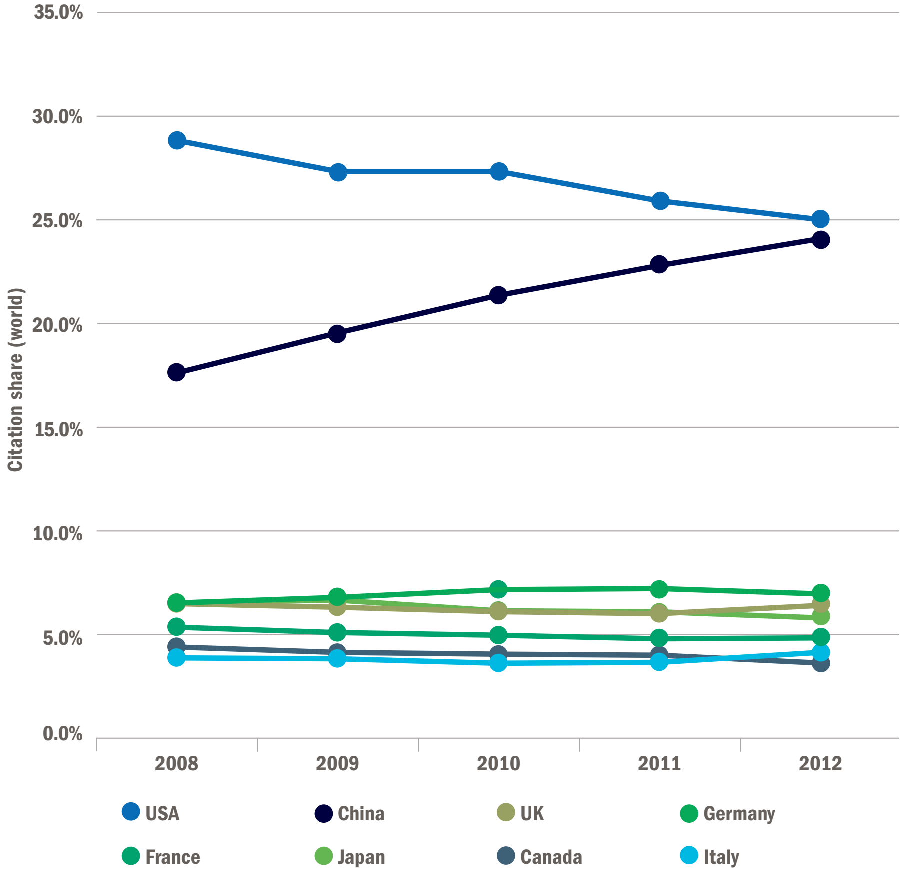
Fig. 3.3: Citation share – world



Source: Scopus

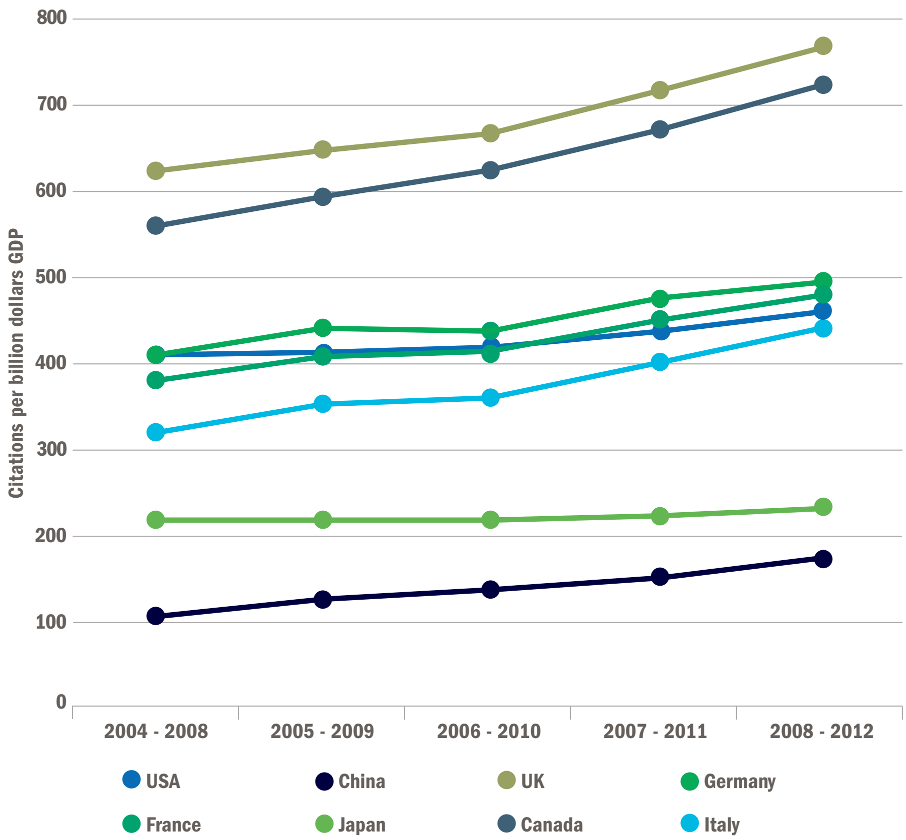
255 *International Comparative Performance of the UK Research Base – 2013* **256** *Insights from international benchmarking of the UK science and innovation system*, A report by Tera Allas, BIS Analysis Paper Number 03, Annexes, January 2014, p64 **257** *International Comparative Performance of the 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 **258** ibid, p62 **259** ibid, p105 **260** ibid, p109

Fig. 3.4: Citation share (Engineering) – world



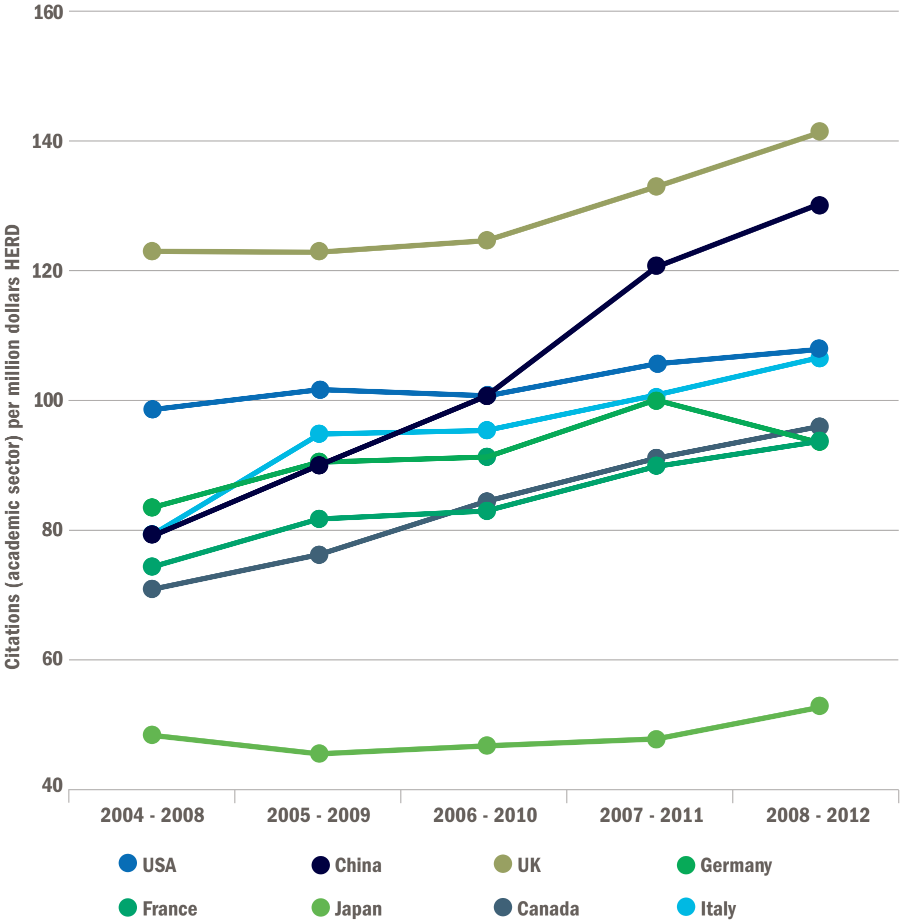
Source: Scopus

Fig. 3.5: Citations per billion dollars GDP – UK and comparator countries



Source: Scopus

Fig. 3.6: Citations (academic sector) per million dollars HERD – UK and comparator countries



Source: Scopus

Part 1 – Engineering in Context
4.0 Population changes

There will be some significant population challenges in the UK going forward which will affect the pool of GCSE level pupils and the pool available for progressing into the Higher Education. The number of 14-year-olds is set to fluctuate significantly, falling by 7.3% between 2012 and 2017 before jumping by 15.9% five years later. There will also be a drop in the number of 18-year-olds, which will decrease by 8.9% between 2012 and 2022. To further compound the population issue, if we assume that currently people start work at 18 and stay in employment until 65 then the average number of years of employment the average person in the UK has is 24 years. This points to the fact that, over the next 24 years, half of the current working population will retire.

In addition, this chapter shows there will be some significant population challenges in the years to come. Between 2012 and 2022, 8,983,084 people will turn 21 and could enter the workforce. But in Section 15.3 we show that over the same period there will be 14.4 million job openings, representing a significant challenge for employers and the Government.

4.1 Population size

Table 4.0 shows that population variations are due to have a significant effect on the numbers of young people at each of the key points in education. The number of 18-year-olds is set to drop from 802,033 in 2012 to 755,736 in 2017 and 730,822 in 2022, an 8.9% fall in just 10 years (although this will recover to 809,416 by 2027). This means that the number of young people available to progress into higher or vocational education will be limited.

The number of 14-year-olds is set for a similar drop, from 748,443 in 2012 to 694,005 in 2017 (-7.3%) before jumping dramatically to 804,279 in 2022 – an increase of 15.9% in just five years.

Table 4.1 also reveals that the number of 21-year-olds is set to vary significantly, dropping from 875,604 in 2012 to 817,671 in 2017 and 749,481 in 2022. This is a drop of 14.4% in 10 years. It also shows that in the same period, 8,983,084 will turn 21 in the UK. However, in Section 15.3 we show that over the same 10 year period there will be 14.4 million job openings. This therefore raises some key questions about whether there will be enough people entering the jobs market to fill the job openings that will appear.

Table 4.0: Population projections by ages 14, 16, 18, 21 (2012-2037)[261] – UK

	Years					
	Overall					
Age	**2012**	**2017**	**2022**	**2027**	**2032**	**2037**
14	748,443	694,005	804,279	811,925	826,027	814,200
16	769,344	705,090	765,255	824,562	826,736	823,261
18	802,033	755,736	730,822	809,416	827,643	831,533
21	875,604	817,671	749,481	799,049	847,633	842,653
	Male					
14	383,373	356,108	412,067	416,361	423,660	417,736
16	396,751	360,832	392,053	423,099	424,301	422,629
18	411,313	387,706	375,138	414,863	425,045	427,149
21	446,484	420,794	382,914	409,296	435,438	433,372
	Female					
14	365,070	337,897	392,212	395,564	402,367	396,464
16	372,593	344,258	373,202	401,463	402,435	400,632
18	390,720	368,030	355,684	394,553	402,598	404,384
21	429,120	396,877	366,567	389,753	412,195	409,281

Source: Office for National Statistics

Table 4.1: Number of 21-year-olds in the population (2012-2022) – UK

2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Total**
875,604	861,260	839,440	838,909	815,463	817,671	821,722	802,256	792,279	768,999	749,481	8,983,084

Source: Office for National Statistics

261 The Office for National Statistics produces population forecasts through to 2112. However beyond 2037 the reliability of the forecasts becomes less certain

These population variations are also due to have a significant effect on Key Stage cohorts (Table 4.2). Key Stage 3 student numbers will fall from 2,202,021 in 2012 to 2,136,423 in 2017 but then increase by 12.6% between 2017 and 2022 (2,405,843). Key Stage 4 is affected significantly by a one-period drop of 9.7% between 2012 (1,539,170) and 2017 (1,389,144), before the number is set to recover to 1,544,166 in 2022.

4.1.1 School population in the UK

Table 4.3 shows that there are 4,116 state-maintained secondary schools in the UK, with 3,800,924 pupils – an average of 923 per school. In England, there are 3,181,360 pupils in 3,329 secondary schools – about 956 per school, more than the UK average. The number of pupils per school in England contrasts strongly with the rest of the UK. In Wales, there is an average of 875 students per school, in Scotland it is 794 students per school and in Northern Ireland around 686 students per school.

Table 4.2: Population projections by Key Stage (2012-2037) – UK

	Years					
	Overall					
Age	**2012**	**2017**	**2022**	**2027**	**2032**	**2037**
7-11	3,495,386	3,922,473	4,088,591	4,114,484	4,061,912	3,934,778
12-14	2,202,021	2,136,423	2,405,843	2,451,822	2,474,461	2,428,056
15-16	1,539,170	1,389,144	1,544,166	1,656,936	1,653,240	1,642,023
Total	63,705,030	65,824,545	67,900,618	69,522,983	70,564,192	71,080,266
	Male					
	2012	**2017**	**2022**	**2027**	**2032**	**2037**
7-11	1,789,160	2,006,971	2,095,021	2,108,538	2,082,265	2,017,759
12-14	1,128,344	1,094,890	1,231,489	1,257,032	1,268,932	1,245,576
15-16	791,159	711,772	791,623	850,311	848,320	842,805
Total	31,315,072	32,482,191	33,604,658	34,482,683	35,058,902	35,370,051
	Female					
	2012	**2017**	**2022**	**2027**	**2032**	**2037**
7-11	1,706,226	1,915,502	1,993,570	2,005,946	1,979,647	1,917,019
12-14	1,073,677	1,041,533	1,174,354	1,194,790	1,205,529	1,182,480
15-16	748,011	677,372	752,543	806,625	804,920	799,218
Total	32,389,958	33,342,354	34,295,960	35,040,300	35,505,290	35,710,215

Source: Office for National Statistics

Table 4.3: Number of primary and secondary schools and pupils by nation (2013 or 2014) – UK

	Primary	**Secondary**	**Independent**
England: number of schools (January 2014)[262, 263]	16,788	3,329	2,411
England: number of students (January 2014)[264]	4,416,710	3,181,360	578,975
Wales: number of schools (January 2014)[265, 266]	1,357	213	70
Wales: number of students (January 2014)[267, 268]	269,421	186,427	8,603
Scotland: number of schools (2013)[269, 270, 271]	2,056	364	72
Scotland: number of students (2013)[272, 273]	377,382	289,164	31,146
Northern Ireland: number of schools (2013/14)[274, 275]	839	210	15
Northern Ireland: number of students (2013/14)[276, 277]	162,253	143,973	688

262 *Schools, pupils and their characteristics: local authority and regional tables: SFR15/2014, Table 2a*, Department for Education, January 2014, Table 2a www.gov.uk/government/uploads/system/uploads/attachment_data/file/335177/SFR15_2014_national_tables_v101.xlsx **263** State-funded primary and secondary schools **264** *Schools, pupils and their characteristics: local authority and regional tables: SFR15/2014, Table 2a*, Department for Education, January 2014, Table 2a www.gov.uk/government/uploads/system/uploads/attachment_data/file/335177/SFR15_2014_national_tables_v101.xlsx **265** *School Census Results, 2014*, Welsh Government, January 2014, Table 1; http://wales.gov.uk/docs/statistics/2014/140724-school-census-results-2014-en.pdf **266** Maintained primary and secondary schools. There are also four middle schools. **267** *School Census Results, 2014*, Welsh Government, January 2014, Table 5; http://wales.gov.uk/docs/statistics/2014/140724-school-census-results-2014-en.pdf **268** There are also 3,542 pupils in middle schools **269** *Pupil Census 2013 supplementary data*, Scottish Government, February 2014, Table 1.1 www.scotland.gov.uk/Resource/0044/00443349.xls **270** State-funded primary and secondary schools **271** The number of Independent schools is a reflection of the number of 'member' schools as registered by the Scottish Council of Independent Schools (SCIS) in their *Directory of Independent Schools 2013/2014*; www.scis.org.uk/assets/Uploads/Publications/IG0473SchoolsDirectory20132014FINALFORWEB.PDF **272** *Pupil Census 2013 supplementary data*, Scottish Government, February 2014, Table 1.1 www.scotland.gov.uk/Resource/0044/00443349.xls **273** The number of Independent school pupils reported by SCIS; www.scis.org.uk/facts-and-statistics **274** *Schools and pupils in Northern Ireland 1991/92 to 2013/14*, Department of Education, March 2014, Table: Number of Educational Establishments in Northern Ireland by Management Type; www.deni.gov.uk/enrolment_time_series_updated_1314_r3.xlsx **275** Controlled and maintained primary (including grammar school prep departments) and post-primary schools (including grammar schools) **276** *Schools and pupils in Northern Ireland 1991/92 to 2013/14*, Department of Education, March 2014, Table: Number of Pupils attending Educational Establishments in Northern Ireland by School Type; www.deni.gov.uk/enrolment_time_series_updated_1314_r3.xlsx
276 Years 1-7 pupils only **277** Years 1-7 pupils only

Table 4.4 shows the number of state secondary schools by 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 higher number of schools in the South West than in Yorkshire and the Humber, despite a slightly lower number of secondary pupils. As expected, there are significantly more schools in the most heavily populated region of the South East (489) compared with those at the other end of the population spectrum, such as the North East (188).

Table 4.4: State secondary schools by region (2014) – England

Region	Number of state secondary schools
East Midlands	292
East of England	402
London	456
North East	188
North West	455
South East	489
South West	329
West Midlands	407
Yorkshire and The Humber	311
Total	3,329

Source: Department for Education[278]

4.2 Ethnicity

Table 4.5 reveals the ethnic makeup of England (and its regions) and Wales[279] as of mid-2009. While white British remains by far the major ethnic group in England and Wales with 83.3% of the population, some regions have significantly greater proportions of ethnic minority groups than others. The national average is influenced heavily by London, which is significantly more ethnically diverse than anywhere else. It has a white British population of just 59.5%, with significant minorities of Asian or Asian British (13.2%), black or black British (10.1%) and white other (10.2%). The West Midlands is next in terms of diversity, with 8.5% Asian or Asian British and 2.7% black or black British people. This compares with Wales where the respective figures are just 2.7% and 0.3%. The urban nature of the UK's ethnic minority 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 BME[280] population."[281] 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."[282] However, this 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."[283]

This is supported by Table 4.6, which shows that while the overall number of 10- to 14-year-olds (3,196,200) is lower than 15- to 19-year-olds (3,513,100) – a fact accounted for mainly by a fall of 273,300 in the number of white British young people – the proportion of mixed, Asian or Asian British, and black or black British young people is rising.

Table 4.5 Regional population percentage by broad ethnic group (mid-2009 estimate) – England and Wales

	Broad ethnic group[284]							
	All groups	White British	White other[285]	Mixed[286]	Asian or Asian British[287]	Black or black British[288]	Chinese	Other
England and Wales	54,809,100	83.3%	4.6%	1.8%	5.9%	2.8%	0.8%	0.8%
England	51,809,700	82.8%	4.7%	1.8%	6.1%	2.9%	0.8%	0.8%
North East	2,584,300	92.4%	2.2%	1.0%	2.7%	0.8%	0.4%	0.5%
North West	6,897,900	88.4%	3.2%	1.4%	4.7%	1.2%	0.6%	0.5%
Yorkshire and the Humber	5,258,100	86.8%	2.8%	1.5%	6.2%	1.4%	0.6%	0.7%
East Midlands	4,451,200	87.0%	3.1%	1.6%	5.4%	1.6%	0.7%	0.6%
West Midlands	5,431,100	82.4%	3.2%	1.9%	8.5%	2.7%	0.6%	0.7%
East of England	5,766,600	85.2%	4.9%	1.7%	4.4%	2.1%	1.1%	0.7%
London	7,753,600	59.5%	10.2%	3.5%	13.2%	10.1%	1.8%	1.7%
South East	8,435,700	85.7%	5.0%	1.7%	4.2%	1.9%	0.7%	0.8%
South West	5,231,200	90.5%	3.5%	1.3%	2.3%	1.2%	0.6%	0.6%
Wales	2,999,300	93.0%	2.9%	1.0%	1.8%	0.6%	0.4%	0.4%

Source: Office for National Statistics[289, 290]

278 *Schools, pupils and their characteristics: local authority and regional tables: SFR15/2014*, Department for Education, January 2014, Table 7a; www.gov.uk/government/uploads/system/uploads/attachment_data/file/335178/SFR15_2014_LA_tables_v101.xlsx 279 Scotland and Northern Ireland use different categories and therefore have not been included 280 Black and minority ethnic 281 *A Portrait of Modern Britain*, Policy Exchange, 2014, p7 282 *A Portrait of Modern Britain*, Policy Exchange, 2014, p6 283 *A Portrait of Modern Britain*, Policy Exchange, 2014, p6 284 These categories differ from those employed by the Office for National Statistics (ONS) 285 Includes "White: Irish" and "White: other white" 286 Includes "Mixed: white and black Caribbean", "Mixed: white and black African", "Mixed: white and Asian" and "Mixed: other mixed" 287 Includes "Asian or Asian British: Indian", "Asian or Asian British: Pakistani", "Asian or Asian British: Bangladeshi", and "Asian or Asian British: Other Asian" 288 Includes "Black or black British: Black Caribbean", "Black or black British: black African" and "Black or black British: Other black" 289 Available at www.ons.gov.uk/ons/rel/peeg/population-estimates-by-ethnic-group--experimental-/current-estimates/population-estimates-by-ethnic-group-mid-2009--experimental--.zip. 290 The Population Estimates by Ethnic Group are experimental statistics and have not been shown to meet the standards required for National Statistics. Information on sources of uncertainty is provided in the Quality and Methodology Information document available from www.ons.gov.uk/ons/guide-method/method-quality/quality/quality-information/social-statistics/index.html

Table 4.6: England and Wales ethnicity of population by age (mid-2009 estimate) – England and 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 groups	54,809,100	100.0%	3,196,200	100.0%	3,513,100	100.0%
White British	45,682,100	83.4%	2,651,900	83.0%	2,925,200	83.3%
White other	2,506,800	4.6%	81,100	2.5%	104,100	3.0%
Mixed	986,600	1.8%	112,000	3.5%	104,100	3.0%
Asian or Asian British	3,219,500	5.9%	216,400	6.8%	227,500	6.5%
Black or black British	1,540,100	2.8%	101,700	3.2%	106,400	3.0%
Chinese	451,500	0.8%	15,500	0.5%	22,300	0.6%
Other	422,600	0.8%	17,500	0.6%	23,500	0.7%

Source: Office for National Statistics

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

Engineering is a crucial component of the UK economy. Engineering enterprises had a collective turnover of £1.17 trillion: an increase of 6.7% over the 12 months to March 2013 and a quarter (24.9%) of the turnover of all VAT/PAYE registered enterprises. Despite this economic growth, the rate of change in supply is far too slow to meet the forecast UK demand for engineering skills.[291] This is a serious point of concern for businesses and Government.

In order to meets this demand, we must ensure that the perception of science, technology, engineering and maths (STEM) continues to improve and that teachers, parents, careers advisers and businesses work together to attract and inspire young people to study STEM subjects and help them to progress towards engineering as a profession.

Whilst there have been marked improvements in the knowledge and perceptions of young people and their influencers towards STEM subjects and engineering careers, our brand monitor survey clearly shows there is more to be done. Almost one in five (17%) of all STEM teachers think that a career in engineering is undesirable for their students, rising to 19% for the 25- to 44-year-old group. Also, when asked to name an engineering development from the past 50 years that has had an impact on their lives, only two out of five (41%) of those aged 20+ could name one.

This chapter outlines the challenges that remain as well as the progress made in improving perceptions of STEM as a subject area and engineering as a career.

5.1 Young people and their influencers

The importance of engineering is by no means underestimated by the British public. The *2014 Public Attitudes to Science* study reports that 88% believe that engineers make a valuable contribution to society.[292] This is a similar proportion to those who believe that scientists make a valuable contribution to society (90%), which, in turn, is higher than the percentage (77%) of Europeans who think that science has a positive impact on society.[293] Other key findings from the report show that 31% of people believe that they are not clever enough to understand engineering. However, this goes down to 21% for those aged 16-24, suggesting increasing confidence in those who have recently been part of our target audience.[294] Unfortunately, while 24% of the public claim that school put them off science, this number rises to 27% for those aged 16-24.[295] Positively, the percentage of those who trust engineers who work for private companies has increased from 70% to 74% between 2011 and 2014, while the figure for those working for universities has gone from 84% to 89%.[296]

King's College London's *ASPIRES* study[297] has shown that 80% of young people believe that, "scientists are brainy", which, the authors conclude, "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.[298] It also claims that there is no evidence of a 'poverty of aspiration'[299] among those aged 10-14 or their parents. This is supported by research which shows that almost 76% of 13- to 15-year-olds would like to go to university but that only 47% actually did so.[300] This demonstrates that aspiration more generally is not a significant problem when compared with attainment and participation.[301]

291 See Section 15.3 for more details **292** *Public Attitudes to Science 2014*, Department for Business, Innovation and Skills, March 2014, p41; www.ipsos-mori.com/Assets/Docs/Polls/pas-2014-main-report.pdf **293** *Responsible Research and Innovation (RRI)*, Science and Technology, European Commission, November 2013, p5; http://ec.europa.eu/public_opinion/archives/ebs/ebs_401_en.pdf **294** *Public Attitudes to Science 2014 topline results*, Department for Business, Innovation and Skills, March 2014, p11; www.ipsos-mori.com/Assets/Docs/Polls/pas-2014-topline.pdf **295** *Public Attitudes to Science 2014*, Department for Business, Innovation and Skills, March 2014, p114 **296** *Public Attitudes to Science 2014 topline results*, Department for Business, Innovation and Skills, March 2014, p15 **297** *ASPIRES Young people's science and career aspirations, age 10 –14*, King's College London, November 2013; www.kcl.ac.uk/sspp/departments/education/research/aspires/ASPIRES-final-report-December-2013.pdf **298** *ASPIRES Young people's science and career aspirations, age 10 –14*, King's College London, November 2013, p3 **299** *ASPIRES Young people's science and career aspirations, age 10 –14*, King's College London, November 2013, p1 **300** *Educational aspirations and attitudes over the business cycle, Institute for Social and Economic Research*, November 2012, p9; www.iser.essex.ac.uk/publications/working-papers/iser/2012-26.pdf **301** *School and College-level Strategies to Raise Aspirations of High-achieving Disadvantaged Pupils to Pursue Higher Education Investigation*, Department for Education, January 2014, p11

The reason that 'influencing the influencers' is a key strategy for many careers programmes is highlighted by research for the Chartered Institute for Securities and Investment (CISI),[302] which showed that 23% of young people would be interested in working in engineering – placing it second only to information technology. Sadly, in a list of industries of which parents had a strong or fair understanding, engineering came joint second-last with only 14%. Even more worryingly, engineering came highest on a list careers that teachers professed to being unfamiliar with: 39% of teachers stated that they had no personal understanding of engineering as a profession. The role of parents should not be underestimated, with research by the Wellcome Trust and Platypus Research[303] highlighting the association between positive parental attitudes towards science, with discussion of experiences at school and engagement in enrichment activities particularly noted. However, through The Big Bang Fair, we have shown that these perceptions can be improved. For example, when asked, 42% of parents and 43% of teachers said that their knowledge of what people who work in engineering do had increased as a result of attending the fair, while 68% of parents and 70% of teachers said that they were more likely to recommend a career in engineering to an accompanying young person.

5.1.1 Encouraging students into STEM

Research by the Institute of Education[304] found that home support is a greater influence on achievement in physics than prior attainment. The Institute also found that students expressed the desire to choose mathematics and/or physics based on future rewards in education and careers as well as on the basis of manifesting a conceptual understanding in the subject and good teaching. 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.[305]

The report also claims that a lack of this science capital has led many to be unaware of the diversity of post-16 routes and therefore to believe that post-16 science qualifications are 'not relevant for me'.[306] It is vitally important that families are engaged as much as young people, especially in "understanding that science and mathematics qualifications have a strong exchange value in the education and labour market and are not purely specialist routes leading to a narrow range of careers in science."[307] The concept of 'science for all' should be promoted given current perceptions of the subject as being only for the 'brainy'.

Research by the National STEM Centre has highlighted the importance of senior support and prioritisation within schools in determining success in the STEM subjects, although the reasons for such prioritisation are unclear given the importance of the area.[308] The report also covers opportunities outside class time, including STEM lunchtime or after school clubs, and states that some are only open to the most able while others fail to attract as many girls.[309] This is backed up by research reported by the Department for Education which shows that subject guidance from schools is of the utmost importance in raising aspiration among high-achieving disadvantaged pupils. In particular, the report highlights schools which discuss preferred EBacc subjects with pupils choosing GCSEs.[310]

Taking these factors into account, research for the BG Group suggests that STEM engagement activities should incorporate several key elements which include:

- stimulating and practical learning that is relevant to work, life and local conditions
- interactive scientific enquiry and problem solving
- an enriched curriculum, with informal learning and extracurricular activities
- confidence building in STEM, especially for disadvantaged groups
- continuing professional development for STEM teachers
- information and advice on STEM study, qualifications and careers[311]

5.1.2 Encouraging students to persist with STEM

The *ASPIRES* study shows that while students remain positive about science as a potentially academically rewarding subject from Year 6 to Year 9 (11- to 14-years-old), their enjoyment decreases year-on-year (Table 5.0). Qualitative data suggests 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.[312] This trend might explain the drop-off in numbers after the age of 16, with Ofsted claiming that:

"Not enough subject leaders analyse why pupils of both genders either continue or stop studying science subjects after the age of 16. Uninspiring teaching was one reason pupils gave to inspectors to explain why they did not wish to continue studying science. Another was not seeing the purpose of what they were studying, other than to collect examination grades."[313]

Table 5.0: Attitudes to school science across surveys (Year 6-Year 9)

	Percentage agreeing/strongly agreeing		
Survey questions	**Year 6**	**Year 8**	**Year 9**
If I study hard, I will do well in science	80.6%	82.3%	81.4%
My teacher expects me to do well in science	68.4%	69.9%	71.4%
Studying science is useful for getting a good job in the future	79.9%	84.8%	83.8%
We learn interesting things in science lessons	73.8%	73.2%	65.7%
Science lessons are exciting	58.1%	52.1%	42.9%
I look forward to my science lessons	51.7%	47.8%	42.7%

Source: *ASPIRES*[314]

302 *Parents, Teachers and Young People's Attitudes to Financial Services*, Chartered Institute for Securities and Investment, 2014; www.cisi.org/bookmark/genericform.aspx?form=29848780&URL=91652952 303 *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 304 Simon S. et al. Understanding Participation in Mathematics and Physics (UPMAP). Institute of Education, 2012; http://www.ioe.ac.uk/UPMAP_AERA2012.pdf, p20 and *Engineering Engagement – The Research Perspective*, EngineeringUK, December 2013, p3 305 *ASPIRES Young people's science and career aspirations*, age 10 –14, King's College London, November 2013, p3 306 *Vision for science and mathematics education, Royal Society,* 2014, p31; https://royalsociety.org/~/media/education/policy/vision/reports/vision-full-report-20140625.pdf 307 *Ten Science Facts and Fictions: The Case for Early Education about STEM Careers*, King's College London, 2012, p3; www.kcl.ac.uk/sspp/departments/education/research/aspires/10FactsandFictionsfinalversion.pdf 308 *School organisation and STEM career-related learning,* National STEM Centre, August 2013, p2 309 *School organisation and STEM career-related learning*, National STEM Centre, August 2013, p9 310 *School and College-level Strategies to Raise Aspirations of High-achieving Disadvantaged Pupils to Pursue Higher Education Investigation*, Department for Education, January 2014, p70 311 *STEM Education Learning Report Social Investments in Science, Technology, Engineering and Mathematics Education*, BG Group PLC and the National Foundation for Educational Research, June 2014, p3-4; www.nfer.ac.uk/publications/BGAS01/BGAS01.pdf 312 *ASPIRES Young people's science and career aspirations, age 10 –14*, King's College London, November 2013, p17 313 *Maintaining curiosity*, Ofsted, November 2013, p5 314 *Young people's science and career aspirations, age 10 –14*, King's College London, November 2013, p17

Despite this, 42% of Year 9 pupils remain interested in studying more science in the future.

The decision to continue with STEM study must be seen in the context of more general decision-making. The Skills Commission cites research from the Nuffield Review to show that young people make both implicit and explicit choices regarding their post-16 education and career by the age of 14 – with academic routes chosen earlier than vocational. They therefore argue the importance of interventions before this age.[315]

5.1.3 STEM enrichment and enhancement activities

We believe that a coordinated approach to (engineering) employer engagement in schools is the key way in which we can reach the numbers of young people needed to help deliver the UK's future science, engineering and technology sectors. We have just completed the pilot stage of the Tomorrow's Engineers employer engagement expansion project, the aim of which is to coordinate, on a region-by-region basis, the school-based careers initiatives and activities that engineering employers are delivering. The project is designed to become a national programme that provides regional-level support to business, linking engineering employers with schools, and helping to create the next generation of engineers.

Research by the Education and Employers Taskforce reinforces the importance of employer engagement with pupils, particularly on 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[316]

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 Not in Education, Employment or Training (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[317]

The importance of such activities in the light of science capital is supported by the ASPIRES study, which argues that "Efforts to broaden students' aspirations, particularly in relation to STEM, need to begin at primary school. The current focus of most activities and interventions – at secondary school – is likely to be too little, too late."[318]

EngineeringUK delivers The Big Bang Fair, The Big Bang Near Me Fairs, and Tomorrow's Engineers in partnership with businesses, professional engineering institutions and third sector organisations. These careers inspiration programmes currently reach upward of 150,000 young people directly and over 500,000 indirectly each year through online and offline channels. These programmes provide opportunities for authentic careers inspiration by enabling face-to-face interactions between STEM professionals and young people, helping to set a context for students' classroom learning.

5.2 Career aspirations, guidance and work experience[319]

In Section 5.1, we reported that 23% of young people would be interested in working in engineering – an interest level second only to information technology.[320] This is within the context of research by FreshMinds which suggests that 72% of children have a clear idea of what job they would most like to do in the future, including 77% of those receiving Free School Meals (FSM) and 71% of those who did not.[321] However, against a rapidly changing jobs market – which in 2010 included a top 10 of roles that didn't even exist in 2004 – the jobs children aspire to are typically 'traditional'. In fact, one in five children said they did not feel informed about what jobs are available.[322]

The *ASPIRES* study has made clear that the perception of a strong connection between studying science and becoming a scientist should be challenged and replaced with the message that the subject "keeps your options open".[323] This should also highlight "the links between science and popular aspirations (such as business)."[324] The *ASPIRES* report uses data from the *Understanding participation in mathematics and physics* (UPMAP) study to support its findings that the transferability of science qualifications is extremely important in predicting whether students go on to study STEM post-16, with perceived positive implications for future jobs being particularly influential.[325]

The need for careers information to be available to both pupils and teachers is evidenced by the fact that 17% of STEM teachers would still not recommend a career in engineering to their pupils.[326] Furthermore only 36% of STEM teachers felt confident in giving engineering careers advice.[327] Targeting the influencers of young people with up-to-date, accurate and non-stereotypical guidance about the range of engineering and STEM-related careers is essential in persuading students to persist with STEM throughout school, university, apprenticeships and employment.

5.2.1 Career guidance

In January 2014 report, the World Economic Forum stated the following:

"High quality career guidance helps inform educational and career choices that are more in line with available and foreseen labour market opportunities. Rapid transformation characterizes many sectors, making it increasingly important to prepare career guidance workers and counsellors to understand labour market information and job demands. This should be part of the policy agenda for responsive education and training."[328]

The Confederation of British Industry (CBI)/ Pearson *Education and Skills Survey* 2014 showed that 80% of UK businesses believe careers advice for young people "is not good enough to help them make informed decisions about future career options", with only 3% thinking it adequate.[329] 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.[330]

315 *Many Pathways Forging Consensus on 14-19 Education and Training*, Skills Commission, November 2013, p18 **316** *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 **317** *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 **318** *ASPIRES Young people's science and career aspirations, age 10 –14*, King's College London, November 2013, p4 **319** Also see Section 1.1.6 which covers related issues
320 *Parents, Teachers and Young People's Attitudes to Financial Services*, Chartered Institute for Securities and Investment, 2014; www.cisi.org/bookmark/genericform.aspx?form=29848780&URL=91652952
321 *Careers Guidance: Guaranteed Summary Report of Online Survey*, FreshMinds, January 2014, p5; www.aoc.co.uk/sites/default/files/Freshminds%20Summary%20Report.pdf **322** *Careers Guidance: Guaranteed Summary Report of Online Survey,* FreshMinds, January 2014, p3 **323** See also *Good career guidance,* Gatsby Charitable Foundation, April 2014, p13; www.gatsby.org.uk/GoodCareerGuidance **324** *ASPIRES Young people's science and career aspirations, age 10 –14*, King's College London, November 2013, p4 **325** *ASPIRES Young people's science and career aspirations, age 10 –14*, King's College London, November 2013, p15-16 **326** Engineers and Engineering Brand Monitor 2014 – data tables **327** Engineers and Engineering Brand Monitor 2014 – data tables **328** *Matching Skills and Labour Market Needs Building Social Partnerships for Better Skills and Better Jobs*, World Economic forum, January 2014, p6; www3.weforum.org/docs/GAC/2014/WEF_GAC_Employment_MatchingSkillsLabourMarket_Report_2014.pdf **329** *Gateway to growth CBI/Pearson Education and Skills Survey 2014*, Confederation of British Industry and Pearson, 2014, p63; www.cbi.org.uk/media/2807987/gateway-to-growth.pdf **330** *Vision for science and mathematics education*, Royal Society, 2014, p57

This issue has been affected significantly by the decision in The Education Act (2010) to transfer the responsibility for careers guidance from local authorities to individual schools. According to April 2014 statutory guidance from the Department for Education, this advice must be independent and impartial, promote the best interests of the pupil receiving the advice and include information on a full range of options, both academic and vocational.[331] This requirement was extended in September 2013 to Years 8-13 and to all Further Education and Sixth Form Colleges.[332] The necessity of exposing pupils to the diversity of STEM-related careers early – particularly through business engagement – is now part of the statutory guidance,[333] which states that "Every school should engage fully with their local employer and professional community to ensure real-world connections with employers lie at the heart of the careers strategy."[334]

However, despite this guidance, the National Foundation for Educational Research has made clear its concern about the transfer of responsibility for careers guidance from local authorities to schools due to the potential for inconsistency and a lack of coordination,[335] citing Ofsted's own report.[336] Additionally, its own research has shown that some schools feel the statutory requirement for independent and impartial advice is unclear.[337] The Pearson Think Tank adds to this concern, claiming that, despite small increases over the three years to 2013 in careers education, the overall pattern of provision is patchy, with some schools increasing career-related activities but a greater number reducing them. The Social Mobility and Child Poverty Commission reported that "55% of employers think not enough young people leave school with work experience and it seems disadvantaged children are more likely to struggle to get access to high quality opportunities". The commission also heard complaints that "firms find it hard to get a foot in the door of some schools", while survey data suggesting that "over a quarter of businesses (27%) cited lack of interest among schools or pupils as a key barrier to engagement."[338, 339]

However, despite the importance of schools and teachers, a study by the Institute for Public Policy Research has shown that families are the most common source of careers advice for pupils, with advice from family (again) and friends the most important factor in deciding future careers for 15% of pupils surveyed.[340, 341] Therefore, the importance of informing parents, including through enrichment activities and the development of science capital, cannot be underestimated.

The Department for Education's statutory guidance also requires schools to "provide sustained contacts with employers, mentors and coaches who can inspire pupils with a sense of what they can achieve and help them understand how to make this a reality." The guidance also requires schools to:

"provide access to a range of activities that inspire young people, including employer talks, careers fairs, motivational speakers, college and university visits, coaches and mentors. Schools should also consider the needs of pupils who require more sustained or intensive support before they are ready to make career decisions. High quality mentoring and employer engagement can be an important part of delivering against the statutory careers duty."[342]

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."[343, 344]

These messages have got through to some employers. For example, the Construction Industry Training Board (CITB) recently released a report that calls for construction employers to help the three-quarters of schools failing to meet their legal obligation to offer independent careers advice[345] by visiting them and challenging the "outdated stereotype" that construction is "a hard, dirty manual job for boys."[346] Its study of career influencers, carried out by Pye Tait Consulting, also showed that over:

- 60% of careers advisers in schools offer no information on jobs prospects based on available work[347]
- 44% of school teachers admit to giving a pupil bad or uniformed advice in the past[348]
- 82% of school teachers don't feel they have the appropriate knowledge to advise pupils on their careers
- 82% are calling for better guidance on advising pupils about their options post-16[349]

The CBI/Pearson *Education and Skills Survey* 2014 showed that 80% of businesses have links with at least one school or FE College, while businesses recognise that they "have a key role in engaging with schools (57%) and offering more STEM-based apprenticeships (57%). They also see the need to work with universities to ensure the business-relevance of courses (54%)."[350] Additionally, the CBI[351] has called for the creation of Local Brokers, who would be nationally-mandated, Government-funded and help to coordinate and facilitate links – and particularly careers provision with regular work contacts – between schools, colleges and industry. Lord Young's proposed Enterprise Advisers is a similar concept. In this regard, it should be noted that EngineeringUK is about to roll out a new national Tomorrow's Engineers employer engagement programme which will provide regional-level support to business, linking engineering employers with schools and thereby helping to create the next generation of engineers. This will be done by:

- coordinating employer/school engagement activity regionally
- providing a best practice toolkit that includes engineering careers material
- developing and sharing an evaluation framework to measure impact and effectiveness

Indeed, the underlying support given to STEM careers provision by EngineeringUK has been recognised by the Department for Business, Innovation and Skills, which claims that the "signs of welcome developments in careers provision" include:

"A content rich intelligence-base, developed by UK Engineering and other Science, Technology, Engineering and Mathematics (STEM) organisations that monitors input and demand from schools and colleges for STEM resources and activities."[352]

331 *Careers guidance and inspiration in schools Statutory guidance for governing bodies, school leaders and school staff*, Department for Education, April 2014, p7; www.gov.uk/government/uploads/system/uploads/attachment_data/file/302422/Careers_Statutory_Guidance_-_9_April_2014.pdf **332** *Securing Independent Careers Guidance Guidance for General Further Education Colleges and Sixth Form Colleges*, Department for Education and the Department for Business, Innovation and Skills, June 2013, p3; www.gov.uk/government/uploads/system/uploads/attachment_data/file/207240/Securing-Independent-Careers-Guidance.pdf **333** *Careers guidance and inspiration in schools Statutory guidance for governing bodies, school leaders and school staff*, Department for Education, April 2014, p8 **334** Careers guidance and inspiration in schools Statutory guidance for governing bodies, school leaders and school staff, Department for Education, April 2014, p10 **335** *Careers guidance: If not an annual careers plan – then what?*, National Foundation for Education Research, September 2013, p2 **336** *Going in the right direction?: Careers Guidance in Schools from September 2012*, Ofsted, September 2013, p11, www.ofsted.gov.uk/sites/default/files/documents/surveys-and-good-practice/g/Going%20in%20the%20right%20direction.pdf **337** *Hidden Talents: Examples of Transition of Careers Guidance from Local Authorities to Schools*. National Foundation for Education Research, October 2012, p8; www.nfer.ac.uk/publications/LGCG01 **338** *State of the nation 2013: social mobility and child poverty in Great Britain, Social Mobility and Child Poverty Commission*, October 2013, p197; www.gov.uk/government/uploads/system/uploads/attachment_data/file/292231/State_of_the_Nation_2013.pdf **339** See also *Competing in a race to the top Results from the employer survey for the Adonis Growth Review*, Andrew Adonis, March 2014, p9 **340** *Driving a Generation Improving the Interaction between Schools and Businesses*, Institute for Public Policy Research, January 2014, p14 **341** See also *Going in the right direction?: Careers Guidance in Schools from September 2012, Ofsted,* September 2013, www.ofsted.gov.uk/sites/default/files/documents/surveys-and-good-practice/g/Going%20in%20the%20right%20direction.pdf **342** *Careers guidance and inspiration in schools Statutory guidance for governing bodies, school leaders and school staff*, Department for Education, April 2014, p7 **343** *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 **344** see Section 16.4.1 for a detailed case study **345** See also *Going in the right direction?: Careers Guidance in Schools from September 2012*, Ofsted, September 2013, p11 **346** *Educating the Educators*, Construction Industry Training Board, February 2014, p2; www.citb.co.uk/documents/construction%20careers/citb-educating-educators-careers-report.pdf **347** *Educating the Educators*, Construction Industry Training Board, February 2014, p2 **348** *Educating the Educators*, Construction Industry Training Board, February 2014, p4 **349** *Educating the Educators*, Construction Industry Training Board, February 2014, p4 **350** *Gateway to growth, CBI/Pearson Education and Skills Survey 2014*, Confederation of British Industry, 2014, p7; www.cbi.org.uk/media/2807987/gateway-to-growth.pdf **351** *Future possible: the business vision for giving young people the chance they deserve*, Confederation of British Industry, 2014, p5; ww.cbi.org.uk/media/2855199/future-possible.pdf **352** *Taking action: Achieving a culture change in careers provision*, National Careers Council, September 2014, p13-14; www.gov.uk/government/uploads/system/uploads/attachment_data/file/355473/bis-14-1080-taking-action-achieving-a-culture-change-in-careers-provision.pdf

It has also recommended that greater consideration be given to partnering with, and working through existing organisations including EngineeringUK and The Big Bang.

Within the critical issues of careers advice, there remains a disturbing disparity between the quality of advice provided on vocational pathways versus their academic counterparts. A survey by the CBI using Barclay's LifeSkills Youth Barometer also found that while between 62% and 65% of young people aged 14-25 had received careers guidance based on academic routes, only 17% had been advised on vocational qualifications.[353, 354] The CBI claimed that "This is scandalous – at a recent college visit to 60 apprentices working for a major civil engineering firm, our staff discovered only three had received any active encouragement at school to go for the route they were on, which will lead to a fantastic career,"[355] while "93% felt they were not provided with all the information they need to make informed choices on their future career."[356] The survey also found that:

- fewer than 10% wanted more support on GCSE and A level subject choices
- 20% wanted more information about post-school routes
- 16% wanted more talks from employers
- 14% wanted more information about work experience and internships
- 13% wanted more advice about the value and relevance of qualifications.[357]

5.2.2 Work experience

Research by the Education and Employers Taskforce for the Edge Foundation[358] 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.[359] Research has also shown that graduates "with work experience get better degrees, higher wages and are less likely to be unemployed."[360]

This finding is reinforced by a City & Guilds report which shows that 67% of employers would be more likely to hire a young person with work experience over someone with none, while 78% believe that relevant work experience is essential to ensure young people are ready for work.[361] The UK Commission for Employment and Skills supports this, claiming that "29% of employers say that experience is critical when recruiting young people and a further 45% say it is significant," and while "the majority of employers think young people are well prepared for work … lack of experience is also the number one reason that employers turn young job applicants away."[362]

These findings and sentiments, however, are made redundant by findings from the Wellcome Trust survey of 460 14– 18-year-olds, which revealed that 39% had no work experience while 71% of the remainder had none with a STEM employer.[363]

The reality is that despite improving business engagement with schools and colleges, there remain obstacles on both sides to providing work experience. The CBI/Pearson *Education and Skills Survey 2014* claims that 31% of employers say there is "insufficient guidance and support on how to make work experience placements worthwhile. This has long been an area of concern to businesses and the Government's decision to end compulsory work experience in England sends a negative signal about the perceived value of placements."[364]

Research commissioned by the CBI, UKCES, Edge Foundation and Department for Children, Schools and Families revealed three key reasons why more employers do not engage with schools:

1. It's (probably) too difficult
2. No one asked me
3. I don't really get the business case[365]

In return, secondary schools claim they are facing significant challenges in including engagement at Key Stage 4, including:

1. It's too expensive
2. It's too hard to find the right people/ opportunities
3. Government isn't interested anymore
4. The curriculum is too tight[366]

Finally, it is worth noting the research undertaken by the Education and Employer Task Force, which found that the career ambitions of both 52% of 13- to 14- and 15- to 16-year-olds lay in just three out of 25 occupational groupings.[367] The Adonis Review has shown that work experience is reinforcing this narrow focus. It claims that while there are around 500,000 work experience placements per year in England, with around two thirds of young people involved, half of them are undertaken in one of four areas: sport and leisure; society health and development; business administration and finance; or retail. Only 1% are in information and communication technology or manufacturing.[368]

353 *93% of young people are not getting the careers information they need*, Confederation of British Industry and Barclay's LifeSkills, 2013; www.cbi.org.uk/media-centre/press-releases/2013/11/93-of-young-people-are-not-getting-the-careers-information-they-need-cbi. See also *Future possible: the business vision for giving young people the chance they deserve*, Confederation of British Industry, 2014, p6 **354** See also *Mending The Fractured Economy Smarter State, better jobs*, Adonis Review, July 2014, p29 **355** *Future possible: the business vision for giving young people the chance they deserve*, Confederation of British Industry, 2014, p6 **356** *93% of young people are not getting the careers information they need*, Confederation of British Industry and Barclay's LifeSkills, 2013 **357** *93% of young people are not getting the careers information they need*, Confederation of British Industry and Barclay's LifeSkills, 2013 **358** *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 **359** *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 **360** *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 **361** *Making Education Work: Preparing Young People for the Workplace*, City & Guilds, 2013, p4; www.cityandguilds.com/~/media/Documents/Courses-and-Quals/quals-explained/techbac/making-education-work%20pdf.ashx **362** *Not just making tea… Reinventing work experience*, UK Commission for Employment and Skills, p4; www.gov.uk/government/uploads/system/uploads/attachment_data/file/299597/Not_just_making_tea.pdf **363** *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 **364** *Gateway to growth CBI/Pearson Education and Skills Survey 2014*, Confederation of British Industry and Pearson, 2014, p60 **365** *Profound employer engagement in education: What it is and options for scaling it up*, Education and Employers Taskforce, p12-13 **366** *Profound employer engagement in education: What it is and options for scaling it up*, Education and Employers Taskforce, p14-16 **367** *Nothing in common: the career aspirations of young Britons mapped against projected labour market demand (2010-2020)*, Mann A et al, March 2013, p8; www.educationandemployers.org/media/18037/nothing_in_common_final.pdf **368** *Mending The Fractured Economy Smarter State, better jobs*, Adonis Review, July 2014, p64

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5.3 Promoting STEM subjects and engineering to women

Research has shown that men are more likely than women to find engineering interesting.[369] This is concerning. Given that the number of 18-year-olds overall is due to drop by around 10% in 2022 and the number of engineering workers required in that period is set to increase, encouraging women into the STEM sector is vital in order to fulfil business needs – a requirement recognised by the House of Commons Science and Technology Committee.[370] Indeed, if women were to participate more fully in STEM employment, it could contribute an additional £2 billion to the economy.[371]

This may be influenced by parental perceptions of engineering: 12% of parents stating that they would like their son to become an engineer – the highest proportion for any job – while only 2% said the same about their daughter. In contrast, while 16% would prefer their daughter to become a teacher, only 5% would like their son to.[372] Despite improvements in female participation in STEM at GCSE level, the number of women taking A level physics remains low – though higher than in 2013 – with females accounting for 23.7% of entrants in physics and 39.4% in mathematics in 2014.[373]

The *ASPIRES* study has shown that, even though a higher percentage of girls favour science as a subject, more boys aspire to pursue science careers. While 18% of boys and 12% of girls aspire to become scientists at ages 12-13, 64% of girls want to pursue careers in the arts, with those who define themselves as 'girly' especially unlikely to want a science career.[374] Research by FreshMinds has shown that the top three sectors for boys were uniformed services, IT, and medicine, while for girls they were medicine, education, and animal care.[375] This trend of declining participation of girls in STEM continues through to Higher Education: research by the Women's Business Council shows that of university places accepted in 2011, only 22% in mathematics and computer science, 18% in technology and 13% in engineering were taken by women, compared with 89% in nursing and 85% in education.[376]

This disparity is especially prevalent in vocational routes, with just 490 women studying engineering apprenticeships in England in 2011/12 – just 4.4% of the total – compared with 10,770 men. CBI/Barclays LifeSkills Youth Barometer research shows that while 30% of young men receive careers advice on apprenticeships, the figure is reduced by a quarter for women.[377] To address this issue, the unions UNITE and the TUC, along with Cogent, launched an initiative in February 2014 to promote engineering, science and manufacturing apprenticeships to women, including developing literature for teachers in schools and colleges.[378]

The challenge of promoting STEM to women and encouraging them into engineering is clear and articulated well by the World Economic Forum who state that "over time, therefore, a nation's competitiveness depends, among other things, on whether and how it educates and utilizes its female talent." [379]

369 *Public Attitudes to Science 2014*, Department for Business, Innovation and Skills, March 2014, p45 **370** *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 **371** *Building on progress: boosting diversity in our workplaces*, Confederation of British Industry, 2014, p3 **372** *Improving Diversity in STEM, Campaign for Science and Engineering*, May 2014, p23; http://sciencecampaign.org.uk/CaSEDiversityinSTEMreport2014.pdf **373** See Table 8.4 for more detail **374** *ASPIRES Young people's science and career aspirations, age 10 –14*, King's College London, November 2013, p3 **375** *Careers Guidance: Guaranteed Summary Report of Online Survey,* FreshMinds, 2014, p6 **376** *Maximising women's contribution to future economic growth*, Women's Business Council, June 2013, p11; www.gov.uk/government/uploads/system/uploads/attachment_data/file/204751/DCMS_WBC_Full_Report_v1.0.pdf **377** *Building on progress: boosting diversity in our workplaces*, Confederation of British Industry, 2014, p3 **378** *Unite launches joint initiative to promote engineering and science to young women*, Unite, www.unitetheunion.org/news/unite-launches-joint-initiative-to-promote-engineering-and-science-to-young-women **379** *The Global Gender Gap Report 2013*, World Economic Forum, 2013, p31

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

As 'birth not worth' has become more a determinant of life chances, higher social mobility - reducing the extent to which a person's class or income is dependent on the class or income of their parents - has become the new holy grail of public policy.[380]

In today's world economy, education and skills are the driving forces for progress. Wealth and individual well-being, in turn, depend on nothing more than what people know and what they can do with what they know. There is no shortcut to equipping people with the right skills and to providing people with the right opportunities to use their skills effectively. And if there's one lesson the global economy has taught policymakers over the last few years, it's that we cannot simply bail ourselves out of a crisis by printing money. Instead, in today's world economy, education and skills are the driving forces for progress. Investing in high-quality education will thus be the key for improving the economic and social well-being of people around the world.[381]

In previous reports we have justly focused on the plight of those 16- and 17-year-olds Not in Education, Employment or Training (NEETs). However, due to the ramifications of raising the school leaving age to 18 in 2015[382] (the effects of which are described in Section 6.1), the focus for policy makers will be more on 18- to 24-year-olds. This shift was highlighted by the Institute of Public Policy Research (IPPR) in its report *No more NEETs, a plan for all young people to be learning or earning*.[383]

However, as IPPR also pointed out, there are doubts about whether an adequate implementation plan is in place. In particular, it is not clear that schools and colleges have strategies and provision capable of meeting the needs of those who would otherwise drop out of formal learning before this point. This will require improvements in both academic and vocational options for 14- to 18-year-olds.[384]

6.1 Our untapped potential

Our new 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.[385] The data in this section will show that in Q1 2014, there were still 728,000 18- to 24-year-old NEETs, a visible untapped pool that Government, business and industry, professional engineering institutions and third sector organisations need to be cognisant of.

Progress on reducing the numbers of NEETs is being made. Figures published by the Department for Business, Innovation and Skills (BIS) and the Department for Education (DfE), show that for England in the first quarter of 2014 (January to March) compared with the same period in 2013:[386]

- there are 774,000 16- to 24-year-olds who are NEET (13.1%) - this is down 135,000 (2 percentage points) on last year, and is the lowest rate for this quarter since 2005
- there are 122,000 16- to 18-year-olds NEET (6.7%) - this is down 29,000 (1.5 percentage points) on last year, and is the lowest since comparable data began in 2001
- there are 652,000 19- to 24-year-olds NEET - this is down 105,000 (2.3 percentage points) on last year, and is the lowest since 2008
- the figures also show that 94.2% of 16- and 17-year-olds are participating in education and training, the highest comparable participation rate since consistent records began in 2001

380 *State of The Nation 2013: social mobility and child poverty in Great Britain*, The Social Mobility and Child Poverty Commission, October 2013, p1 **381** *Education, Pre-distribution and Social Justice*, Policy Network, March 2014, p6 **382** http://www.education.gov.uk/childrenandyoungpeople/youngpeople/participation/rpa **383** *No More NEETs, A Plan For All Young People To Be Learning Or Earning*, Institute of Public Policy Research, November 2013 **384** Ibid, p49 **385** See Section 15.3 for further details **386** https://www.gov.uk/government/news/neet-in-england-at-lowest-level-since-2005, 22 May 2014

Alongside this news we are able to examine the same groups of people but over a longer period – Q1 2009 to Q1 2014 – and broken down by age and percentage of cohort (Table 6.0).[387]

The data highlights two key points:

1. The drastic reduction in 16- to 17-year-old NEETs from 109,000 (8.4%) in Q1 2009 to 46,000 (3.8%) in Q1 2014 reflects the effects of raising the school leaving age to 17 in 2013. It endorses the view[388] that, following the rise to 18 in 2015, the issue of NEETs for policy makers will be 18- to 24-year-olds.
2. Whilst numbers of 18- to 24-year-olds NEETs have fallen from 815,000 (17.4%) in Q1 2009 to 728,000 (15.4%) in Q1, having almost 1 in 6 in this age group still NEET is not acceptable collectively and, for individuals, a travesty.

Before moving on, it should be noted that the IPPR pointed out in its report, *Growing up and becoming an adult*, that with few entry-level jobs for school-leavers, most young people are now staying in education until they are 18. However, they highlight that many are not engaged in worthwhile learning. Previously, young people who left school without good qualifications would have gone straight into work, usually with formal training and structured progression routes. With this route now almost entirely cut off, many young people are working towards low-value vocational qualifications that fail to prepare them for work or further study.[389] Worryingly, IPPR predicts that one in five teenagers who gain low-level qualifications can expect to be neither working nor in further studies by the time they are 20.

6.1.1 The geography of youth unemployment

We are increasingly familiar and even desensitised to these UK NEETs figures. However, a recent report by the Work Foundation looked beneath these numbers at the geography of youth unemployment and found large differences in youth unemployment levels within the UK[390] that reflect a familiar pattern of labour market disadvantage. In most cases, the places with the highest youth unemployment rates are those that have experienced economic distress for some time and have failed to adjust to the changing geography of the UK's economy (Figure 6.0).[391] They also make the point that in some places youth unemployment is so high that young people may need to be supported to look for opportunities elsewhere.

Table 6.0: Not in Employment, Education, or Training (2009–2014) – England

NEET LFS Series		16-year-olds	17-year-olds	18-year-olds	16- to 17-year- olds	16- to 18-year- olds	16- to 24-year- olds	18- to 24-year- olds	19- to 24-year- olds
Q1 2009	**Number**	43,000	66,000	110,000	109,000	219,000	924,000	815,000	705,000
	Percentage of cohort	6.6%	10.0%	16.8%	8.4%	11.2%	15.5%	17.4%	17.5%
Q1 2010	**Number**	32,000	58,000	106,000	90,000	196,000	921,000	831,000	725,000
	Percentage of cohort	5.1%	8.6%	16.9%	7.0%	10.2%	15.3%	17.6%	17.7%
Q1 2011	**Number**	34,000	49,000	79,000	83,000	161,000	927,000	844,000	766,000
	Percentage of cohort	5.2%	7.9%	12.2%	6.5%	8.4%	15.4%	17.7%	18.6%
Q1 2012	**Number**	38,000	57,000	85,000	95,000	180,000	960,000	865,000	780,000
	Percentage of cohort	6.2%	9.0%	13.7%	7.6%	9.7%	15.9%	18.1%	18.8%
Q1 2013	**Number**	26,000	40,000	86,000	65,000	152,000	909,000	843,000	757,000
	Percentage of cohort	4.6%	6.0%	13.8%	5.4%	8.2%	15.1%	17.6%	18.2%
Q1 2014	**Number**	20,000	27,000	76,000	46,000	122,000	774,000	728,000	652,000
	Percentage of cohort	3.2%	4.6%	12.5%	3.8%	6.7%	13.1%	15.4%	15.9%

Source: Labour Force Survey
Q1 related to the months January – March

387 *Statistical First Release, NEET Quarterly Brief – January to March 2014*, Reference SFR 13/2014, 22 May 2014 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/312742/Quarterly_Brief_NEET_Q1_2014_Final.pdf **388** *No More NEETs, A Plan For All Young People To Be Learning Or Earning*, Graeme Cooke, Institute for Public Policy Research, November 2013 **389** *Growing up and becoming an adult*, Institute for Public Policy Research, November 2013, p5 **390** *The geography of youth unemployment: a route map for change*, The Work Foundation, April 2014, p5 **391** Uses travel to work areas

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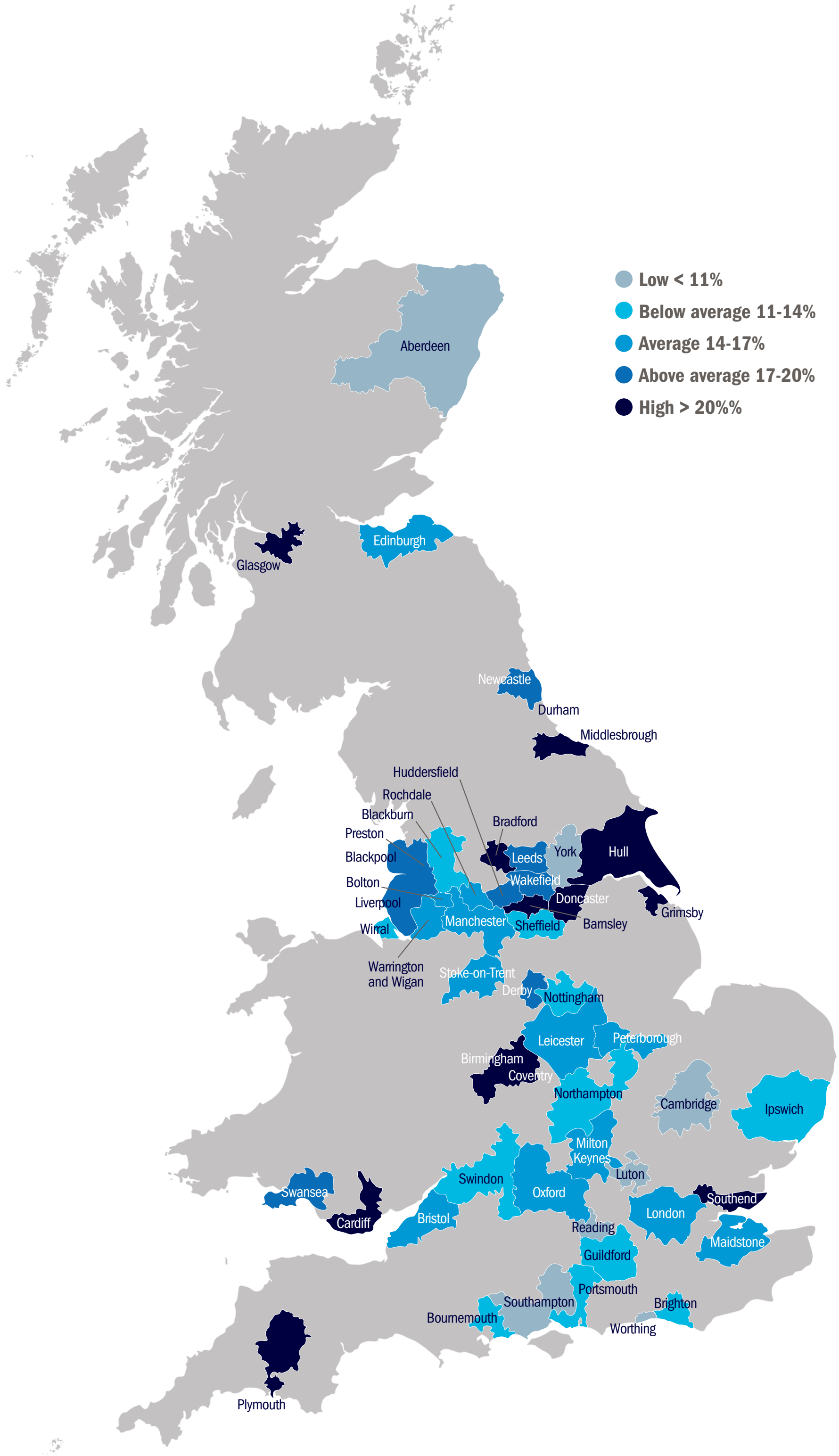
Fig. 6.0: NEET rates (2012/13) – UK



Source: The Work Foundation

6.1.2 London bucking the trend

The Department for Education statistics show an unprecedented and surprisingly high level of university entry among pupils on Free School Meals in inner London for pupils who finished school in 2011.[392]

The figures show that 63% of poor pupils in London schools and colleges progressed into Higher Education. Among pupils taking A levels, 53% on average went into Higher Education.

These figures challenge the idea that pupils from poorer backgrounds will perform less well at school than their wealthier counterparts.

The statistics show that the proportion of poorer pupils in inner London going into Higher Education (63%) is higher than better off pupils in the North East (54%), North West (57%), East Midlands (51%), West Midlands (53%), East of England (51%), South East (49%) and South West (47%). Furthermore, in all these regions the figures for poorer pupils – as defined by eligibility for Free School Meals – are even lower. In the South East of England, 34% of poorer pupils continue to Higher Education, little more than half the figure for inner London.

392 http://www.bbc.co.uk/news/education-28089648

6.1.3 What about everyone else?

Worldwide, young people are three times more likely than their parents to be out of work.[393]

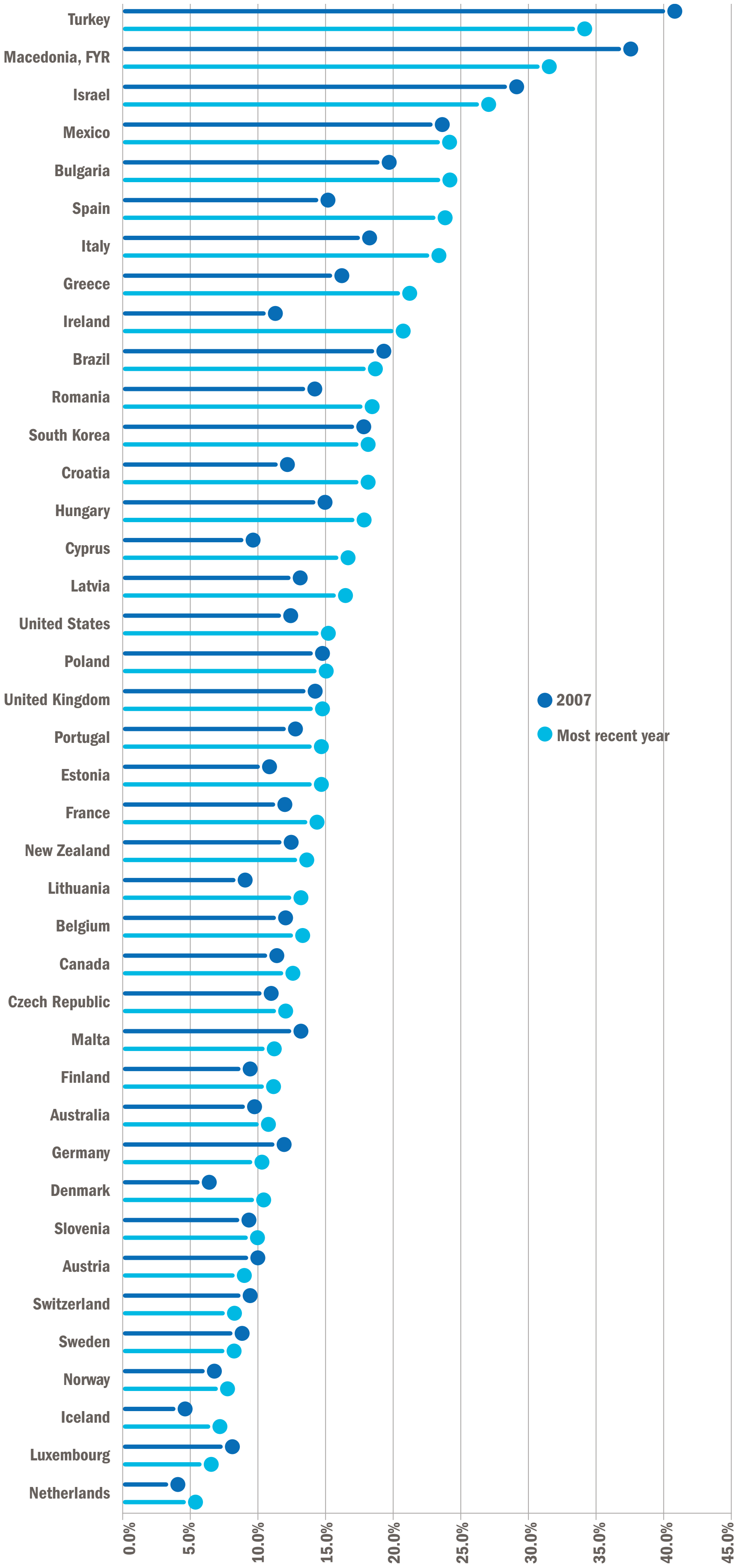
In Greece, Spain, and South Africa, more than half of young people are unemployed, and jobless levels of 25% or more are common in Europe, the Middle East, and Northern Africa. In the Organisation for Economic Co-operation and Development (OECD) countries, more than one in eight of all 15- to 24-year-olds are NEET.[394] Around the world, the International Labour Organization estimates that 75 million (13.1%) of young people are unemployed – up from 11.6% in 2007. Including estimates of underemployed youth would potentially triple this number.[395] This represents not just a gigantic pool of untapped talent. It is also a source of social unrest and individual despair.[396]

Within the European Union (EU) the situation is no better:

- Current youth unemployment levels in the EU are exceptionally high. According to Eurostat, the EU's statistical service, the seasonally adjusted rate of youth unemployment across the 28 EU Member States (EU28) stood at 22.9% in February 2014, more than double the overall unemployment rate of 10.6%.[397] In comparison, the EU 28 youth unemployment rate in 2007 was 12.1%.[398]
- There were 5.5 million unemployed young people (15- to 24-year-olds) looking for, but unable to find, work in the EU in the first quarter of 2013. Even more worryingly, there were more than 7.5 million young people classed as NEET – over 13% of the youth population.[399]
- Between 2007 and 2011/12, the share of young people aged 15–29 classed as NEET has risen in 30 out of the 40 countries for which figures are available (Figure 6.1). In Ireland and Spain, the NEET rate has risen by more than 9.4 and 8.7 percentage points respectively since 2007.[400]

Finally, it should be noted that, with the exception of Austria, Germany and Luxembourg, all Member States have seen an increase in the number of NEETs since the peak of the economic crisis in 2008.[401]

Fig. 6.1: Young people that are NEET as the share of the population aged 15–29 (2007 and most recent year)



Source: ILO (2013e, table 10c)

393 *Global Employment Trends 2014, Risk of a jobless recovery?*, International Labour Organisation, January 2014 394 "NEET rates among youth in OECD countries: Percentage of population aged 15–24, 2007 Q1–2011 Q1," OECD Employment Outlook 2012, Organisation for Economic Co-operation and Development (OECD), 2012. 395 Jenny Marlar, "Global unemployment at 8% in 2011," Gallup, April 2012. 396 *The geography of youth unemployment: a route map for change*, The Work Foundation, April 2014, p11 397 Eurostat news release, 1 April 2014, available at:http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/3-01042014-AP/EN/3-01042014-AP-EN.PDF 398 Eurostat, 'Youth unemployment rate', available at:http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/ 399 *European Jobs and Skills a Comprehensive Review 2014*, Institute of Public Policy Research, April 2014, p128 400 *Global Employment Trends 2014, Risk of a jobless recovery?*, International Labour Organisation, January 2014 401 Ibid

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6.2 New insights and data

The most relevant findings that have emerged since the last report are described in the following sub-sections.

6.2.1 GCSEs and under-achievement

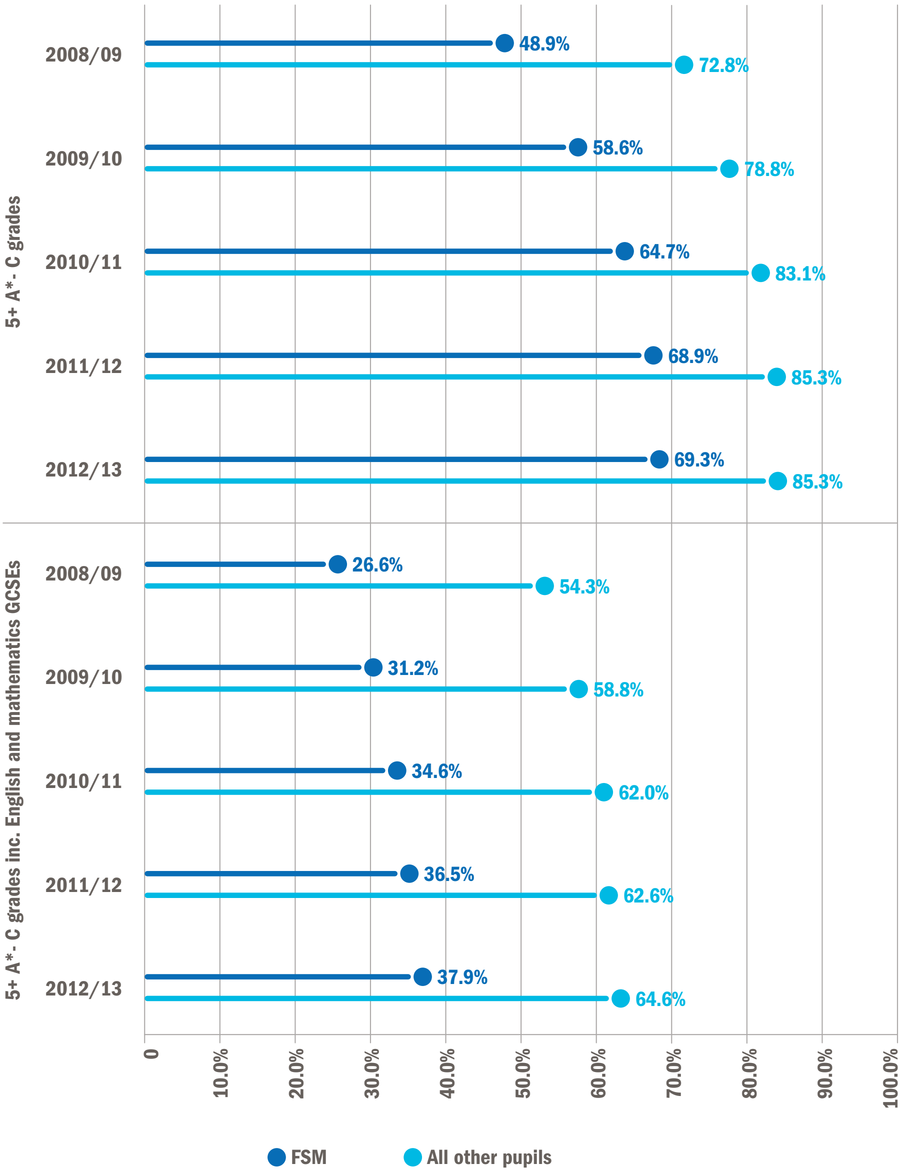
We have previously noted and referenced[402] the striking inequities between different cohorts of young people differentiated by their eligibility for Free School Meals (FSM). This is particularly evident with respect to attainment, ethnicity and school effectiveness, as the following three sections will show.

6.2.1.1 Free School Meals, disadvantaged pupils and attainment

Pupils known to be eligible for FSM performed less well as a group in all the main indicators at Key Stage 4, compared with all other pupils. Figure 6.2 clearly shows the startling difference in GCSE attainments for pupils eligible for FSM compared with all other pupils.[403]

The attainment gap for the percentage achieving five or more GCSEs at grade A* to C or equivalent narrowed by 8.0 percentage points between 2008/09 and 2012/13: 69.3% of pupils eligible for FSM achieving this indicator in 2012/13, compared with 85.3% of all other pupils. The attainment gap between the percentage achieving five or more GCSEs at grade A* to C or equivalent including English and mathematics narrowed by 1.0 percentage point between 2008/09 and 2012/13: 37.9% of pupils known to be eligible for FSM achieved this indicator compared with 64.6% of all other pupils.

Fig. 6.2: Percentage of pupils achieving 5 or more GCSEs at grade A*-C or equivalent, and 5 or more GCSEs at grade A*-C or equivalent including English and mathematics GCSEs or iGCSEs by Free School Meals eligibility (2008/09-2012/13)[404]



Source: Department for Education[405]

402 *Engineering UK 2014 The state of engineering*, EngineeringUK, December 2013, p42 403 Statistical First Release, SFR 05/2014, Department for Education, 23 January 2014 404 Revised data 405 *GCSE and Equivalent Attainment by Pupil Characteristics in England 2012/13*, Department for Education, 23 January 2014, p7

6.2.1.2 White working class children

"The underperformance of low-income white British pupils matters, particularly because they make up the majority – two-thirds – of such pupils. So the lowest-performing group of poor children is also the largest. If we don't crack the problem of low achievement by poor white British boys and girls, then we won't solve the problem overall".[406]

In June 2013, Ofsted's report *Unseen children: access and achievement 20 years on*[407] exposed the problem of "white working class children" underachieving in England's education system.[408] Ofsted described how white British children eligible for Free School Meals (FSM) were now the lowest-performing children at age 16, with only 31% of this group achieving five or more GCSEs at A*–C including English and Mathematics.[409]

Overall, the evidence[410] from analysing FSM data is that:

- white British children eligible for FSM are consistently the lowest performing ethnic group of children from low income households, at all ages (other than small subgroups of white children)
- the attainment 'gap' between those children eligible for FSM and the remainder is wider for white British and Irish children than for other ethnic groups
- this gap widens as children get older

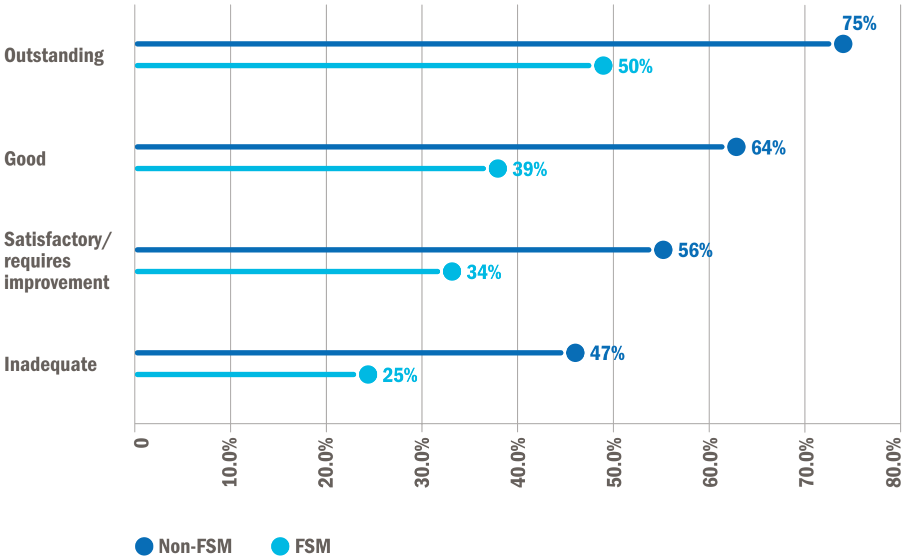
6.2.1.3 School Ofsted rating (quality)

We have seen (Section 6.2.1.1) that FSM pupils underachieve at GCSE. However, underachievement has also been shown to relate to school effectiveness (Ofsted rating).[411]

Figure 6.3 clearly shows that the attainment of five GCSEs at grade A*-C varies for both FSM and non-FSM cohorts depending on overall school effectiveness, but that the FSM cohort has consistently lower attainment of five GCSEs at grade A*-C compared with the non-FSM cohort for all school categories.

Finally, it is interesting to note that in addition to the differences related to school Ofsted rating, there are also differences dependent on the type of school a child attends. Research shows that during a person's early career – between the ages of 26 and 42 – someone attending independent school will earn on average £193,700 more than someone attending a state school. Compared with someone who attended state school, a person who went to independent school on average earns 43% more per hour at age 34, 35% more at age 38 and 34% more at age 42.[413]

Fig. 6.3: Percentage of pupils eligible for Free School Meals attaining five GCSEs at grade A*-C including English and mathematics, by school overall effectiveness judgement



Source: Ofsted[412]

6.2.2 Higher Education – access and progression

Social mobility matters for reasons of fairness: the circumstances of a person's birth should not determine the life they go on to lead. There is also a strong economic rationale. Untapped potential is a waste of productive resources that no country can afford if it is to compete effectively in the global market. Increasing social mobility supports the drive toward sustainable growth by creating a more highly skilled workforce and putting people in the right jobs for their talents.[414]

Those who go to university in the UK derive great benefits in their lives.[415] They are more likely to be employed, more likely to enjoy higher wages and better job satisfaction, and more likely to find it easier to move from one job to the next. Higher Education enables individuals from low-income backgrounds to enter higher status jobs and increase their earnings. Graduates also enjoy substantial health benefits – a reduced likelihood of smoking, and lower incidence of obesity and depression. They are less likely to be involved in crime, more likely to be engaged with their children's education and more likely to be active in their communities.

However, with respect to access to and progression within Higher Education – the playing field is not level.

6.2.2.1 Access

There is a clear strategy[416] for access and student success in Higher Education; with the unifying ideal being that everyone with the potential to benefit from Higher Education should have equal opportunity to do so.

However, a gap still remains between the participation rates of disadvantaged and advantaged young people.[417] Figure 6.4 shows that across the period 1998/99–2011/12, participation 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 are now three times higher than quintile 1, compared with around four times higher at the start of the period.[418]

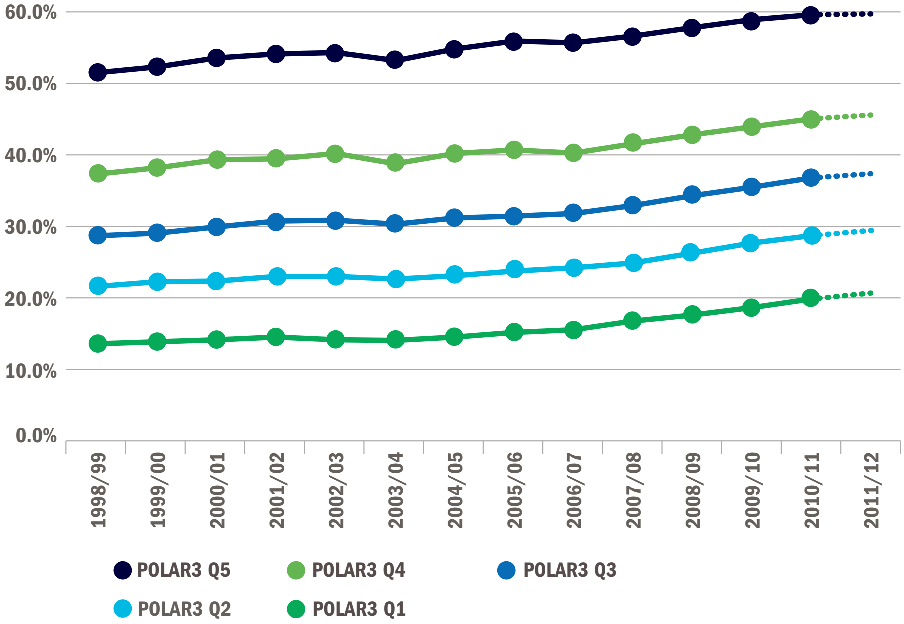
406 Ofsted, Unseen children – HMCI speech (June 2013), p4 407 Ofsted, Unseen children: access and achievement 20 years on (June 2013) 408 "White working class boys are consigned to education scrapheap, Ofsted warns", The Daily Mail, 15 June 2012 409 Ofsted, Unseen children: access and achievement 20 years on (June 2013), p30 410 *Underachievement in Education by White Working Class Children*, House of Commons Education Committee, 11th June 2014, p19 411 *Underachievement in Education by White Working Class Children*, House of Commons Education Committee, 11 June 2014, p26 412 Ofsted, *Unseen children: access and achievement 20 years on* (June 2013), p30 413 *Open Access An independent evaluation*, Social Market Foundation, 3 July 2014, p9 414 *Higher Education as a tool of social mobility: Reforming the delivery of HE and measuring professional graduate output success*, Centre Forum, May 2014, p8 415 *Securing a Sustainable Future for Higher Education in England*, Lord Browne, 2010 416 *National strategy for access and student success in Higher Education*, Department for Business, Innovation and Skills, April 2014 417 *ibid,* p19 418 http://www.hefce.ac.uk/whatwedo/wp/ourresearch/polar/polar3/

There are also notable differences between lower, medium and higher entry tariff Higher Education Institutions (HEIs). Figure 6.5 shows that the participation rate of this group at **universities with high entry tariffs** has remained relatively flat since the late 1990s,[419] peaking at 3.1% in the 02/03 cohort and remaining at, or below, 3% since then. By contrast, participation rates for this group at medium and lower entry tariff institutions have increased since the early 2000s, rising sharply since the 07/08 cohort, and with the greatest increase at lower tariff institutions (from 6% for the 07/08 cohort to 8.5% for the 11/12 cohort).

These large differences in the chances of young people from disadvantaged backgrounds entering high tariff universities compared with their more advantaged peers are partly explained by prior attainment at school. This often leaves them lacking the necessary grades in the requisite subjects to meet highly selective universities' entry requirements:[420]

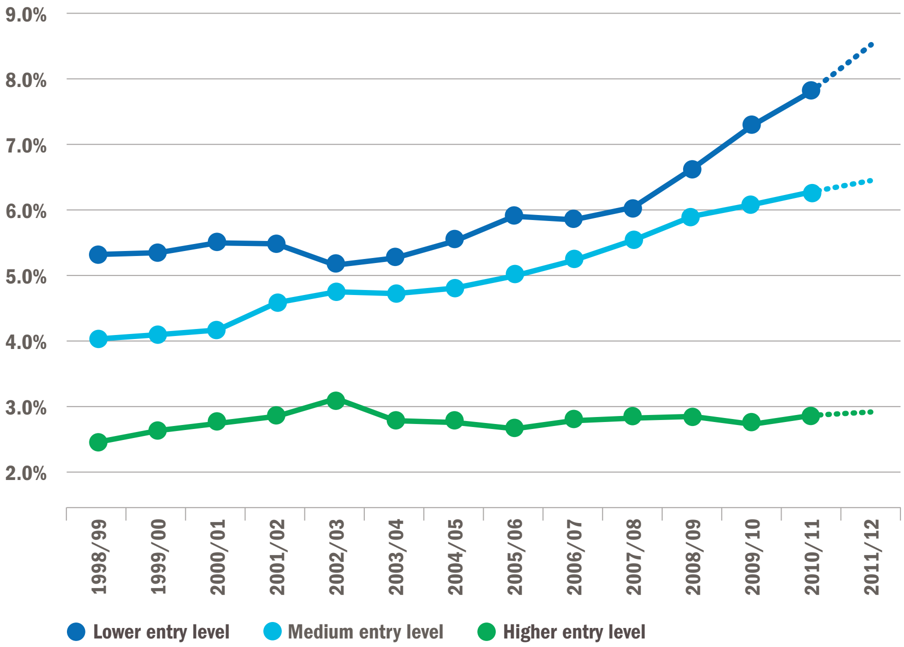
"The picture ... is one of early inequality in attainment amongst pupils from disadvantaged backgrounds which increases incrementally through primary and secondary education. Disadvantaged pupils may well have had a more limited curriculum choice from the age of 14 and are significantly less likely to progress to post-16 education than their advantaged peers, even if they are very able. When they do progress, they are less likely to achieve the highest grades. As many as 60,000 pupils (10% of the cohort) were at some point in the top fifth of school performers, but did not enter HE by age 19."[421]

Fig. 6.4: Young participation rate for all POLAR3 quintiles (1998/99-2011/12)



Source: HEFCE 2013/28

Fig. 6.5: Participation rates by selectivity for most disadvantaged 40% of young people



Source: OFFA 2014/01

419 *National strategy for access and student success in Higher Education*, Department for Business, Innovation and Skills, April 2014, p222 **420** *National strategy for access and student success in Higher Education*, Department for Business, Innovation and Skills, April 2014, p26 **421** Harris, Sir Martin "What more can be done to widen access to highly selective universities?" (OFFA 2010/03), available at www.offa.org.uk/publications

6.2.2.2 Progression

Unfortunately, the disparities continue in Higher Education. For example, Figure 6.6 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%.[422]

This is further compounded for those who progress beyond the first year with their university education, as there remains a difference in attainment when you look at the proportion of students attaining a first or upper second by their prior A level attainment for POLAR quintiles 1 and 5.[423] This difference is evident, students from quintile 1 (who are least likely to progress to university) on average do worse than students from quintile 5 (students who are most likely to progress to university) even though they had the same A level attainment at the outset.[424]

6.2.3 Careers and engagement with young people

We have already highlighted[425] the critical contribution of careers information, advice and guidance at a national level for the future of STEM and, indeed, all areas of the economy. However, it is dismaying to see that even on this aspect the FSM cohort is often at a disadvantage, particularly with respect to access.

The IPPR report *Driving a generation* highlights that pupils as young as 12 are engaged in thinking seriously about their careers. However, they want more help, more work experience, and more information about local job opportunities, including visits from employers and visits to their sites. Pupils need this help: the lack of interest in post-GCSE science, technology, engineering and mathematics (STEM) courses and vocational education among girls, for example, is a cause for concern given that skills shortages in these sectors are looming. IPPR also found evidence that pupils had insufficient knowledge about which careers did and did not have science qualifications as prerequisites. These findings demonstrate the importance of educating young people early on about both careers and the educational choices they will need to make to realise their ambitions. It is an issue for pre-GCSE ages, not just after the age of 16.[426]

However, studies by the Wellcome Trust[427] have identified that young people from disadvantaged backgrounds are less likely to access informal science learning opportunities. This is of serious concern, given that such experiences can develop personal, social and emotional skills, nurture relationships between young people and their peers and adults, and benefit their educational outcomes.[428]

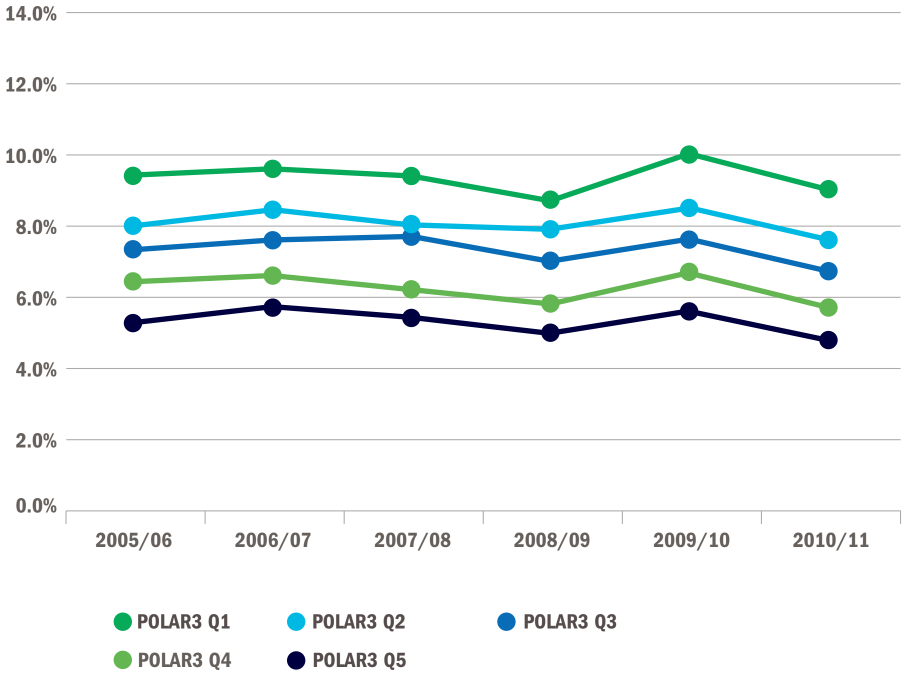
Furthermore, the studies concluded that the classroom is not always a welcome environment to learn about science, especially for those who are more disengaged from formal (school-based) learning.[429] To this end, it is important that opportunities to engage with science outside of formal education in the classroom – that is, opportunities for informal learning – are as accessible and engaging for disadvantaged groups as they are for those families from better-off backgrounds, who already make extensive use of such activities.

Yet, the Wellcome Trust found that young people from low socio-economic status (SES) families are less likely to have access to informal science learning opportunities, which places them at an educational and, in the long term, economic disadvantage.[430]

The access to informal science learning and engagement with cultural opportunities and out-of-school activities is even more important for young people from low SES families.[431] Research shows that differences in experiences over the summer period can attribute to around two-thirds of the difference in learning between low and high SES students during the school year.[432, 433]

Interestingly, research has shown a strong link between visits by children to museums and galleries and participation in the arts as adults. An analysis[434] of data from the *Taking Part* survey, a large-scale survey of cultural participation conducted by the Department for Culture, Media and Sport (DCMS). The analysis showed that being encouraged by parents to

Fig. 6.6: Percentage of young entrants who are no longer in HE after one year, by POLAR3 classification



Source: HEFCE 2013/07

422 *National strategy for access and student success in Higher Education*, Department for Business, Innovation and Skills, April 2014, p52 **423** *Differences in degree outcomes: Key findings*, Higher Education Funding Council for England, March 2014, p26 **424** For further details see Figure 11.18 **425** See Section 1.1.6 for more details **426** http://www.ippr.org/images/media/files/publication/2014/01/Driving-a-generation_Jan2014_11820.pdf **427** *Experiments in Engagement: Engaging with young people from disadvantaged backgrounds*, Wellcome Trust, April 2014 http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtp056346.pdf **428** *ibid* **429** Experiments in Engagement: Engaging with young people from disadvantaged backgrounds, Wellcome Trust, April 2014 http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtp056346.pdf, p4 **430** *ibid*, p2 **431** *ibid*, p8 **432** Alexander KL, Entwisle DR, Olson LS. *Lasting consequences of the summer learning gap.* American Sociological Review 2007;72:167-80. **433** Downey DB, von Hippel PT, Broh B. *Are schools the great equalizer? Cognitive inequality during the summer months and the school year.* American Sociological Review 2004;69(5):613-35. **434** Oskala A et al. *Encourage children today to build audience for tomorrow: Evidence from the Taking Part Survey on how childhood involvement in the arts affects arts engagement in adulthood.* London: Arts Council England; 2009. [Online] Available at http://www.artscouncil.org.uk/media/uploads/documents/publications/Encouragechildrentoday_phpxNJHVZ.pdf participate in arts activities (eg drawing, writing stories, music, acting, dancing) and attend arts events (eg exhibitions, theatre, music, carnivals, arts festivals) when growing up has a strong influence on the chances of being an active arts consumer as an adult, second only to education. This effect is seen even when all other factors such as gender, age, ethnicity, social status, income and education are taken into account.

And whilst this is not specifically about engagement with informal science learning opportunities, it could be suggested that similar principles may apply for science learning and it would be an interesting point for future research.

6.2.4 Women

Unfortunately, even in these enlightened times we still find ourselves having to explicitly highlight the under-utilised position of women. To this end, the Women's Business Council (WBC)[435] was set up in 2012 to advise Government on how women's contribution to growth can be optimised.

At a basic level, there is an economic argument to be made. The WBC report *Maximising women's contribution to future economic growth*[436] makes the point that while women need work, work also needs women. By equalising the labour force participation rates of men and women, the UK could increase GDP per capita growth by 0.5 percentage points per year, with potential gains of 10% of GDP by 2030.[437] The Council also states that there are over 2.4 million women who are not in work but want to work, and over 1.3 million women who want to increase the number of hours they work.[438]

Additionally, IPPR research has shown that many women with young children find themselves juggling care and work responsibilities. For some of these women reconciling these two responsibilities can become too great a task and some eventually leave work to care.[439]

This is an unnecessary loss to the economy. If the employment rate of women increased by 10%, it would mean an extra 1.3 million women in paid work. In turn, the Government would raise an extra £1.7 billion in income tax and £2.1 billion in national insurance contributions – £3.8 billion in total. It would also make substantial savings on the social security budget (£5.5 billion).

Is the UK making any progress?

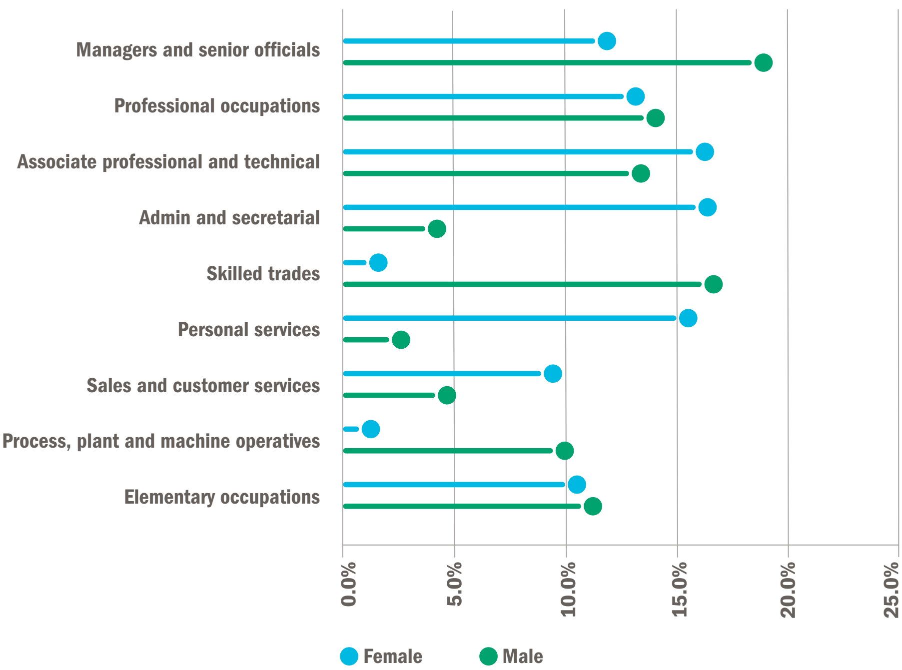
Professional Boards Forum BoardWatch[440] tracks the appointments of women to UK boards following the publication of Lord Davies's report in February 2011. Following the appointment of Patrice Merrin as non-executive director at Glencore plc on 26 June 2014, the Forum was able to announce that "there are no all-male boards on the FTSE 100". In fact, 21.6% of FSTE 100 companies[441] have female directors – up from 12.5%. 26.9% of these women are non-executive directors (up from 15.6%) and 6.9% are executive directors (up from 5.5%).

In terms of employment, the latest records show that 67.2% of women aged 16-64 were in employment in the fourth quarter of 2013, the highest proportion since comparable records began in 1971. This compares to a male employment rate of 77.1%.[442]

Whilst it is pleasing to note that employment of women is at the highest level ever, Figure 6.7 shows the inequities in the types of roles compared with men. Twelve percent of women in employment work as managers or senior officials, compared with 19% for men. Fourteen percent of women are employed in professional occupations, slightly lower than the 15% of men working in these roles.[443] It also shows that many more women than men work in administrative and secretarial occupations and in personal services occupations.

It is not only in the workforce that women are at a disadvantage. We have highlighted the importance of maths and physics as key subjects leading to engineering careers[444] and, in particular, emphasised the relatively lower progression of physics GCSE students to AS level. In *It's different for girls* (2012) the Institute of Physics (IoP) demonstrated that the situation is worse for girls: almost half (49%) of state-funded, co-educational schools sent no girls at all to do A level physics. They did however find that a girl is four times more likely to take physics A level if she attends a single-sex, independent school than if she attends a state, mixed school. These results have led to a qualitative shift in IoP thinking on this issue,

Fig. 6.7: Employment by occupation and gender (Q4 2013) – UK



Source: Working Futures 2012-22

435 http://womensbusinesscouncil.dcms.gov.uk/ **436** *Maximising women's contribution to future economic growth*, Women's Business Council, DCMS, June 2013 http://womensbusinesscouncil.dcms.gov.uk/ **437** *Effects of Reducing Gender Gaps in Education and Labour Force Participation on Economic Growth in the OECD, OECD Social, Employment and Migration Working Papers No. 138*, OECD, 2012 **438** Labour Force Survey, Q4 2012 **439** http://www.leftfootforward.org/2014/06/employment-is-up-yet-again-but-the-job-is-not-quite-done/ 12-06-14 **440** http://www.boardsforum.co.uk/boardwatch.html **441** http://www.boardsforum.co.uk/boardwatch.html, accessed 24th July 2014 **442** Debate on Contribution of women to the economy: House of Commons Library briefing note, Last updated: 4 March 2014, p1 **443** Debate on Contribution of women to the economy: House of Commons Library briefing note, Last updated: 4 March 2014, p4 **444** See Sections 1.1.5 and 11.6.4 for further details whereby they now take it that the school environment is preventing many girls from benefiting from the opportunities that physics A level offers. There is no problem with girls' academic achievement: generally girls outperform boys in physics, as they do in most subjects.

The last word in this sub-section go to The World Economic Forum who make the gender point most succinctly: "over time, therefore, a nation's competitiveness depends, among other things, on whether and how it educates and utilizes its female talent."[445]

6.3 Government action

Three main Government departments have responsibility for a particular area of youth policy:[446]

- The Department for Education has overall responsibility for education (up until the ages of 18) and children's services in England.
- The Department for Business, Innovation and Skills is responsible for working with Further and Higher Education providers to ensure they are supporting people to gain the skills they need to compete in the global economy.
- The Department for Work and Pensions is responsible for welfare and pension policy, including the provision of services through Jobcentre Plus, and oversees the Government's two main employment schemes: the Work Programme (for the long term unemployed) and Work Choice (for people with disabilities).

In addition to these departments and to ensure the coordination of business across Government it was announced in July 2013 that the Government is putting young people at the heart of policy-making by asking the Cabinet Office[447] to lead the next phase of cross-Government youth policy.

The Government has also established a package of measures to help young people get the best possible start in life. This includes:[448]

- introducing a rigorous new curriculum and world-class qualifications, ensuring proper preparation for Further and Higher Education, and work
- ensuring that young people who have not achieved at least a C in GCSE English or maths must continue studying those subjects up to the age of 18
- removing low-quality vocational qualifications from league tables in favour of courses proven to deliver the skills employers demand
- introducing a £30 million package of funding designed to improve prospects for up to 20,000 vulnerable young people, helping to prevent them becoming NEET
- spending £7.2 billion in 2014/2015 to fund a place in education or training for every 16- or 17-year-old who wants one
- encouraging schools and colleges to use employers to mentor and inspire young people towards ambitious careers, as part of revamped careers guidance
- raising the participation age so that young people in England are now required to continue in education or training beyond the age of 16
- introducing the 2015 Pupil Premium Awards[449] across England: schools that do the most to help disadvantaged pupils improve their results stand to win a share of £4 million

Alongside these measures we should record the role of Traineeships. These were introduced in England in August 2013 to support a significant number of young people into apprenticeships and other employment opportunities.[450] Their core target group 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 16-19 and qualified below level 3, or 19-24 and have not yet achieved a full level 2
- training providers and employers believe have a reasonable chance of being ready for employment or an apprenticeship within six months of engaging in a Traineeship

In addition, the Government has asked Local Enterprise Partnerships (LEPs) to consider the following activities:[451]

- reducing the number of NEETs and those at risk of disengaging
- providing additional literacy and numeracy support for young people
- developing additional and innovative approaches to support and motivate young people with no or few qualifications into training and the workplace
- creating innovative programmes for marginalised groups to help bring them to and support them in learning
- providing support to embed programmes for young NEETs
- brokering opportunities for young people and supporting local employers to take on young people who are NEET

Closer to home

In June 2014 came the announcement of a £30 million fund to increase the supply of engineers, to encourage more women into the sector and to address engineering skills shortages in smaller companies. The fund will enable engineering companies to establish training programmes to develop future engineers and boost the number of women in the profession.[452]

445 *The Global Gender Gap Report2013*, World Economic Forum, 2013, p31 **446** *The geography of youth unemployment: a route map for change*, The Work Foundation, April 2014, p16 **447** https://www.gov.uk/government/news/cabinet-office-to-take-on-responsibility-for-cross-government-youth-policy **448** https://www.gov.uk/government/news/lowest-rate-of-young-people-neet-for-20-years 25 June 2014 **449** https://www.gov.uk/government/news/schools-best-at-helping-disadvantaged-pupils-to-share-4-million-prize-fund **450** *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, p26 **451** *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 **452** Website accessed on the 12 June 2014 (https://www.gov.uk/government/news/30-million-fund-to-secure-supply-of-engineers-and-boost-number-of-women-in-sector)

6.4 Cost to the economy

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.[453]

Over their working life, a person who has been NEET will lose up to £50,000 in earnings compared with a non-graduate peer who has never been NEET, and up to £225,000 compared with a graduate peer who has never been NEET.[454] Furthermore, the cost to Britain's NEET problem is around £22 billion in additional public spending and in excess of £77 billion a year when including lost income.[455]

Save the Children[456] has looked at this issue from a different angle. The charity determined that, if the UK had taken action in recent decades to close the achievement gap at 11, so that the poorest pupils achieved the same levels as others by the end of primary school, then:

- 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

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, then:

- 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.[457]

453 *Higher Education as a tool of social mobility: Reforming the delivery of HE and measuring professional graduate output success*, Centre Forum, May 2014, p8 **454** *Make NEETs History in 2014*, Impetus Private Equity Foundation, January 2014, p11 **455** Coles, B; Godfrey, C; Keung, A et al (2010) *Estimating the life-time cost of NEET: 16- to 18-year-olds Not in Education, Employment or Training*. University of York, York. **456** *Too young to fail – Giving all children a fair start in life*, Save the Children, 2013, p9 **457** *Education to Employment: Getting Europe's Youth into Work*, McKinsey Center for Government, p5

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Part 2 - Engineering in Education and Training
7.0 GCSEs and equivalent qualifications

Whilst the UK education qualifications system is becoming more demanding, it is also becoming more fragmented, making it impractical to compare accurately this year's and last year's 'supply' figures. However, we can at least determine that in 2014 there were 777,236[458] entrants to GCSE or equivalent mathematics and 173,958[459] GCSE or equivalent entrants to physics across the UK. There were also 26,169 entries to iGCSE mathematics and 15,688 to physics in 2012/13.

7.1 Education in England

Like the rest of the education system, the GCSE system – particularly in England – is going through a period of considerable change. The independent review from Lord Lingfield[460] highlighted the need for improvement when he showed that in 2011, 14% of 16- to 18-year-olds were functionally illiterate and over a quarter (28%) were functionally innumerate. To compound this problem, the state-funded school-aged secondary school population up to the age of 15 is projected to increase by 17% between 2014 and 2023.[461]

It is worth noting that students themselves want to do well at school: 60% of 11- to 15-year-olds say it means a great deal and a third (34%) say it means quite a lot, while 98% say that getting their GCSEs is very important (77%) or important (21%).[462] So while there are challenges that need to be addressed and the state-funded secondary school population is growing, the desire to do well exists amongst students.

Since the coalition Government has come to power, there has been significant growth in the number of academy schools. By July 2014, there were almost 4,000 academies.[463] Over half of secondary schools are now academy schools.[464] Academy schools can be sponsored and, to date, 45 FE Colleges are co-sponsors of academy schools,[465] while 110 independent schools are also supporting academies, either individually or via federations or groups of academy schools.[466]

Free schools were launched by the Department for Education in June 2010.[467] By September 2013, 93 free schools opened, raising the total number to 174,[468] with a further 105 scheduled to open in September 2014.[469] The 174 free schools operating in September 2013 were educating an estimated 24,000 pupils.[470]

The Department for Education expects free schools to raise the quality of education by:[471]

- increasing local choice for parents
- injecting competition between local schools
- tackling educational inequality
- encouraging innovation

However, the National Audit Office has shown that 42 free schools have opened in areas with no forecast need for extra school places.[472]

University Technical Colleges (UTCs) were launched in September 2010.[473] There are 50 UTCs either open or in development, and they will create places for 30,000 students.[474] The development of UTCs has been supported by 320 employers, over 40 universities[475] and 45 FE Colleges.[476]

There are also 45 studio schools open or in development which will provide places for 15,000 young people. Over 400 employers are supporting studio schools by helping to shape the curriculum and by providing work experience and mentoring opportunities.[477]

458 This is a combination of GCSE maths plus equivalent Scottish qualifications (excluding lifeskills mathematics and those studying Scottish qualifications which are not comparable to GCSE A*-C grades) **459** This is a combination of GCSE physics, plus those completing further additional science and equivalent Scottish qualifications (excluding those studying Scottish qualifications which are not comparable to GCSE A*-C) **460** *Professionalism in Further Education Final Report of the Independent Review Panel*, The Lord Lingfield Kt, MEd DLitt FCGI DL, October 2012, p18 **461** *National Pupil Projections – Future Trends in Pupil Numbers*, Department for Education, 16 July 2014, p2 **462** *Educational aspirations and attitudes over the business cycle*, Institute for Social and Economic Research, November 2012, p8 **463** *Academies annual report Academic year: 2012 to 2013*, Department for Education, July 2014, p6 **464** *The Annual Report of Her Majesty's Chief Inspector of Education, Children's Services and Skills*, Ofsted, 11th December 2013, p7 **465** *College Key Facts 2013/14*, Association of Colleges, 2013, p16 **466** *ISC Census 2014*, Independent Schools Council, 2014, p22 **467** *Establishing Free Schools*, National Audit Office, 11th December 2013, p5 **468** *Academies annual report Academic year: 2012 to 2013*, Department for Education, July 2014, p40 **469** *Establishing Free Schools*, National Audit Office, 11th December 2013, p5 **470** *Establishing free schools*, House of Commons Committee of Public Accounts, 30 April 2014, p9 **471** *Establishing Free Schools*, National Audit Office, 11th December 2013, p5 **472** *Establishing Free Schools*, National Audit Office, 11th December 2013, p15 **473** *Autumn Statement 2013*, HM Treasury, December 2013, p52 **474** *Academies annual report Academic year: 2012 to 2013*, Department for Education, July 2014, p43 **475** *Academies annual report Academic year: 2012 to 2013*, Department for Education, July 2014, p43 **476** *College Key Facts 2013/14*, Association of Colleges, 2013, p16 **477** *Academies annual report Academic year: 2012 to 2013*, Department for Education, July 2014, p44

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.

As well as changing the profile of schools in England, the Government is also changing how they are held accountable. The Department for Education has announced a new accountability framework, which will be based on 2016 exam results.[478] The new framework will consist of:[479]

- progress across eight subjects (which will be called Progress 8)
- attainment across eight subjects (which will be called Attainment 8)
- the percentage of pupils achieving a C grade or better in both GCSE or iGCSE English and maths
- the English Baccalaureate

The Government is also in the process of reviewing the national curriculum.[480 481] However, it is difficult to determine what the impact of these measures will be. Academy schools, which now form a majority of secondary schools in England, don't have to follow the national curriculum.[482] This poses a potential risk for the engineering community as under the national curriculum it is compulsory to study maths and science at Key Stage 4.[483]

GCSE subjects are also being reviewed by the Department for Education and Ofqual. The reformed English literature, English language and mathematics GCSEs will be available for teaching from 2015, with sciences following in 2016.[484]

A new grading system for the revised GCSE subjects is also proposed, with scores ranging from 9-1 (9 being the highest grade).[485]

The Government is also introducing approved vocational qualifications for 14- to 19-year-olds that will count in the Key Stage 4 performance tables.[486] In June, the Government also published guidance for awarding bodies for the requirements of 14- to 16-year-old qualifications in order for them to be counted in the performance tables.[487]

The English Baccalaureate (EBacc) was introduced in 2009/10 and recognises achievement across:[488 489]

- English
- maths
- two sciences
- a language
- history or geography

However, there is a sharp division in the proportion of students in selective state schools (92%) who have at least five good GCSEs in EBacc subjects, compared with a third (33%) in non-selective state schools.[490]

The Government has recognised the importance of continuing the study of maths and from September 2013, students who don't have a GCSE A*-C in maths will be expected to continue their study towards this qualification as part of their 16-19 education.[491] In 2014, 37.6% of 16-year-olds studying maths failed to get an A*-C grade.

The Government is also introducing core maths for those students who achieve a grade A*-C at GCSE level but who don't continue with advanced maths after age 16.[492] It is estimated that the introduction of core maths could affect over 200,000 students per year.

The Department for Education is also investing in the education sector. In addition to money allocated for opening new free schools and UTCs, the Government is investing £2.35 billion to create new places for the rising school population.[493] This is on top of the £5 billion already committed to increasing school places. In addition to this expenditure to increase the number of places, the Department for Education is spending £2 billion on rebuilding and repairing schools for the period 2015 to 2021.[494]

However, despite all this investment, the Department for Education has projected it faces a budget shortfall of £600 million in 2015/16, which will rise to £4.6 billion by 2018/19.[495] This budget shortfall is being driven by an increase in the school population, increased teacher pay and pension contributions and the costs associated with new policies.[496]

In addition, it should be noted that there is a considerable spending gap between state schools and independent schools. In 2011/12, average expenditure per state pupil in secondary academies was £6,058 but average fees for independent schools in 2012 were double this, at £12,153.[497] Research has also indicated that capital expenditure, per pupil, for independent schools is roughly three times that of capital spend for state schools.[498]

7.1.1 Free School Meals and social mobility[499]

To be eligible for Free School Meals, the parent or children must receive one of the following benefits:[500]

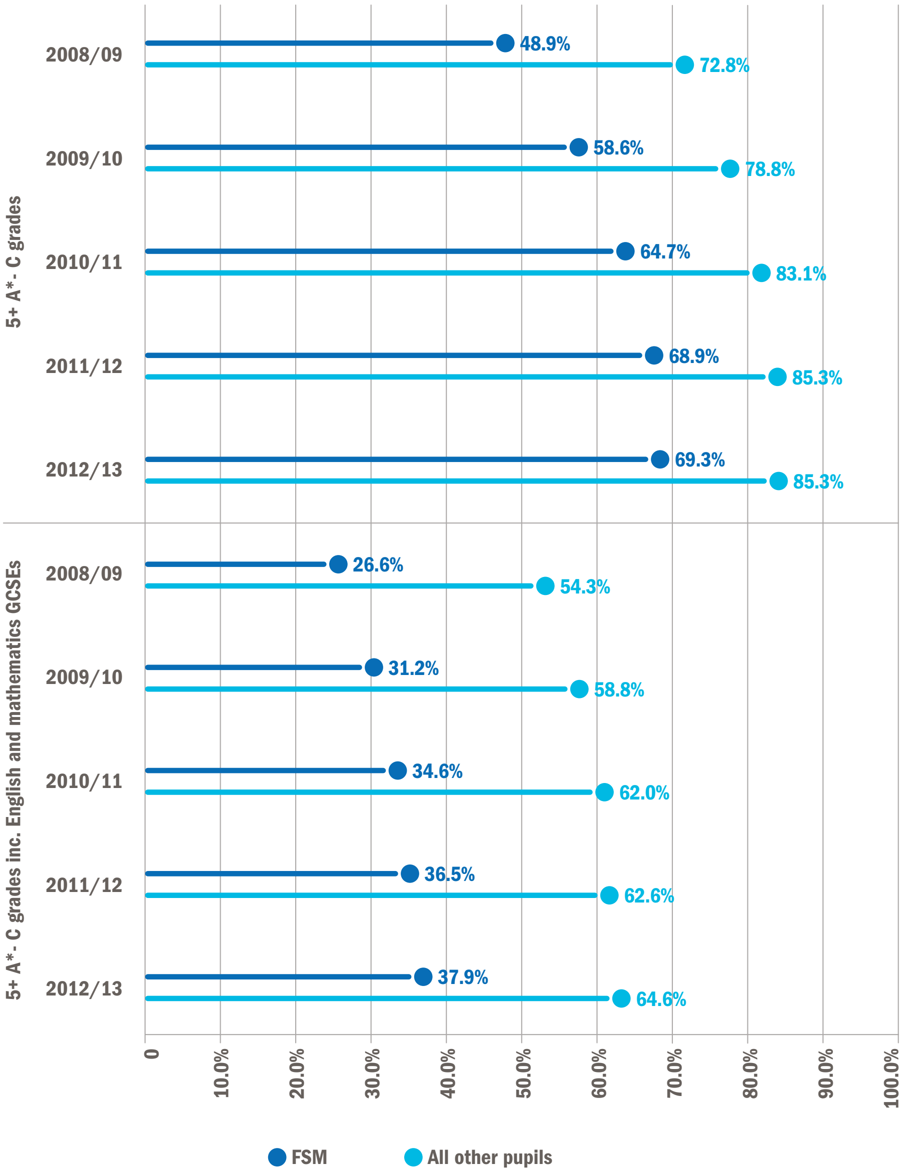
- Income Support
- Income-based Jobseekers Allowance
- Income-related Employment and Support Allowance
- Support under Part VI of the Immigration and Asylum Act 1999
- the guaranteed element of State Pension Credit
- Child Tax Credit (provided they are not also entitled to Working Tax Credit and have an annual gross income of no more than £16,190)
- Working Tax Credit run-on – paid for four weeks after qualification for Working Tax Credit ends
- Universal Credit (currently in place in pathfinder areas only)

According to Ofsted, nationally, 16% of secondary school students are eligible for Free School Meals.[501]

Figure 7.0 shows that between 2008/09 and 2012/13 the proportion of students attaining five GCSEs at grades A*-C including maths and English has increased for both students in receipt of Free School Meals and all other students. However, the percentage point gap between students on Free School Meals and all other students was 27.7% in 2008/09, and by 2012/13 this had decreased by only one percentage point to 26.7%.

478 *Key Stage 4 performance tables: inclusion of 14 to 16 qualifications 2016*, Department for Education, December 2012, p3 **479** For further details on school accountability see https://www.gov.uk/government/consultations/secondary-school-accountability-consultation **480** Website accessed on the 28 August 2014 (https://www.gov.uk/government/collections/national-curriculum-review) **481** The national curriculum review will include the content of biology, chemistry, physics and double award science to be taught in 2016 **482** Website accessed on the 28 August 2014 (https://www.gov.uk/types-of-school/academies) **483** For a full list of national curriculum subjects please see https://www.gov.uk/national-curriculum/key-stage-3-and-4 **484** *Results of the consultation on revised A level subject content,* Professor Mark E. Smith, March 2014, p6 **485** *GCSE Mathematics Helping you make the most of the new approach – a brief guide to an exciting new specification for first teaching in September 2015*, OCR, p2 **486** For further details please see https://www.gov.uk/government/publications/vocational-qualifications-for-14-to-19-year-olds **487** For further details please see https://www.gov.uk/government/publications/14-to-16-qualifications-technical-guidance **488** *GCSE and Equivalent Attainment by Pupil Characteristics in England 2012/13*, Department for Education, 23 January 2014, p4 **489** For a list of EBacc eligible subjects please see https://www.gov.uk/government/publications/english-baccalaureate-eligible-qualificationsm **490** *Progress made by high-attaining children from disadvantaged backgrounds Research report*, Social Mobility and Child Poverty Commission, June 2014, p8 **491** *Level 1 and 2 Attainment in English and Mathematics by 16-18 Students*, Department for Education, 10th October 2013, p1 **492** *Introduction of 16 to 18 core maths qualifications Policy Statement*, Department for Education, December 2013, p3-4 **493** Website accessed on the 28 August 2014 (http://www.bbc.co.uk/news/education-25432376) **494** Website accessed on the 28 August 2014 (http://www.bbc.co.uk/news/education-27238259) **495** *The Department for Education budget after 2015*, Association of Colleges, May 2014, p2 **496** *The Department for Education budget after 2015*, Association of Colleges, May 2014, p2 **497** *Open Access An independent evaluation*, Social Market Foundation, 3 July 2014, p19 **498** *Open Access An independent evaluation*, Social Market Foundation, 3 July 2014, p19 **499** Also see Section 6.2.1.1 for additional information on Free School Meals **500** *Free school meal entitlement and child poverty in England*, Department for Work and Pensions, December 2013, p4 **501** *Maintaining curiosity*, Ofsted, November 2013, p28

Fig. 7.0: Percentage of pupils achieving 5 or more GCSEs at grade A*-C or equivalent, and 5 or more GCSEs at grade A*-C or equivalent including English and maths by Free School Meals eligibility (2008/09-2012/13) – England



Source: Department for Education[502]

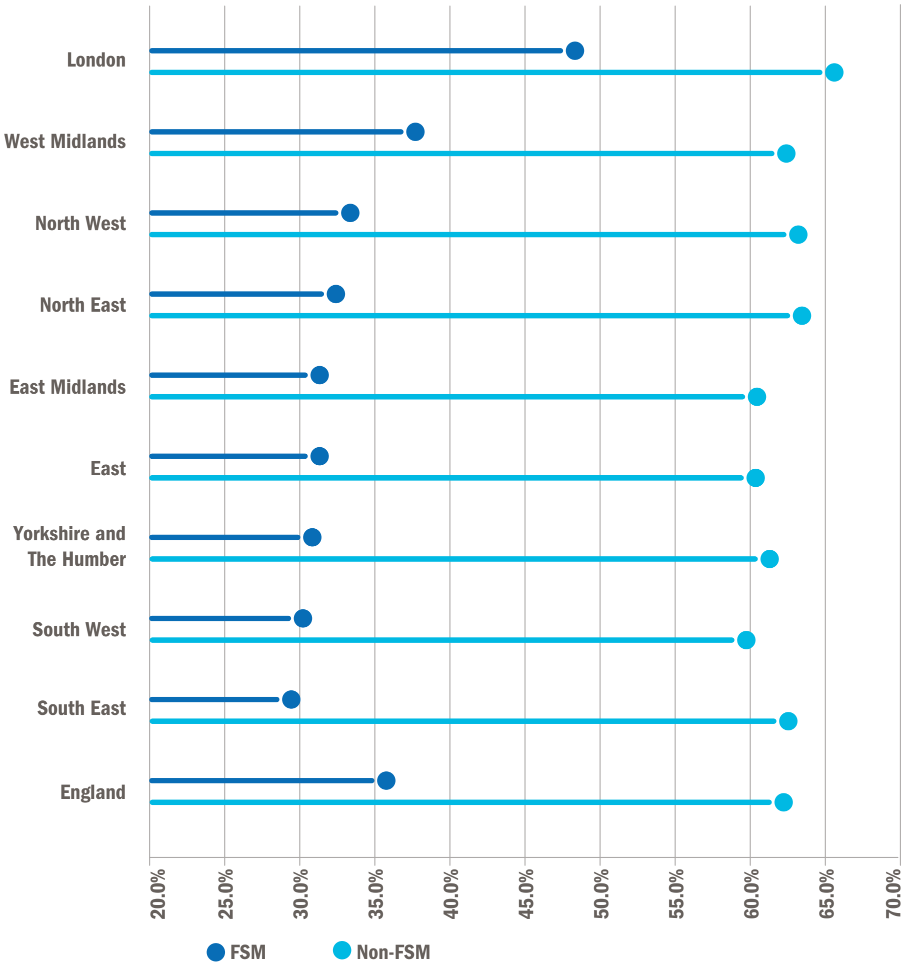
Figure 7.1 looks at attainment of five GCSEs A*-C including English and maths by regions of England. It shows that there is a considerable variation in both the overall attainment levels for students in receipt of Free School Meals and those who aren't but also that there is a degree of regional variation in the percentage point gap between these two groups of students. The Social Mobility and Child Poverty Commission clearly states that it is not only living in a disadvantaged area that determines how well you do at school but also where in the country that disadvantage occurs.[503] Finally, the Department for Education has shown that disadvantaged girls perform better than disadvantaged boys across all the attainment indicators.[504]

One way that the Government is trying to tackle the poor performance of disadvantaged students is through the pupil premium.[505] The Department for Education is distributing £2.5 billion via the pupil premium formula for the academic year 2014/15.[506 507] This means that for 2014/15, each secondary school in England will receive £935 for every eligible pupil,[508 509] or an average-sized secondary school with an average number for eligible pupils will receive additional funding of around £200,000.[510]

Apart from the social injustice of inequality, there is also a clear economic argument for improved social mobility. The cost of child poverty is estimated to be £29 billion.[511] Improving social mobility could increase UK GDP by 4% by 2050.[512] The Sutton Trust has shown that working class parents have strong aspirations for their children's educational success but are less able to effect choice, partly as a result of a lack of information and knowhow and partly due to financial constraints.[513] The Sutton Trust also goes on to say that education is the key issue for social mobility.[514]

502 *GCSE and Equivalent Attainment by Pupil Characteristics in England 2012/13*, Department for Education, 23 January 2014, p7 **503** *State of the nation 2013: social mobility and child poverty in Great Britain*, Social Mobility and Child Poverty Commission, October 2013, p181 **504** *GCSE and Equivalent Attainment by Pupil Characteristics in England 2012/13*, Department for Education, 23 January 2014, p6 **505** See Section 6 for further details on the pupil premium **506** *Autumn Statement 2013*, HM Treasury, December 2013, p52 **507** For further details on the pupil premium see https://www.gov.uk/pupil-premium-information-for-schools-and-alternative-provision-settings **508** Website accessed on the 29 August 2014 (https://www.gov.uk/pupil-premium-information-for-schools-and-alternative-provision-settings) **509** Eligibility is based on pupils who have been in receipt of Free School Meals at any point in the last 6 years **510** *The pupil premium: an update*, Ofsted, July 2014, p4 **511** *State of the nation 2013: social mobility and child poverty in Great Britain*, Social Mobility and Child Poverty Commission, October 2013, p10 **512** *State of the nation 2013: social mobility and child poverty in Great Britain*, Social Mobility and Child Poverty Commission, October 2013, p10 **513** *Parent Power? Using money and information to boost children's chances of educational success*, The Sutton Trust, December 2013, p40 **514** *Parent Power? Using money and information to boost children's chances of educational success*, The Sutton Trust, December 2013, p8

Fig. 7.1: Percentage of pupils achieving five or more GCSEs at A*-C or equivalent including English and maths by region (2013) – England



Source: The Social Mobility and Child Poverty Commission[515]

7.1.2 School destination

To round off looking at students in England, it is worth looking at their destination. Eighty nine percent of students completing Key Stage 4 at state funded schools were in education, employment and/or training the year after completing their studies.[516] This includes 5% of students completing their Key Stage 4 studies who went into an apprenticeship.[517]

7.2 Education in Wales

The Welsh Government has stated that a key priority for Wales is addressing the shortage of STEM skills to boost economic growth.[518] In 2012, the Welsh Government published its latest STEM strategy,[519 520] which included mapping out STEM engagement activity[521] and bringing greater coordination and leadership for STEM engagement activities.[522] In addition, the Welsh Government intends to increase the proportion of young people studying science. The National Science Academy will be the key mechanism for achieving this increase.[523]

7.3 Education in Northern Ireland

The Northern Ireland Government has also developed a STEM strategy, which was launched in 2011.[524] Its report makes it clear that Northern Ireland needs to do more to make STEM subjects seem interesting, enjoyable and stimulating and to make sure that there are clear progression routes from studying STEM at school through to Further and Higher Education.[525]

Northern Ireland has a revised curriculum that includes a clear focus on numeracy, science and technology.[526] The Department of Education in Northern Ireland has also been encouraging students to study STEM subjects while at school.[527] However, it should be noted that science is not a compulsory subject at Key Stage 4 in Northern Ireland,[528] which raises the risk that students will not study science beyond age 14.

7.4 Education in Scotland

Compulsory education in Scotland begins at the age of five and ends at 16. It covers primary school years P1-P7 and secondary school years S1-S4, at the end of which pupils usually take GCSE-equivalent qualifications in Intermediate 2 or National 5, with the latter set entirely to replace the former in 2015-2016. In 2013, there were 665,499 primary and secondary pupils in Scotland and 47,770 teachers in 2,418 council-run schools.[529]

The Scottish Curriculum for Excellence (CfE) sets out the learning objectives of the state school student population. While the focus on mathematics and science within the curriculum remains mostly within disciplinary boundaries – with no direct mention of STEM – there is recognition of interdisciplinary learning within both. There is mention of the importance mathematics holds within engineering.[530] For science, the curriculum suggests that a "wide range of open-ended experience, challenges and investigations," – including in applied areas such as engineering – develop knowledge applicable to the needs of society.[531] The CfE also points out that "links exist between, and across, the sciences and other areas of the curriculum: for example, engineering offers possible links among the sciences, mathematics and the technologies," which provide young people with "a means of understanding the world around them."[532]

515 *Lessons from London schools for attainment gaps and social mobility*, Social Mobility and Child Poverty Commission, June 2014, p10 **516** *Destinations of Key Stage 4 and Key Stage 5 students, 2011/12*, Department for Education, 26 June 2014, p4 **517** *Destinations of Key Stage 4 and Key Stage 5 students, 2011/12*, Department for Education, 26 June 2014, p4 **518** *Evaluation of Techniquest and Techniquest Glyndŵr School Services*, Welsh Government Social Research, 2014, p3 **519** The Welsh Government STEM strategy can be accessed at http://wales.gov.uk/docs/det/publications/120306scienceen.pdf **520** *Evaluation of Techniquest and Techniquest Glyndŵr School Services*, Welsh Government Social Research, 2014, p3 **521** *Science for Wales A strategic agenda for science and innovation in Wales*, Welsh Government, 2012, p30 **522** *Science for Wales A strategic agenda for science and innovation in Wales*, Welsh Government, 2012, p30 **523** *Science for Wales A strategic agenda for science and innovation in Wales*, Welsh Government, 2012, p32 **524** *Success through STEM*, Northern Ireland Government, 2011 **525** *Success through STEM*, Northern Ireland Government, 2011, p10 **526** *Success through STEM*, Northern Ireland Government, 2011, p10 **527** *Success through STEM one year on,* Northern Ireland Government, March 2011, p8 **528** Website accessed on the 28 August 2014 (http://www.rsc.org/ScienceAndTechnology/Policy/EducationPolicy/EdIssues/NIeducation/Changes.asp) **529** *School Education*, Audit Scotland for the Accounts Commission, June 2014, p4; www.audit-scotland.gov.uk/docs/local/2014/nr_140619_school_education.pdf **530** *Curriculum for Excellence*, Education Scotland, p188 **531** *Curriculum for Excellence*, Education Scotland, p254 **532** *Curriculum for Excellence*, Education Scotland, p258

The January 2014 Progress Report for the CfE Implementation Plan 2013/14 claims that progress is being made in STEM for early years and broad general education. A number of national initiatives have been introduced in order to provide framework support for the new curriculum. Selected updates are listed below, with Education Scotland working to deliver the following:

- In partnership with Scottish Schools Education Research Centre (SSERC), to provide professional learning and build capacity at local level to develop teacher confidence and skills in the delivery of primary science – throughout 2013/14 and beyond.
- To provide a programme of professional learning for those teaching computing science, both in the BGE S1 – S3 and in support of the new national qualifications developed and implemented – throughout 2013/14 and beyond.
- To continue to promote the understanding of the place of both computing science and ICT within the BGE – throughout 2013/14 and beyond.[533]

In the Senior Phase, the following progress updates particularly relevant to STEM are highlighted:

- On-going support for National STEM Coordinator with a view to facilitate greater partnership working between schools, industry, Further Education / Higher Education (FE/HE).[534]
- A programme of professional learning for those teaching computing science, both in the BGE S1 – S3 and in support of the new national qualifications developed and implemented – throughout 2013/14 and beyond.[535]

The CfE Implementation Plan 2014-15 sets out the Government's approach to STEM in the upcoming academic year more explicitly. The following national plans are stated:

- Input to Curriculum Network events to update practitioners on national qualifications. Target food and drink, ICT, computing science and science, technologies, engineering and mathematics (STEM) subjects.[536]
- Contribute to interdisciplinary learning across STEM and in partnership with the social studies team in relation to business education. The focus on business education will be on developing ICT skills and digital literacy.[537]
- Collaborate with Energy Skills Scotland, Skills Development Scotland and other key partner organisations and networks to develop a strategy for promotion of careers in the energy sector (with the model developed to be extended to other STEM sectors).[538]
- Continue to engage with Education Authorities and other key partners to promote relevant and innovative contexts for interdisciplinary learning in STEM including community resilience, the circular economy and citizen science.[539]

Engineering education and development in Scotland is also catered for by STEM Central,[540] a portal to STEM education and careers resources.

7.5 GCSE entrant numbers

Table 7.0 shows the 10-year trend for the number of entries to different STEM subjects. In 2014, there were 5,217,573 entrants to all subjects. This was a decline of 4.2% on the previous year and a decline of 9.0% on 2005. There was a large amount of volatility across the different STEM subjects in 2014. Computing was the subject with the largest increase: up 294.4%, to 16,773 entrants. The next largest increase was for engineering, which rose by 73.5% to 5,027 entrants. This was followed by statistics: up 40.5% to 61,642 entrants.

It is also worth noting that entrant numbers to additional science increased by 14.3% to 323,994. However, this increase should be viewed with caution. The Assessment and Qualifications Alliance (AQA) has introduced a further additional science course, which provides an alternative route to studying three GCSE science subjects (science, additional science and further additional science).[541] The 21,119 students entered for further additional science have been included in the figures for additional science, which inflates the entrant numbers for further science.[542]

Looking specifically at mathematics and science subjects shows that entrance to mathematics fell by 3.1% to 736,403 in 2014. The three separate science subjects plus core science are the four STEM subjects with the largest percentage declines. Biology has fallen by 18.6% (to 141,900), while science fell 16.9% (to 374,961) and chemistry fell by 16.8% (to 138,238). Finally, physics fell 14.6% (to 137,227). However, the 21,119 students who entered further additional science will have covered all of the physics curriculum (if they have also studied core and additional science), meaning that the fall in physics numbers may not be as serious as the headline figure suggests.

Ofqual has said that, as science qualifications have moved from modular to linear exams, schools may have changed how they approach GCSE science subjects and the timing of exam entries. This could explain some of the variation being seen within science subjects.[543]

533 *Curriculum for Excellence Implementation (CfE) Plan 2013-14 – Progress Report*, Education Scotland, 2014, p8 **534** *Curriculum for Excellence Implementation (CfE) Plan 2013-14 – Progress Report*, Education Scotland, 2014, p15 **535** *Curriculum for Excellence Implementation (CfE) Plan 2013-14 – Progress Report*, Education Scotland, 2014, p17 **536** *Curriculum for Excellence Implementation Plan 2014-15*, Education Scotland, p4 **537** *Curriculum for Excellence Implementation Plan 2014-15*, Education Scotland, p7 **538** *Curriculum for Excellence Implementation Plan 2014-15*, Education Scotland, p8 **539** *Curriculum for Excellence Implementation Plan 2014-15*, Education Scotland, p8 **540** www.educationscotland.gov.uk/stemcentral **541** Institute of Physics **542** Joint Council for Qualifications **543** *Summer 2014 GCSEs and IGCSEs The potential impact on results of changes in entry patterns*, Ofqual, May 2014, p3

Table 7.0: GCSE full STEM courses entries (2005-2014) – all UK Candidates

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Change over one year	Change over 10 years
Science double award – halved to illustrate	494,450	479,789	478,028	8,433	-	-	-	-	-	-		
Science double award	988,900	959,578	956,056	16,866	-	-	-	-	-	-		
Science	-	-	57,316	537,606	493,505	453,757	405,977	552,504	451,433	374,961	-16.9%	
Additional science	-	-	-	433,468	396,946	352,469	306,312	289,950	283,391	323,944	14.3%	
Mathematics	741,422	750,570	760,299	738,451	754,738	762,792	772,944	675,789	760,170	736,403	-3.1%	-0.7%
Design and technology	396,668	371,672	354,959	332,787	305,809	287,701	253,624	240,704	219,931	213,629	-2.9%	-46.1%
Biology	56,522	60,082	63,208	85,521	100,905	129,464	147,904	166,168	174,428	141,900	-18.6%	151.1%
Chemistry	53,428	56,764	59,219	76,656	92,246	121,988	141,724	159,126	166,091	138,238	-16.8%	158.7%
Computing	-	-	-	-	-	-	-	-	4,253	16,773	294.4%	-
ICT	103,400	109,601	99,656	85,599	73,519	61,022	47,128	53,197	69,234	96,811	39.8%	-6.4%
Physics	52,568	56,035	58,391	75,383	91,179	120,455	140,183	157,377	160,735	137,227	-14.6%	161.0%
Science single award	89,348	96,374	98,485									
Statistics	51,432	68,331	82,682	86,224	77,744	69,456	53,400	50,620	43,870	61,642	40.5%	19.9%
Mathematics (additional)	3,256	3,282	9,793	16,973	18,765	17,183	13,282	3,436	3,478	3,495	0.5%	7.3%
Engineering						-	1,850	2,128	2,897	5,027	73.5%	
All subjects	5,736,505	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	-4.2%	-9.0%

Source: Joint Council for Qualifications

Table 7.1 shows the number of entrants to STEM subjects in 2013 and 2014 by the three age groups. It shows that for all subjects early entry, driven by Government policy changes, has declined by 39.5%, while entry has increased by 1.2% for those aged 16 and by 15.5% for those aged 17+. Specifically, entry to mathematics from students aged 15 or younger has dropped by three quarters (76.9%), while the numbers of 16-year-olds and over-17s entering maths GCSEs has increased by 16.4% and 29.8% respectively. Ofqual has also identified that as mathematics has moved to linear exams, entry patterns have changed: more students are being entered for mathematics in the summer rather than in the January or March exam periods.[544]

For science, early entry has declined by a third (34.4%) but entry by 16-year-olds has increased by a quarter (24.4%) and is up by 15.0% for those aged 17+. Science is predominately taken in Year 10, followed by additional science in Year 11. Therefore the decline in entrants aged 15 and under has brought down the total number of students entered for this subject.

For additional science, early entry has declined by more than a quarter (28.7%). However, the number of entrants aged 16 has risen 16.4% and aged 17+ by 22.4%.

Early entrance to physics has halved (down 54.6%), while entrant numbers are down 13.2% for 16-year-olds and 1.3% for those aged 17+. In other words, entrant numbers have declined in all age groups.

Table 7.2 shows the number of entrants for different STEM subjects by home nation. It shows that for all three home nations, mathematics is the largest STEM subject, with Wales having the largest percentage (16.0%), followed by Northern Ireland (15.0%) and England (14.0%).

By comparison, England has the largest proportion of entrants to physics (2.7%), followed by Wales (2.1%) and then Northern Ireland (1.7%).

Table 7.1: Entry for GCSE full STEM courses by age group (2013-2014) – all UK Candidates

	2013				2014				Change over one 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	315,981	125,733	9,719	451,433	207,394	156,391	11,176	374,961	-34.4%	24.4%	15.0%	-16.9%
Additional science	13,608	266,086	3,697	283,391	9,698	309,722	4,524	323,944	-28.7%	16.4%	22.4%	14.3%
Mathematics	170,357	512,312	77,501	760,170	39,292	596,524	100,587	736,403	-76.9%	16.4%	29.8%	-3.1%
Design and technology	12,411	204,784	2,736	219,931	9,901	200,962	2,766	213,629	-20.2%	-1.9%	1.1%	-2.9%
Biology	15,654	153,727	5,047	174,428	7,962	128,879	5,059	141,900	-49.1%	-16.2%	0.2%	-18.6%
Chemistry	10,065	153,235	2,791	166,091	5,522	129,982	2,734	138,238	-45.1%	-15.2%	-2.0%	-16.8%
Computing[545]					724	15,842	207	16,773				
ICT	7,209	63,832	2,446	69,234	6,749	87,512	2,550	96,811	-6.4%	37.1%	4.3%	39.8%
Physics	6,258	151,899	2,578	160,735	2,840	131,842	2,545	137,227	-54.6%	-13.2%	-1.3%	-14.6%
Statistics	15,975	27,525	370	43,870	26,445	34,730	467	61,642	65.5%	26.2%	26.2%	40.5%
Mathematics (additional)	2	2,812	664	3,478	9	2,760	726	3,495	350.0%	-1.8%	9.3%	0.5%
Engineering	358	2,475	64	2,897	445	4,470	112	5,027	24.3%	80.6%	75.0%	73.5%
All subjects	806,141	4,412,187	226,996	5,445,324	489,190	4,466,309	262,074	5,217,573	-39.3%	1.2%	15.5%	-4.2%

Source: Joint Council for Qualifications

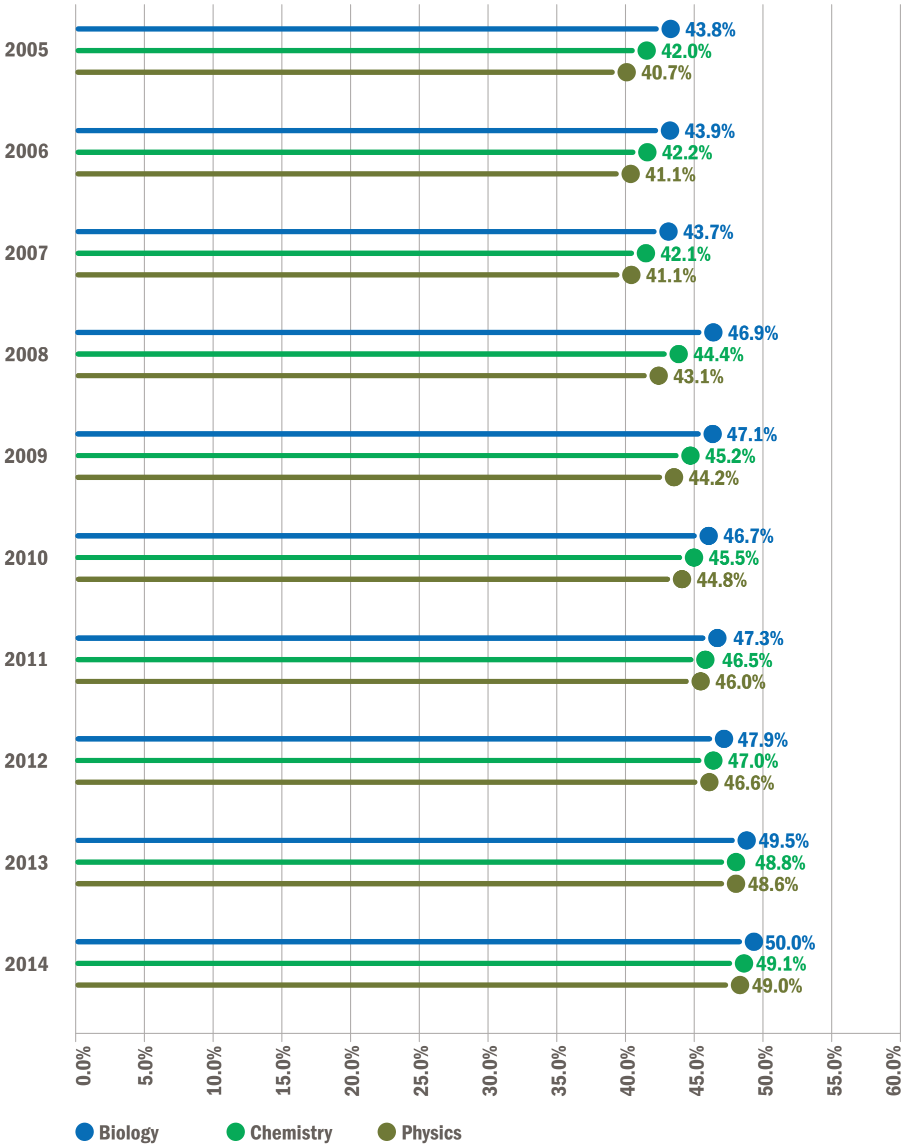
544 *Open letter to schools and colleges*, Ofqual, 26 June 2014, p1 545 Entrants by age group is not available for computing in 2013

Table 7.2: GCSE full STEM courses entries by home nation (2014) – all UK Candidates

	England		Wales		Northern Ireland	
	Number of entrants	Percentage of all subjects	Number of entrants	Percentage of all subjects	Number of entrants	Percentage of all subjects
Science	346,778	7.3%	19,952	7.2%	8,231	4.8%
Additional science	309,067	6.5%	13,113	4.7%	1,764	1.0%
Mathematics	666,225	14.0%	44,224	16.0%	25,954	15.0%
Design and technology	200,133	4.2%	8,793	3.2%	4,703	2.7%
Biology	131,669	2.8%	6,151	2.2%	4,080	2.4%
Chemistry	129,052	2.7%	6,035	2.2%	3,151	1.8%
Computing	16,351	0.3%	313	0.1%	109	0.1%
ICT	84,234	1.8%	4,827	1.7%	7,750	4.5%
Physics	128,373	2.7%	5,847	2.1%	3,007	1.7%
Statistics	60,312	1.3%	949	0.3%	381	0.2%
Mathematics (additional)	0	0.0%	0	0.0%	3,495	2.0%
Engineering	4,495	0.1%	184	0.1%	348	0.2%
All subjects	4,768,259		276,622		172,692	

Source: Joint Council for Qualifications

Fig. 7.2: Proportion of female entrant numbers to separate science GCSEs (2005-2014) – all UK candidates



Source: Joint Council for Qualifications

Figure 7.2 shows the proportion of female entrants to separate science GCSEs over a 10-year period. It shows that in 2014, each of the separate science subjects had the highest proportion of female entrants for the last 10 years. For biology, exactly half (50.0%) of entrants were female, while for chemistry it was 49.1%, closely followed by physics on 49.0%.

7.6 A*-C[546] achievement rates

Table 7.3 shows the proportion of all entrants who achieve an A*-C grade, by English region and the devolved nations. It shows that for all the regions and devolved nations the A*-C pass rate has increased from 2002 to 2014. However, it also shows that there is a degree of variation in A*-C pass rates. London had the largest increase (14.9%), followed by the North East (14.6%), while in Wales the increase was only 6.9%.

Similarly, the proportion of entrants getting A*-C grades in 2014 varied between the different regions of England and devolved nations. Northern Ireland had the highest A*-C pass rate, at 78.0% compared with 64.9% in Yorkshire and The Humber, meaning that there is scope for further improvement in A*-C pass rates.

The 10-year trend in the proportion of entrants getting A*-C in different STEM subjects is shown in Figure 7.3. Overall, two thirds (68.8%) of all entries in 2014 achieved an A*-C grade. Ofqual has noted that entry patterns in England are noticeably different to 2013 and consequently results may look different to previous years.[547] Ofqual has also noted that students who took their GCSE exams in the summer of 2014 had to take their exams at the same time and weren't able to take units early or re-sit any units (although they could still re-sit the whole GCSE qualification).[548]

Looking at the different STEM subjects shows that six had an above-average A*-C pass rate. The highest pass rate for a STEM subject was mathematics (additional) which had a pass rate of 93.5%. Statistics was also above average with a pass rate of 70.2%.

546 Grades A*-G are passes within GCSEs. However we purposely only analyse A*-C pass rates, as this is the rage of grades frequently required for entry onto AS level courses 547 *Summer 2014 GCSEs and IGCSEs The potential impact on results of changes in entry patterns*, Ofqual, May 2014, p2 548 *Summer 2014 GCSEs and IGCSEs The potential impact on results of changes in entry patterns*, Ofqual, May 2014, p1

For all three separate science subjects, at least nine in 10 entrants achieved an A*-C grade: physics had the highest pass rate of the three at 91.3%, closely followed by chemistry (90.7%) and biology (90.3%).

The final STEM subject to have an above A*-C pass rate was ICT, with 69.5%.

Looking at the STEM subjects that had below average pass rates reveals that only two in five (41.6%) of those studying GCSE engineering got an A*-C. Science had the second-lowest A*-C pass rate at 59.1%, while mathematics had a pass rate of 62.4%.

The Sutton Trust has shown that for most people, the level of maths used in the workplace is "simple mathematics in complex settings" and that the level of mathematics required lies almost wholly within the GCSE curriculum.[549] The OECD has also shown that when students believe that investing the effort in learning will have a positive impact they score significantly higher in mathematics.[550]

According to Ofsted, English and mathematics are not taught well enough – around a third of lessons observed over a four-year period were judged as below good quality, and this is compounded by poorer quality teaching for lower sets.[551]

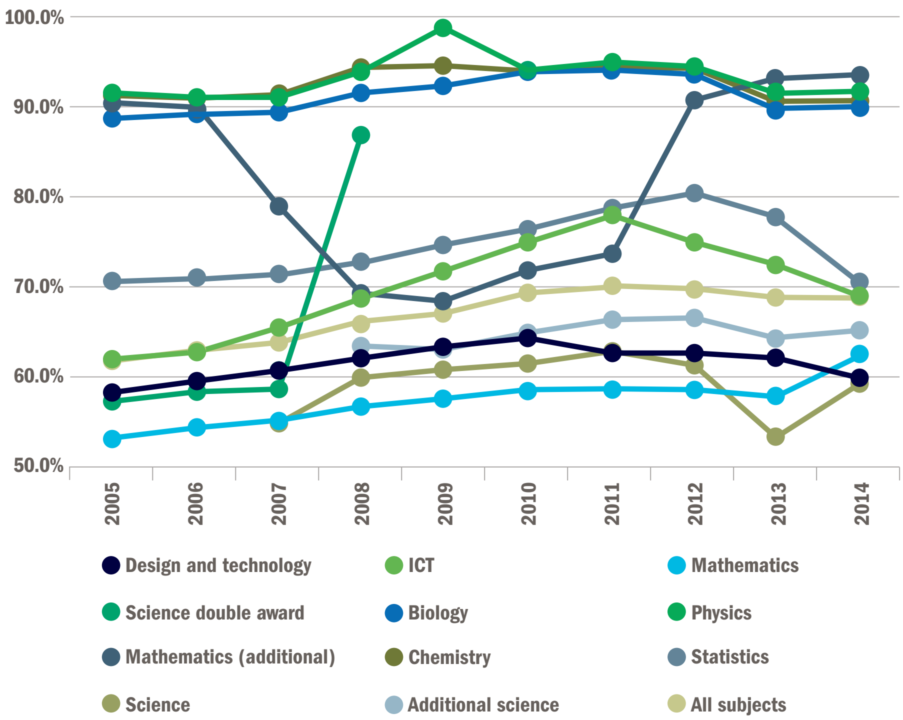
Ofsted has shown that schools that made science interesting for pupils have raised their achievement in science.[552] They also showed that practically-based investigation was the most effective approach.[553] However, a survey of science teachers has shown that a quarter had reduced the amount of practical work in courses due to changes in the curriculum, assessment priorities, budgets and lack of technician support.[554] The Royal Society has also estimated that the shortfall in school science technicians is around 4,000.[555]

Table 7.3: Proportion of entries achieving an A*-C grade by English region and devolved nation (2002-2014) – all UK candidates

	2002	2014	Percentage point change 2002-2014
North East	51.1%	65.7%	14.6%
North West	55.5%	68.3%	12.8%
Yorkshire and The Humber	51.9%	64.9%	13.0%
West Midlands	55.5%	66.7%	11.2%
East Midlands	56.2%	65.7%	9.5%
Eastern	60.2%	68.8%	8.6%
South West	61.8%	69.0%	7.2%
South East	62.3%	70.9%	8.6%
London	56.8%	71.7%	14.9%
Wales	59.7%	66.6%	6.9%
Northern Ireland	68.4%	78.0%	9.6%
Other UK	71.6%	74.0%	2.4%
All UK	57.9%	68.8%	10.9%

Source: Joint Council for Qualifications

Fig. 7.3: GCSE A*-C pass rates (2005-2014) – all UK candidates



Source: Joint Council for Qualifications

549 *The Employment Equation: Why our young people need more maths for today's jobs*, The Sutton Trust, July 2013, p2 550 *Do students have the drive to succeed?*, OECD, March 2014, p1 551 *The report of Her Majesty's Chief Inspector of Education, Children's Services and Skills*, Ofsted, 2013, p6 552 *Maintaining curiosity*, Ofsted, November 2013, p40 553 *Maintaining curiosity*, Ofsted, November 2013, p40 554 *Vision for science and mathematics education*, Royal Society, 2014, p48 555 *Vision for science and mathematics education*, Royal Society, 2014, p48

Table 7.4 shows the proportion of A*-C grades for different STEM subjects in 2013 and 2014 by age group. Table 7.1 shows that, with the exception of statistics, mathematics (additional) and engineering, early entry to all STEM subjects decreased in 2014. Table 7.4 shows that, with the exception of statistics and mathematics (additional), the A*-C pass rate for early entrants to STEM subjects has increased, with engineering (26.6%) having the largest increase. The largest decrease was for mathematics (additional) which fell by 11.1%.

However, there is much less volatility in the results of entrants who took STEM subjects at age 16: although, as we have previously mentioned, it is difficult to compare results between 2013 and 2014 due to the change in the profile of entrants. The largest increase was for mathematics (up 3.9%) while the largest decrease was for statistics (down 5.2%).

Table 7.4: GCSE A*-C pass rates by age (2013/2014) – all UK candidates

	2013				2014				Percentage point difference 2014 compared with 2013			
	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	55.1%	47.9%	52.8%	53.1%	66.2%	49.8%	55.7%	59.1%	11.1%	1.9%	2.9%	6.0%
Additional science	72.1%	63.8%	59.4%	64.1%	80.4%	65.1%	58.4%	65.5%	8.3%	1.3%	-1.0%	1.4%
Mathematics	51.7%	62.1%	41.1%	57.6%	68.3%	66.0%	38.9%	62.4%	16.6%	3.9%	-2.2%	4.8%
Design and technology	49.2%	62.5%	63.0%	61.8%	55.0%	61.3%	60.4%	61.0%	5.8%	-1.2%	-2.6%	-0.8%
Biology	80.0%	91.7%	62.5%	89.8%	87.1%	91.7%	60.8%	90.3%	7.1%	0.0%	-1.7%	0.5%
Chemistry	81.2%	90.8%	74.5%	90.0%	88.0%	91.2%	76.2%	90.7%	6.8%	0.4%	1.7%	0.7%
Computing	47.1%	70.2%	64.5%	68.4%	65.7%	65.6%	58.0%	65.5%	18.6%	-4.6%	-6.5%	-2.9%
ICT	64.6%	73.4%	70.7%	72.2%	70.5%	69.4%	69.3%	69.5%	5.9%	-4.0%	-1.4%	-2.7%
Physics	83.7%	91.4%	75.3%	90.8%	85.8%	91.7%	76.1%	91.3%	2.1%	0.3%	0.8%	0.5%
Statistics	78.5%	76.8%	74.3%	77.4%	68.4%	71.6%	72.4%	70.2%	-10.1%	-5.2%	-1.9%	-7.2%
Mathematics (additional)	100.0%	92.6%	93.4%	92.8%	88.9%	93.7%	92.6%	93.5%	-11.1%	1.1%	-0.8%	0.7%
Engineering	17.9%	43.9%	62.5%	41.1%	44.5%	40.9%	57.1%	41.6%	26.6%	-3.0%	-5.4%	0.5%
All subjects	58.1%	70.9%	50.4%	68.1%	68.2%	70.1%	47.2%	68.8%	10.1%	-0.8%	-3.2%	0.7%

Source: Joint Council for Qualifications

The importance of achieving high grades in GCSE mathematics and physics is shown in Table 7.5. Seventy-nine percent of those attaining an A* grade in maths progressed to AS level physics, compared with 1% of those getting a grade C. For physics, 43% of those attaining a GCSE A* grade progressed to AS level physics, compared with 5% of those attaining a grade C.

The Social Market Foundation has found that over 70% of students from independent schools attain five A*-C grades including English and mathematics, compared with around 60% of students from the state sector.[556] The difference is even starker for the highest grades: around 40% of exam entries from independent schools result in an A*-A grade, compared with 20% of state school entries. This means that students from independent schools are more likely to achieve the grades needed to progress onto AS and A level maths and physics than students from the state sector.

Table 7.5: Progression from GCSE mathematics and physics to AS/A level mathematics and physics (2012)

	A*	A	B	C
Proportion of entries resulting in each GCSE mathematics grade (2007/08)[557]	5%	11%	17%	26%
Proportion of entries resulting in each GCSE physics grade (2007/08)[558]	23%	29%	26%	15%
Progression rate from GCSE to AS mathematics by Mathematics grade[559]	79%	48%	15%	1%
Progression rate from GCSE to AS physics by physics grade[560]	43%	30%	21%	5%
Progression rate from GCSE to A level mathematics[561]	73%	34%	6%	0%
Progression rate from GCSE to A level physics[562]	38%	22%	8%	1%

Source: Department for Education and National Pupil Database

7.6.1 A*-C achievement rates by gender

Table 7.6 shows the number of male and female entrants to STEM GCSE subjects in 2014 and the proportion achieving an A*-C grade. Overall, 51.1% of all entrants were female. However, only additional science (51.3%) had an above-average proportion of female entrants. By comparison, only 7.0% of entrants to engineering and 15.3% of entrants to computing were female. It also shows that with the exception of mathematics, a higher proportion of females achieved an A*-C grade than male students. This was particularly noticeable in design and technology (female 72.1% compared with male 53.5%).

For mathematics, 62.5% of male students attained an A*-C grade which is slightly more than female students (62.3%). The OECD has shown that there is a large gender difference

Table 7.6: Number of GCSE A*-C passes (2014) – all UK candidates

	Male students			Female students				All students		
	Total number of male students	Percentage A*-C for male students	Calculated number of male students obtaining a grade A*-C	Total number of female students	Percentage A*-C for female students	Calculated number of female students obtaining a grade A*-C	Percentage of all entrants who are female	Total number of all students	Percentage A*-C for all students	Calculated number of all students obtaining a grade A*-C
Design and technology	127,500	53.5%	68,213	86,129	72.1%	62,099	40.3%	213,629	61.0%	130,314
Computing	14,205	64.4%	9,148	2,568	71.6%	1,839	15.3%	16,773	65.5%	10,986
ICT	55,346	66.4%	36,750	41,465	73.5%	30,477	42.8%	96,811	69.5%	67,284
Mathematics	363,168	62.5%	226,980	373,235	62.3%	232,525	50.7%	736,403	62.4%	459,515
Mathematics (additional)	1,818	92.1%	1,674	1,677	94.9%	1,591	48.0%	3,495	93.5%	3,268
Biology	70,988	89.5%	63,534	70,912	91.1%	64,601	50.0%	141,900	90.3%	128,136
Chemistry	70,308	89.5%	62,926	67,930	92.0%	62,496	49.1%	138,238	90.7%	125,382
Physics	69,933	91.0%	63,639	67,294	91.6%	61,641	49.0%	137,227	91.3%	125,288
Statistics	32,685	67.3%	21,997	28,957	73.5%	21,283	47.0%	61,642	70.2%	43,273
Science	184,714	56.2%	103,809	190,247	61.8%	117,573	50.7%	374,961	59.1%	221,602
Additional science	157,891	62.5%	98,682	166,053	68.3%	113,414	51.3%	323,944	65.5%	212,183
Engineering	4,673	39.6%	1,851	354	67.5%	239	7.0%	5,027	41.6%	2,091
All subjects	2,553,106	64.3%	1,641,647	2,664,467	73.1%	1,947,725	51.1%	5,217,573	68.8%	3,589,690

Source: Joint Council for Qualifications

556 *Open Access An independent evaluation*, Social Market Foundation, 3 July 2014, p14 557 Department for Education research report RR195 *Subject progression from GCSE to AS level and continuation to A level* https://www.education.gov.uk/publications/eOrderingDownload/DFE-RR195.pdf Figures taken from Table B; note that these proportions are based on the number of entries (731,900 for mathematics for the 2007/08 cohort) rather than the number of students attempting (609,700). The former includes attempts by these pupils in previous years, but is relevant in assessing the progression of this cohort 558 Ibid 559 Ibid, Table 1.1 – based on the progression of the 2007/08 cohort in the following two years 560 Ibid, Table 1.1 561 Ibid, Table 3.1 562 Ibid

when it comes to self-belief in mathematics ability: girls who perform as well as boys report lower levels of self-efficacy and higher levels of mathematics anxiety.[563]

Across all the main STEM related subjects bar mathematics, girls achieve higher A*- C grades than males and even in mathematics the difference is now marginal, at 62.5% to 62.3% Across all subjects, girls A*-C achievement rates are significantly higher than boys, at 73.1% to 64.3%.

Even though 91.6% of female entrants to physics obtained an A*-C grade, Ofsted has shown that only 4% of girls who obtained two good GCSE science grades attempted A level physics, compared with 15.5% of boys.[564]

7.7 iGCSE qualifications[565]

Table 7.7 shows that iGCSE uptake has increased by 175.7% across all subjects, including STEM, over three years. Of the five different STEM subjects only one, information technology, grew by more than average, with participation growing by 301.1% (although this was from only 473 entries in 2010/11).

Mathematics was the largest of the STEM subjects in each of the three years, with participation growing by 39.9% to 26,169 in 2012/13. It is also worth noting that physics has grown by 162.4% over three years to reach 15,688 in 2012/13.

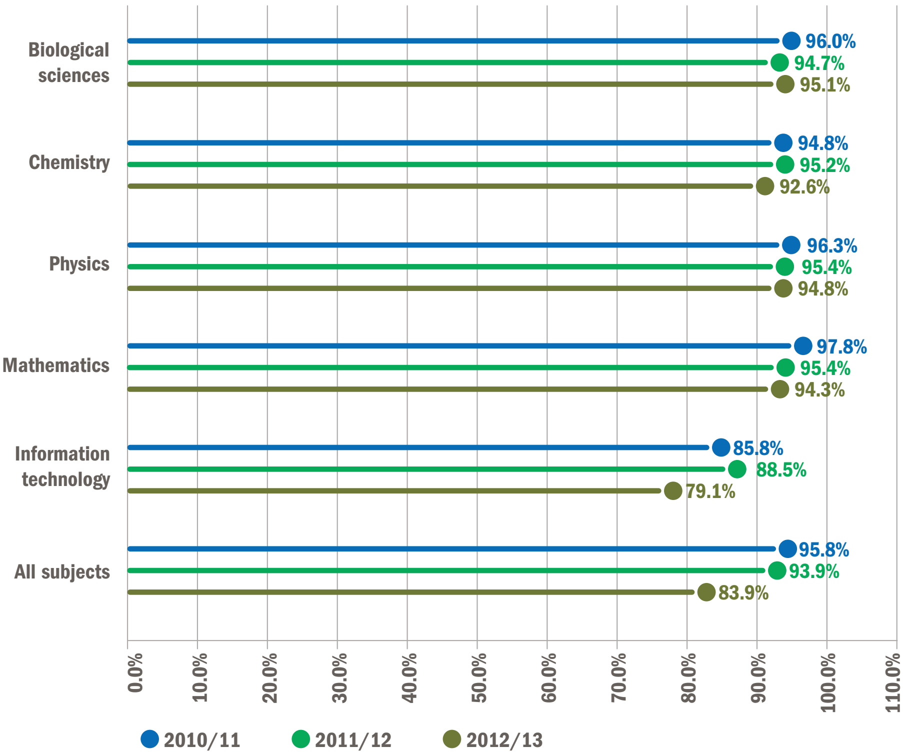
Figure 7.4 shows the A*-C[567] pass rate for all subjects and the different STEM subjects over a three-year period. It shows that for all STEM subjects, the A*-C pass rate was lower in 2012/13 than it was in 2010/11. The largest fall was in information technology – down from 85.8% to 79.1%. Information technology also had the largest increase in entrant numbers.

Table 7.7: iGCSE STEM course entrants (2010/11-2012/13) – England

	2010/11	2011/12	2012/13	Change over one year	Change over three years
Biological sciences	5,408	7,976	14,558	82.5%	169.2%
Chemistry	5,365	7,579	14,619	92.9%	172.5%
Physics	5,979	8,393	15,688	86.9%	162.4%
Mathematics	18,704	23,187	26,169	12.9%	39.9%
Information technology[566]	473	898	1,897	111.2%	301.1%
All subjects	56,842	109,261	156,717	43.4%	175.7%

Source: Department for Education

Fig. 7.4: iGCSE A*-C pass rates (2010/11-2012/13) – England



Source: Department for Education

7.8 Vocational qualifications

Vocational qualifications make up a significant part of the 14-18 education landscape. In this section, we look at the number of students studying vocational STEM subjects with Pearson and OCR. Ofsted believes that it is likely that the number of science vocational courses will decrease over the next year or two, in part because schools are responding to the new combined EBacc measure.[568]

Table 7.8 shows the number of students completing level 2 BTEC STEM subjects over a 10-year period. There was growth over 10 years of 1,365.0% across all BTEC subjects, with the biggest rise in completions being for other sciences – up 30,855.5%.

Completions in engineering increased by 641.4%, with UK completions (659.5%) rising faster than international (360.0%). Overall in 2013/14, 19,632 students completed a level 2 BTEC engineering course, although this was 2.4% lower than the previous year.

There were 39,412 completions for ICT/computing in 2013/14, although this was a decline of 10.9% on the previous year. There were also 12,457 completions in construction, although this was 11.1% lower than the previous year.

563 *PISA 2012 Results: Ready to Learn Students' Engagement*, Drive and Self-Beliefs Volume III, OECD, 2013, p174 564 *Maintaining curiosity A survey into science education in schools*, Ofsted, November 2013, p27 565 Data for 2012/13 is provisional data 566 Information technology also includes computer studies, information systems and any combined syllabus of which information technology is the major part. 567 Grades A*-G are passes within iGCSEs. However we purposely only analyse A*-C pass rates, as this is the rage of grades frequently required for entry onto AS level courses 568 *Maintaining curiosity A survey into science education in schools*, Ofsted, November 2013, p25

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Table 7.8: Number of students completing BTEC selected 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 one year	Change over 10 years
Other sciences	UK	456	1,077	4,038	17,601	34,383	68,314	105,467	125,180	138,182	141,091	2.1%	30,841.0%
	International	0	0	0	0	132	1	11	21	26	66	153.8%	
	Female	232	569	2,102	9,176	18,003	35,372	53,340	62,410	66,992	68,501	2.3%	29,426.3%
	Aged under 19	345	903	3,782	17,196	34,081	67,659	104,802	124,459	137,192	140,352	2.3%	40,581.7%
	Aged 19-24	98	144	214	307	321	440	466	504	657	568	-13.5%	479.6%
	Aged 25+	13	30	42	97	113	214	206	238	350	237	-32.3%	1,723.1%
	Total	**456**	**1,077**	**4,038**	**17,601**	**34,515**	**68,315**	**105,478**	**125,201**	**138,208**	**141,157**	**2.1%**	**30,855.5%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Percentage female	50.9%	52.8%	52.1%	52.1%	52.2%	51.8%	50.6%	49.8%	48.5%	48.5%	0.0%	-4.7%
Engineering	UK	2,488	3,575	4,802	6,652	8,686	9,987	11,735	15,565	19,775	18,896	-4.4%	659.5%
	International	160	713	376	381	181	214	102	299	337	736	118.4%	360.0%
	Female	76	117	172	254	401	537	615	790	1,098	992	-9.7%	1,205.3%
	Aged under 19	2,040	2,990	4,020	6,019	7,888	9,180	10,948	14,520	18,449	18,116	-1.8%	788.0%
	Aged 19-24	517	1,009	1,011	859	830	874	735	1,033	1,325	1,171	-11.6%	126.5%
	Aged 25+	90	288	143	155	148	147	151	309	336	345	2.7%	283.3%
	Total	**2,648**	**4,288**	**5,178**	**7,033**	**8,867**	**10,201**	**11,837**	**15,864**	**20,112**	**19,632**	**-2.4%**	**641.4%**
	Percentage non-UK	6.0%	16.6%	7.3%	5.4%	2.0%	2.1%	0.9%	1.9%	1.7%	3.7%	117.6%	-38.3%
	Percentage female	2.9%	2.7%	3.3%	3.6%	4.5%	5.3%	5.2%	5.0%	5.5%	5.1%	-7.3%	75.9%
ICT/computing	UK	3,716	5,717	8,817	18,845	24,482	29,040	32,251	41,330	44,112	39,094	-11.4%	952.0%
	International	139	260	164	237	222	121	12	319	126	318	152.4%	128.8%
	Female	702	1,143	1,986	6,184	8,310	10,021	11,248	15,360	16,328	13,574	-16.9%	1,833.6%
	Aged under 19	3,153	4,936	7,536	17,329	22,716	26,947	30,084	39,390	42,051	37,438	-11.0%	1,087.4%
	Aged 19-24	621	881	1,244	1,515	1,720	1,900	1,950	1,945	1,841	1,707	-7.3%	174.9%
	Aged 25+	81	159	200	237	268	313	229	312	345	266	-22.9%	228.4%
	Total	**3,855**	**5,977**	**8,981**	**19,082**	**24,704**	**29,161**	**32,263**	**41,649**	**44,238**	**39,412**	**-10.9%**	**922.4%**
	Percentage non-UK	3.6%	4.4%	1.8%	1.2%	0.9%	0.4%	0.0%	0.8%	0.3%	0.8%	166.7%	-77.8%
	Percentage female	18.2%	19.1%	22.1%	32.4%	33.6%	34.4%	34.9%	36.9%	36.9%	34.4%	-6.8%	89.0%
Construction	UK	343	940	1,997	4,089	6,859	9,248	9,955	13,149	13,973	12,446	-10.9%	3,528.6%
	International	1	58	62	92	13	35	25	30	35	11	-68.6%	1,000.0%
	Female	17	32	59	152	254	319	358	409	465	546	17.4%	3,111.8%
	Aged under 19	246	880	1,908	4,037	6,707	9,067	9,694	12,513	13,545	11,896	-12.2%	4,735.8%
	Aged 19-24	91	91	134	122	141	170	209	391	234	233	-0.4%	156.0%
	Aged 25+	7	13	17	21	23	43	76	275	226	327	44.7%	4,571.4%
	Total	**344**	**998**	**2,059**	**4,181**	**6,872**	**9,283**	**9,980**	**13,179**	**14,008**	**12,457**	**-11.1%**	**3,521.2%**
	Percentage non-UK	0.3%	5.8%	3.0%	2.2%	0.2%	0.4%	0.3%	0.2%	0.2%	0.1%	-50.0%	-66.7%
	Percentage female	4.9%	3.2%	2.9%	3.6%	3.7%	3.4%	3.6%	3.1%	3.3%	4.4%	33.3%	-10.2%
All subjects (including STEM and non-STEM)	UK	34,729	63,342	107,047	186,881	264,045	374,263	489,165	581,127	599,610	512,667	-14.5%	1,376.2%
	International	439	1,167	830	1,060	848	826	534	1,571	1,120	2,535	126.3%	477.4%
	Female	14,078	26,765	47,903	87,420	124,038	178,582	235,134	278,388	282,085	237,353	-15.9%	1,586.0%
	Aged under 19	29,938	54,525	96,005	175,192	250,215	358,296	473,031	564,207	581,171	497,600	-14.4%	1,562.1%
	Aged 19-24	4,274	7,385	8,909	9,966	11,575	13,144	13,194	13,986	14,434	12,776	-11.5%	198.9%
	Aged 25+	907	2,551	2,933	2,768	3,089	3,632	3,448	4,460	5,098	4,809	-5.7%	430.2%
	Total	**35,168**	**64,509**	**107,877**	**187,941**	**264,893**	**375,089**	**489,699**	**582,698**	**600,730**	**515,202**	**-14.2%**	**1,365.0%**
	Percentage non-UK	1.2%	1.8%	0.8%	0.6%	0.3%	0.2%	0.1%	0.3%	0.2%	0.5%	150.0%	-58.3%
	Percentage female	40.0%	41.5%	44.4%	46.5%	46.8%	47.6%	48.0%	47.8%	47.0%	46.1%	-1.9%	15.3%

Source: Pearson

Table 7.9 shows that for the OCR Awarding Body, there was overall growth of 53,497% in all vocational qualifications over nine years. Of the STEM qualifications, 18,522 completions in 2012/13 were for other sciences – a decrease of 12.2% on the previous year. The number of completions in ICT/computing was much higher at 218,074. However, this was still a fifth (21.8%) lower than the previous year.

Table 7.9: Number of students completing other selected vocational subjects at level 2, by gender and age (2004/05-2012/13) – all domiciles

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over nine years
Other sciences	UK	0	0	202	5,066	8,560	15,767	20,670	21,095	18,522	-12.2%	
	International	0	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	-17.0%	
	Aged under 19	0	0	190	5,057	8,525	15,742	20,639	21,078	18,509	-12.2%	
	Aged 19-24	0	0	12	8	21	17	9	3	7	133.3%	
	Aged 25+	0	0	0	1	14	8	22	14	6	-57.1%	
	Total	**0**	**0**	**202**	**5,066**	**8,560**	**15,767**	**20,670**	**21,095**	**18,522**	**-12.2%**	
	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%	-5.4%	
ICT/computing	UK	0	0	6,177	67,318	138,392	220,761	263,894	279,102	217,939	-21.9%	
	International	0	0	0	0	9	123	208	164	135	-17.7%	
	Female	0	0	2,866	30,817	65,781	106,750	128,151	135,160	105,709	-21.8%	
	Aged under 19	0	0	6,136	67,144	138,069	220,378	263,740	278,850	217,931	-21.8%	
	Aged 19-24	0	0	35	129	179	270	154	112	68	-39.3%	
	Aged 25+	0	0	6	45	153	236	208	304	75	-75.3%	
	Total	**0**	**0**	**6,177**	**67,318**	**138,401**	**220,884**	**264,102**	**279,266**	**218,074**	**-21.9%**	
	Percentage non-UK			0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	
	Percentage female			46.4%	45.8%	47.5%	48.3%	48.5%	48.4%	48.5%	0.2%	
All subjects (STEM and non-STEM)	UK	477	1,887	10,549	81,154	159,355	253,762	304,757	321,761	255,524	-20.6%	53,469.0%
	International	0	0	0	0	9	123	208	164	135	-17.7%	
	Female	330	1,159	5,490	38,744	77,171	124,514	149,987	157,656	125,078	-20.7%	37,802.4%
	Aged under 19	422	1,739	10,261	80,638	158,451	252,374	304,276	321,376	255,392	-20.5%	60,419.4%
	Aged 19-24	44	112	232	346	449	662	347	205	145	-29.3%	229.5%
	Aged 25+	11	36	56	170	464	849	342	344	122	-64.5%	1,009.1%
	Total	**477**	**1,887**	**10,549**	**81,154**	**159,364**	**253,885**	**304,965**	**321,925**	**255,659**	**-20.6%**	**53,497.3%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	
	Percentage female	69.2%	61.4%	52.0%	47.7%	48.4%	49.0%	49.2%	49.0%	48.9%	-0.2%	-29.3%

Source: OCR

7.9 Scottish qualifications

The Scottish system[569] of standards was reformed for students taking their exams in this year. There are now two qualifications broadly equivalent to the GCSEs of the rest of the UK: Intermediate 2, which will remain until 2015,[570] and National 5. This means that results from this year are not directly comparable with those from 2013.[571] The course for the new National 5 qualification begins at the start of the fourth year and is only one year long – compared with two for the old standards – although it is likely to have led on directly from courses in the previous year. There is a greater likelihood of outright failure and, in general, students take fewer subjects with an emphasis on deeper understanding. However, it is possible to complete an Added Value Unit before or after the exam, which would lead to a National 4 being awarded instead (equivalent to a GCSE grade D-G).

In relation to this year's results, the only Intermediate 2[572] (Table 7.10) STEM subject in which the proportion of students attaining an A-D grade (equivalent to GCSE A*-C) was higher than the overall figure (85.4%) was engineering craft skills, which had only 829 total entries. Core STEM subjects, including biology (79.1% A-D grade attainment), chemistry (79.8%), physics (80.4%) and mathematics (77.4%) were all lower.

In terms of National 5 qualifications (Table 7.11), more applied subjects – such as computing science (90.2%), design and manufacture (94.6%), engineering science (87.8%), fashion and textile technology (98.3%) and music technology (96.4%) – had, on the whole, a larger proportion of A-D grades than the average (87.3%). Core STEM subjects, including biology (76.4% A-D grade attainment), chemistry (80.7%), physics (77.4%) and mathematics (77.7%) were all lower.

Consistency in results between the two qualifications is variable. The overall pass rate has increased from 85.4% in Intermediate 2 to 87.3% in National 5. In chemistry (79.8% and 80.7%) and mathematics (77.4% and 77.7%) the results have stayed broadly similar. However, biology (79.1% and 76.4%) and physics (80.4% and 77.4%) have dropped substantially between the old and new qualifications.

This trend is in contrast to the GCSE results of the rest of the UK, in which students in STEM subjects were all more successful than the overall figure, except in the less-specialised subjects of science and further science.

Table 7.10: Attainment in selected STEM intermediate 2 qualifications (2014) – Scotland[573, 574]

Subjects	Number A-D grade	Percentage A-D grade	Total entries
Biology	5,548	79.1%	7,013
Chemistry	3,064	79.8%	3,839
Computing	1,681	80.4%	2,092
Engineering craft skills	789	95.2%	829
Information systems	382	79.7%	479
Mathematics	14,155	77.4%	18,297
Physics	2,958	80.4%	3,680
Product design	740	83.6%	885
Technological studies	160	83.8%	191
All subjects	82,983	85.4%	97,122

Source: SQA

Table 7.11: Attainment in selected STEM National 5 qualifications (2014) – Scotland[575, 576]

Subjects	Number A-D grade	Percentage A-D grade	Total entries
Administration and IT	3,680	86.2%	4,267
Biology	12,332	76.4%	16,146
Chemistry	11,427	80.7%	14,157
Computing science	5,277	90.2%	5,853
Design and manufacture	3,910	94.6%	4,135
Engineering science	1,138	87.8%	1,296
Fashion and textile technology	357	98.3%	363
Health and food technology	1,378	78.2%	1,763
Lifeskills mathematics	148	66.4%	223
Mathematics	17,504	77.7%	22,536
Music technology	241	96.4%	250
Physics	9,232	77.4%	11,932
All subjects	186,436	87.3%	213,595

Source: SQA

569 All mainstream Scottish qualifications remain part of the Scottish Credit and Qualifications Framework (SCQF) established in 2001. See www.sqa.org.uk/sqa/4609.558.html for further details 570 *National Qualifications*, Scottish Government; www.scotland.gov.uk/Topics/Education/Schools/curriculum/qualifications 571 A table comparing the old qualifications and the new National 1-5 system can be found at www.scqf.org.uk/content/files/Old%20Vs%20New%20%28low%20res%29%20-%20Updated%20July%202013.pdf. Further explanation of the new system can be found at www.sqa.org.uk/sqa/58085.3588.html, www.sqa.org.uk/sqa/58948.html. An explanation of how grades 1-7 for Standard Grade map to credit, general and foundation qualifications, how different exams are administered and who they are aimed at can be found at www.educationscotland.gov.uk/scottishschoolsonline/examguide.asp 572 This is the old qualification which is being phased out for the academic year 2015-16 and replaced fully by National 5 573 Excludes subjects with fewer than 100 A-D grades 574 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, ie results are dependent on both the learner's course assessment result (where applicable) and their successful completion of the related units 575 Excludes those with fewer than 100 A-D grades 576 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, ie results are dependent on both the learner's course assessment result (where applicable) and their successful completion of the related units.

7.10 Teacher workforce

No education system can be better than the quality of its teachers.[577] This section therefore looks at teacher training and the teacher workforce as well reviewing the importance of teaching quality.

7.10.1 Teacher workforce in England

The teacher training sector is undergoing a period of change, similar to the rest of the education sector. Under the Schools Direct scheme, schools have been able to recruit and train those who wish to become teachers, with those completing the course gaining Qualified Teacher Status.[578] In 2013, Schools Direct recruited a fifth of trainee teachers.[579] The Government has also introduced its £2 million Troops to Teachers scheme[580] to train armed forces personnel as teachers within two years of them leaving the military.[581] The Government has also tried to address the shortage of maths and physics specialist teachers by introducing the Maths and Physics Chairs programme, which aims to recruit postdoctoral trainees as teachers.[582] To facilitate the introduction of the new computer science course, a network of 400 master computer science teachers is being developed. These teachers will then create resources to use in class and train other computer science teachers.[583] Finally, on the 1st May 2014 the Secretary of State for Education announced a review of Initial Teacher Training.[584]

Table 7.12 shows the number of teachers by STEM subject and Key Stage in publicly-funded secondary schools for 2013. It shows that overall there were 33,300 teachers delivering mathematics teaching. Looking at the different Key Stages shows that 29,300 taught students in Key Stage 3, compared with 27,500 teaching Key Stage 4 and just 13,300 teaching Key Stage 5.

By comparison, there were far fewer teachers teaching physics (6,200). However, the number of teachers delivering physics courses increased as students got older, with 1,300 teachers delivering physics to Key Stage 3 compared with 4,500 teaching at Key Stage 5. This is a disturbing statistic when you consider that in last year's report we showed that there was a shortage of between 4,000 and 4,500 physics teachers in the UK. This would require 15 years of recruitment at 1,000 new teachers a year to redress. At the time, the rate was 300-400 a year.[585]

Table 7.12: Head count of teachers by STEM subject and Key Stage in all publicly funded secondary schools (2013) – England[586]

			Number of teachers of/at (thousands):		
		Head count of in service teachers (thousands)	Key Stage 3	Key Stage 4	Key Stage 5
Mathematics		33.3	29.3	27.5	13.3
Physics		6.2	1.3	3.5	4.5
Chemistry		7.4	1.3	3.9	5.6
Biology		8.8	1.5	4.3	7.0
Combined/general science		32.9	29.3	26.6	3.0
Other sciences		2.4	0.4	1.2	1.2
Design and technology[587]		13.4	5.9	10.9	3.4
Of which:					
	Electronics / systems and control	1.1	0.4	0.7	0.2
	Food technology	4.9	2.4	3.7	0.8
	Graphics	3.4	1.1	2.5	0.8
	Resistant materials	4.1	1.7	3.1	0.6
	Textiles	3.1	1.1	2.2	1.2
Other/combined technology		14.9	13.5	3.9	2.5
Engineering		1.5	0.3	1.2	0.5
ICT[588]		15.4	13.0	10.4	5.3
Total headcount (STEM and non-STEM subjects)		**233.0**	**206.5**	**205.6**	**121.0**

Source: Department for Education

577 *2013 Global Teacher Status Index*, Varkey GEMS Foundation, October 2013, p9 578 Website accessed on the 2 September 2014 (https://www.gov.uk/government/policies/improving-the-quality-of-teaching-and-leadership/supporting-pages/school-direct) 579 Website accessed on the 3 September 2014 (http://www.bbc.co.uk/news/education-25104936) 580 Website accessed on the 3 September 2014 (http://www.bbc.co.uk/news/education-28263223) 581 Website accessed on the 3 September 2014 (http://www.education.gov.uk/get-into-teaching/troops-to-teachers) 582 Website accessed on the 3 September 2014 (http://www.researchersinschools.org/researchers/maths-and-physics-uplift/) 583 Website accessed on the 3 September 2014 (http://www.bbc.co.uk/news/education-25842199) 584 Website accessed on the 3 September 2014 (https://www.gov.uk/government/news/independent-review-of-initial-teacher-training-courses-launched) 585 See Section 1.1.5 for more details 586 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. 587 Includes construction and built environment. 588 Information and communication technology is abbreviated as ICT.

Table 7.13 shows the proportion of teachers who have a post A level qualification in the STEM subjects they teach. It shows that three quarters (77.6%) of mathematics teachers have a relevant post A level qualification, but only two thirds (66.5%) of physics teachers. The picture for design and technology is slightly better, with 83.6% having a relevant qualification. But it is disturbing to see that for engineering less than one in five (18.6%) have a post A level qualification and for ICT it is under half (44.9%).

However, when you look at the recruitment of trainee teachers, it is possible that the proportion of suitably-qualified STEM teachers will decline further in the future. Ninety percent of the target number of trainee teachers was recruited for maths programmes, while for physics (including physics with maths) the comparable figure was 72%.[589] For design and technology and computer science the picture is much worse, with recruitment only reaching 48% and 57% respectively.

The Campaign for Science and Engineering has shown that the shortage of specialist science and mathematics teachers is particularly pronounced in disadvantaged areas, and this is a possible reason for the underrepresentation of students from disadvantaged backgrounds in STEM subjects.[590] Finally, the Social Market Foundation has found that physics teachers in independent schools are more likely to have a physics degree than teachers in state schools (76% compared with 50%).[591] There is a similar pattern for maths, with 70% of teachers in independent schools having a maths degree compared with less than half of teachers in the state sector.

Table 7.13: Highest post A level qualifications held by publicly funded secondary school teachers (head count) in the STEM subjects they taught (2013) – England[592 593 594]

		Highest level of qualification held in a relevant subject						
		Degree or higher	**Bachelor of Education**	**Postgraduate Certificate of Education**	**Other qualification[595]**	**Any relevant post A level qualification**	**No relevant post A level qualification**	**Head count of teachers (thousands)**
Mathematics		45.4%	5.3%	21.4%	5.5%	77.6%	22.4%	33.3
Physics		55.8%	1.8%	7.9%	1.0%	66.5%	33.5%	6.2
Chemistry		65.1%	1.6%	8.1%	1.3%	76.1%	23.9%	7.4
Biology		78.9%	2.3%	4.3%	0.8%	86.3%	13.7%	8.8
Combined/general science[596]		77.4%	2.8%	8.8%	2.3%	91.3%	8.7%	32.9
Other sciences		78.9%	2.4%	3.0%	1.1%	85.4%	14.6%	2.4
Design and technology[597]		57.1%	12.3%	8.5%	5.8%	83.6%	16.4%	13.4
	Electronics / systems and control	59.7%	14.9%	6.8%	3.3%	84.7%	15.3%	1.1
	Food technology	46.7%	14.2%	10.7%	8.4%	80.1%	19.9%	4.9
	Graphics	65.9%	10.7%	8.0%	3.6%	88.2%	11.8%	3.4
	Resistant materials	64.0%	13.3%	7.8%	4.5%	89.7%	10.3%	4.1
	Textiles	62.6%	8.5%	7.7%	5.6%	84.4%	15.6%	3.1
Other/combined technology		54.5%	11.5%	8.2%	5.3%	79.4%	20.6%	14.9
Engineering		15.8%	0.8%	0.8%	1.1%	18.6%	81.4%	1.5
ICT		27.3%	1.8%	10.7%	5.0%	44.9%	55.1%	15.4

Source: Department for Education

589 *Initial teacher training census for the academic year 2013/14*, Department for Education, 26th November 2013, p2 590 *Improving Diversity in STEM*, Campaign for Science and Engineering, May 2014, p36 591 *Open Access An independent evaluation*, Social Market Foundation, 3 July 2014, p20 592 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. 593 Not including qualifications in Special Educational Needs provision. 594 Teachers are counted once against each subject which they are teaching. 595 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 eg diplomas or Higher Education and Further Education, Foundation Degrees, higher national diplomas and certificates of Higher Education. 596 Teachers qualified in biology, chemistry, or physics are treated as qualified to teach both combined/general science and other science. 597 Teachers qualified in each of the specialist design and technology subjects are treated as qualified to teach other/combined design and technology.

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7.10.2 Teacher workforce in Wales

Table 7.14 shows the proportion teachers in each STEM subject who are trained in that subject. Three quarters (76.1%) of mathematics teachers are trained to teach the subject, but only 45.0% of physics teachers.

7.10.3 Teacher workforce in Scotland

Table 7.15 shows the proportion of teachers for each STEM subject who are teaching their main subject, by gender. It shows that nearly all mathematics teachers (93.2%) are teaching mathematics as their main subject. Female teachers (93.7%) are slightly more likely than male teachers (92.5%) to be teaching mathematics as their main subject.

Nine in 10 (90.7%) physics teachers are teaching it as their main subject, with male teachers (91.8%) slightly more likely to be than female teachers (88.2%).

Given that fewer than three quarters (70.3%) of teachers of all subjects are teaching their main subject, this is a very positive finding.

Table 7.14: Number of teachers registered with General Teaching Council Wales by STEM subject taught versus subject trained (2014) – Wales

	Number known to be trained in subject	Total teaching subject	Percentage known to be trained in subject
Biology	255	441	57.8%
Chemistry	217	436	49.8%
Mathematics	1,150	1,511	76.1%
Physics	176	391	45.0%
Science	353	1,171	30.1%

Source: General Teaching Council for Wales[598]

598 *Annual Statistics Digest, General Teaching Council for Wales*, March 2014, p14

Table 7.15: Secondary school teachers by main subject taught and other subjects taught and gender (2013) – 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	1,359	1,082	2,441	1,450	1,170	2,620	93.7%	92.5%	93.2%
Biology	865	325	1,190	1,001	391	1,392	86.4%	83.1%	85.5%
Chemistry	568	367	935	674	434	1,108	84.3%	84.6%	84.4%
General science	66	50	116	1,082	811	1,893	6.1%	6.2%	6.1%
Physics	240	582	822	272	634	906	88.2%	91.8%	90.7%
All subjects	14,148	8,040	22,188	20,263	11,283	31,545	69.8%	71.3%	70.3%

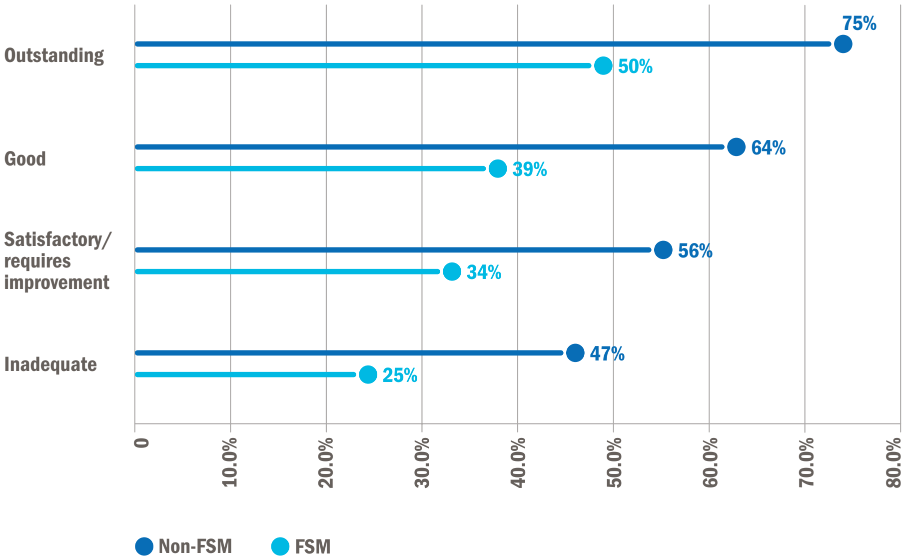
Source: Scottish Government

7.10.4 The importance of teaching quality[599]

At the start of this section we said no education system can be better than the quality of its teachers. We will now explore in more detail the impact that a great teacher can have on children and their learning. Figure 7.5 shows the percentage of students getting five GCSEs at grades A*-C, including English and mathematics, by whether they are in receipt of Free School Meals or not and the Ofsted rating of the school. It shows that students receiving Free School Meals perform less well than their peers not receiving Free School Meals and it also shows that attainment declines as the Ofsted rating declines. However, it does show that students on Free School Meals in an outstanding school are 50% more likely to attain five GCSEs including English and maths than students not in receipt of Free School Meals but studying at a school rated inadequate (47%).

In fact, the Social Mobility and Child Poverty Commission has stated that high quality teaching is the single most important way to raise attainment.[601] However, it also points out that the poorest students are less likely to be in schools with high quality teachers. Finally, the Commission states that school choice matters more for low attaining and disadvantaged students than their more advantaged peers, and that the GCSE results of students who perform poorly at Key Stage 2 can vary widely depending on which school they attend.[602]

Fig. 7.5: Percentage of pupils eligible for Free School Meals attaining five GCSEs at grades A*-C including English and mathematics by school Ofsted rating



Source: House of Commons Education Committee[600]

599 See Section 1.1.4 for more detail on the importance of teaching quality **600** *Underachievement in Education by White Working Class Children*, House of Commons Education Committee, 11 June 2014, p26 **601** *State of the nation 2013: social mobility and child poverty in Great Britain*, Social Mobility and Child Poverty Commission, October 2013, p187 **602** *State of the nation 2013: social mobility and child poverty in Great Britain*, Social Mobility and Child Poverty Commission, October 2013, p192

7.11 How can we get more girls to study physics?

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

Key findings

A comparison of the survey views of 15-year-old boys and girls about physics indicates the pervasiveness of gender issues, with boys more likely to respond positively towards physics-specific statements than girls. Analysis also shows that girls and boys who expressed intentions to participate in physics post-16 gave similar responses towards their physics teachers and physics lessons and had comparable views about the benefits they would experience from their studying physics. However, girls (regardless of intention to participate in physics) were less likely than boys to be encouraged to study physics post-16 by teachers, family and friends. Despite this, there was a subset of girls still intending to study physics post-16. The crucial differences between the girls who intended to study physics post-16 and those who did not was that girls who intend to study physics post-16 had higher physics extrinsic motivation, more positive perceptions of physics teachers and lessons and greater competitiveness.

The nature of the research

Both in the UK and worldwide, there is still a shortage of studies in mathematics and science education that examine student engagement over time and research the reasons for the take up or non-take up of mathematics and science once these subjects become optional.

In the Understanding Participation rates in post-16 Mathematics And Physics project (UPMAP)[603] we have studied these issues. Our presumption is that once students are no longer required to do certain subjects, participation depends at least in part on how students see themselves, the subjects, and themselves in relation to the subjects. None of these is fixed. Each can shift as a result of experiences both inside and outside the classroom.

As is well known, in many countries, boys predominate in physics once the subject is no longer compulsory. In England, attainment levels of boys and girls in physics/science at GCSE are quite similar with, if anything, girls doing slightly better. Given that 51% of science GCSE entries and 46% of physics GCSE entries in England are by girls, this demonstrates there is little if any difference between 16-year-old boys and girls in their ability at physics. In contrast to this, the odds of girls going on to do physics post-16 are substantially less than those for boys, even after controlling for entry requirements into A level, with the gender gap being wider for physics than for any other STEM subject. About four-fifths of the physics A level entries for each of the last ten years have been by boys.

Research design and further findings

The UPMAP project obtained data from 5,034 Year 10 students in 137 UK schools about perceptions of physics, physics lessons and physics teachers. Student questionnaires were designed following a review of the literature, considering factors that may influence post-compulsory participation rates. Alongside questions related to intentions to continue to study physics post-16, the survey included physics-specific items to assess attitudes to physics, attitudes to lessons, attitudes to teachers, support for learning, engagement in extra-curricular activities, intrinsic and extrinsic motivation for learning, engagement with ICT, personality constructs and family/people support for studying physics. In total, we had 130 items that were specific to exploring issues around physics – learning, support and perceptions – and 75 items that related to personality, attitudes and perceptions of learning in general. In addition, we included items in what we term 'core conceptual areas' in physics in order to assess understanding of core physics concepts and confidence. The student questionnaires went through five rounds of design and piloting in order to refine the survey.

The analysis was conducted primarily to explore whether gender explains differences in aspirations, perceptions, motivations and attitudes. Comparisons were generally made between intention to participate groups against non-intention to participate groups and within each intention to participate group. For example, the study compared boys who expressed an intention to participate in physics against girls with the same intention. It also compared girls who expressed an intention to participate with boys who did not have this intention – the latter in order to examine the possibility that some girls hold more positive perceptions about physics than some boys. Focusing on these differences helped to pinpoint whether responses were more to do with being a particular gender or belonging to a particular intention to participate in physics group.

Males reported more positive perceptions and emotional responses towards physics lessons ($p<.001$). The physics-specific self-concept measured students' perceptions of their own abilities as learners of physics. Our survey also measured students' conceptual understanding via conceptual tasks, their confidence in conceptual tasks and their attitudes towards conceptual tasks (a composite score of students' responses to three items asking them about the extent to which they found the tasks easy, enjoyable and interesting). Males had a higher physics self-concept, were more confident in their conceptual tasks and had more positive attitudes to conceptual tasks than females ($p<.001$). However, girls had higher conceptual task scores, which is interesting given that their confidence and self-concepts were lower than those of boys. Girls who intended to participate in post-16 physics had higher 'physics self-concept' scores than boys and girls who did not intended to participate ($p<.001$).

Our survey included constructs that explored the support and encouragement students received for physics learning and post-16 participation. Our construct 'advice and pressure to study physics' contained items about the encouragement students received from family, teachers, friends and acquaintances. Our construct 'home support for physics achievement' contained items that specifically focused on learning support. We included a construct that measured 'home support for learning in general' in order to make comparisons against the physics construct. Finally, we had constructs that measured 'social support for physics learning'. This construct contained items which showed the support students received for work outside of lessons from teachers, family and friends.

Males reported greater amounts of 'advice and pressure to study physics' and 'home support for physics achievement' ($p<.001$).

603 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. We have worked with a number of professional organisations so that the findings become embedded in practice. Please feel able to contact us at m.reiss@ioe.ac.uk or t.mujtaba@ioe.ac.uk

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Discussion

Despite girls and boys who intended to participate in physics post-16 perceiving aspects of their classroom environment in the same way, there were statistically significant differences in other core physics-specific areas. Such girls had lower confidence in their conceptual ability and lower physics self-concept than such boys, even though there was no difference in their conceptual ability. It seems likely that some girls who do not intend to participate in physics post-16 are switched off physics both by their physics environment at school and by issues outside of school, given that girls as a group report receiving less encouragement than boys to study physics post-16.

This conclusion is given support by the finding that girls who intend to study post-16 physics are significantly less likely to receive home support for achievement in physics than boys with the same intention (despite the fact that there was no gender difference for home support for achievement in general). We also found that they hold a lower intrinsic valuation of physics and, in addition, are less likely to receive advice and pressure to study physics post-16, again compared with boys who intend to participate in post-16 physics. Girls who do not intend to participate in physics had the least positive emotional response to physics lessons and perceptions of lessons and were amongst those with very low levels of both extrinsic and intrinsic valuation of physics.[604]

7.12 Asymmetry and dissonance – mathematics policy, performance and practice

Authored by Barry Brooks, Strategic Adviser to the Tribal Board, Tribal plc

Introduction

The STEM subjects are universally recognised as essential ingredients for sustaining the UK's economic regeneration. Yet, wherever you look within the education and skills sector, whether it is at school, in the education and training sector or within Higher Education, concerns are being expressed at the weakness of the mathematics knowledge, skills and understanding of our young people. This weakness has been confirmed by successive international education surveys from TIMMS, through PISA to PIAC.[605] Most recently, as Table 7.16 below demonstrates, the World Economic Forum placed the UK as low as 50th for the quality of its maths and science education.

Table 7.16: World Economic Forum rankings for the quality of maths and science education (2013/14)

	Country ranking for quality of maths and science education
Singapore	1
Finland	2
Belgium	3
Lebanon	4
Switzerland	5
Netherlands	14
France	15
Germany	21
Japan	34
Sweden	41
US	49
UK	50

Source: Policy Network[606]

604 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. 605 **TIMMS** (Trends in International Mathematics and Science Study), **PISA** (Program for International Student Assessment) and **PIAAC** (Programme for the International Assessment of Adult Competencies) 606 *Mending The Fractured Economy – Smarter state, better jobs*, Policy Network July 2014

The challenge that has bedevilled the UK's ability to sustain its previous pre-eminence in STEM innovation can be traced to the gradual decline in the mathematical and numerical competence of our citizens. We have seen fewer young people studying mathematics post-16, leading ultimately to fewer qualified mathematics teachers capable of encouraging and stimulating the next generation of mathematicians. (See Table 7.17 below which positions the UK's mathematics education provision in the context of its economic rivals.)

Policy interventions

In 2014, the Government set about addressing this poor performance and continued paucity of participation in post-16 mathematics by introducing a series of further measures and requirements designed to strengthen the role of mathematics and scaffolded by reformed qualifications. The range of interventions include:

- Those with a GCSE A*-C will be encouraged to study the subject at A level. In 2013 this was around 57.7% of the 695050[608] entrants.
- Those with A*-C who do not wish to study mathematics at A level will be expected to study for a new level 3 qualification entitled Core Mathematics. This has been estimated by the Department for Education to be around 200,000 of the cohort.
- Those with a Grade D at GCSE will be expected to study for the GCSE to improve their GCSE grade. In 2013 this was 18.1% of 695050 entrants.
- Those with lower GCSE grades will be expected to follow a Functional Skills programme to improve their mathematics and numerical competence in advance of eventually studying for a GCSE. In 2013 this 24.2% of the 695050 entrants.

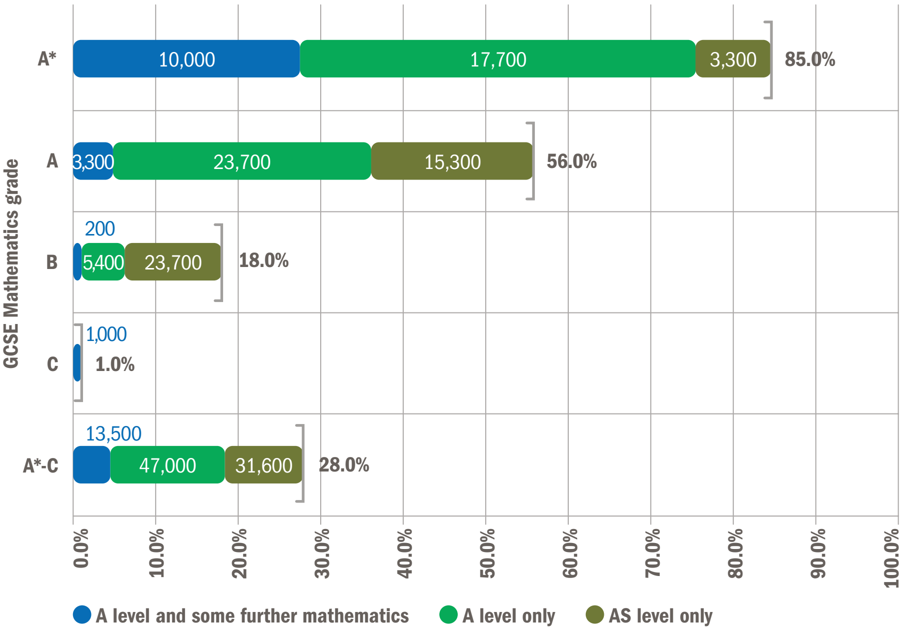
The level of Government's determination to secure an irreversible change in mathematics education post-16 should not be doubted. But as Figure 7.6 below demonstrates, the challenges required to persuade young people to continue with any form of mathematics beyond 16 once they have secured a 'good' pass are not inconsequential.

Table 7.17: Percentage of post-16 population engaged in mathematics education

All (95-100%)	Czech Republic, Estonia, Finland, Japan, Korea, Russia, Sweden, Taiwan
Most (81-94%)	Canada (BC), France, Germany, Hungary, Ireland, USA (Mass)
Many (51-80%)	Australia (NSW), Netherlands, New Zealand, Singapore
Some (21-50%)	Hong Kong, Scotland, Spain
Few (6-20%)	England, Wales, Northern Ireland

Note: The base for the percentages is the number of students in post-16 (or 'upper secondary') education or training.
Source: Nuffield Foundation[607]

Fig: 7.6: Pupils progressing to maths AS/A level by grade in GCSE (2010)



Source: Nuffield Foundation[609]

607 *Mathematics after 16: the state of play, challenges and ways ahead,* Nuffield Foundation, March 2014 608 The cohort size does include some early entrants by schools so exact numbers need to be treated with caution. 609 *Mathematics after 16: the state of play, challenges and ways ahead.* Nuffield Foundation, March 2014

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For 16- to 19-year-olds, the Government has introduced a standard 'funding per pupil tariff', and has made it a condition of funding from September 2014 that students who do not hold a GCSE Maths A*-C must continue to work towards achieving this GCSE post-16. However, this condition has been made at a time when the majority of providers within the post-16 sector are already struggling to recruit and provide enough specialist teachers qualified to teach the full range of maths programmes, as illustrated in Figure 7.7 below.

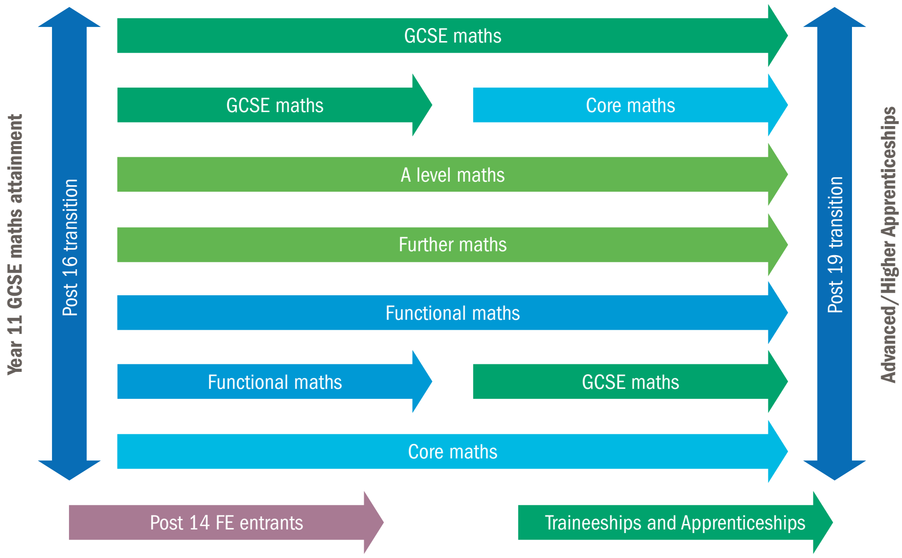
The Government's ambition is also that, by 2020, adults aged 19 and over and apprentices of all ages studying maths will be working towards achievement of the reformed GCSEs, taking stepping stone qualifications if necessary. Functional Skills will continue to be part of apprenticeship completion requirements, but the Government is committed to working with apprenticeship providers to enable them to offer GCSEs to their apprentices.

Performance and practice

Ofqual has been working with awarding organisations to ensure greater 'rigour' in assessment judgements. This has resulted in, as Figure 7.8 below demonstrates, a gradual reduction in GCSE achievements. Furthermore, from September 2015, GCSE maths is being reformed to make it more stretching and more relevant to employer needs. From 2017, the new GCSE will become the national standard qualification for full-time 16- to 19-year-olds who did not achieve a good pass in these subjects by age 16.

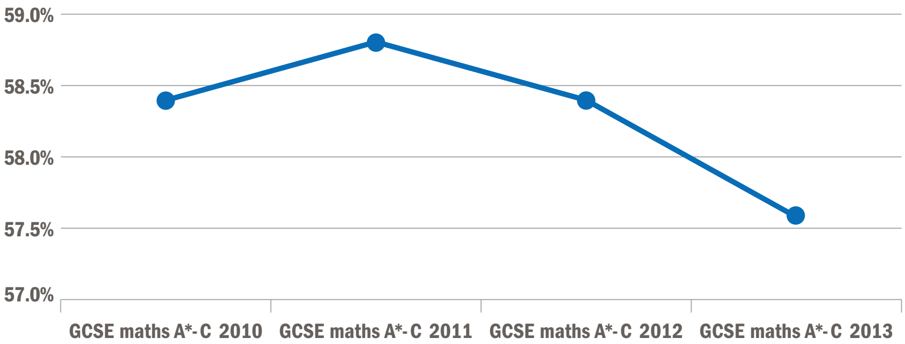
The sector has consistently struggled to recruit and retain sufficient high quality maths teachers,[610] and this shortage of talent remains a barrier to progress. A key element of the Government's response to address this long-standing issue of quality was to establish the National Centre for Excellence in Teaching Mathematics (NCETM) in 2005. NCETM has worked with the mathematics community and successive governments to improve the quality of professional development available to new entrants and established mathematics teachers, as well as to ensure effective communities of practice. As Figure 7.9 below highlights, despite greater levels of investment, an increased profile, improved terms and conditions, Government targets to increase the flow of maths educators into schools and colleges are still not being met.

Fig: 7.7: An overview of the Government's ambitions for and expectations of mathematics provision post-16



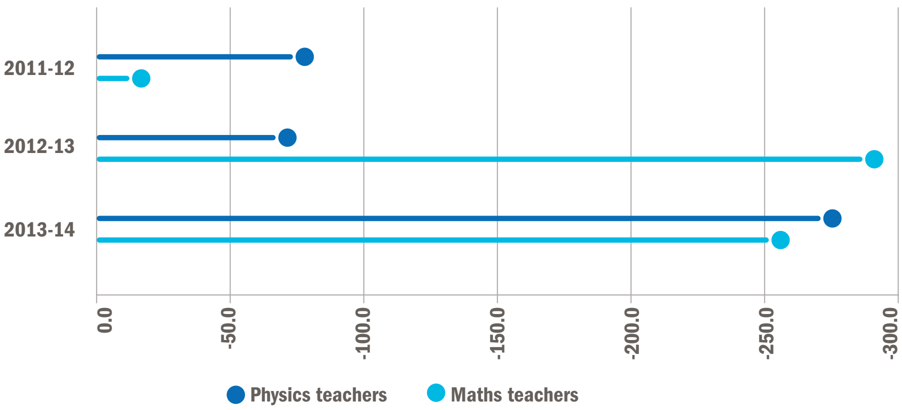
Source: Tribal PLC

Fig. 7.8: Recent GCSE maths grade 'deflation' (2010-2013)



Source: Tribal PLC

Fig. 7.9: Shortfall of new entrants to initial teacher training in physics and maths compared with Government targets (2011/12 – 2013/14)



Source: Mending the fractured economy – smarter state, better jobs. Policy Network July 2014

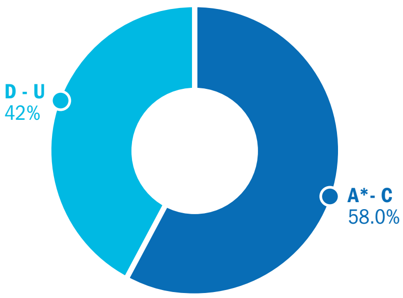
610 Making Mathematics Count, February 2004

A major and more immediate issue for Government is to ensure that the stock of the current workforce is well prepared and better able to address the expected increase in participation in mathematics post-16. In this respect, the Government has been active by investing in a diverse range of new approaches, including the Further Education Workforce Strategy.[611]

The Education and Training Foundation (ETF) has been given a pivotal role in implementing this strategy and is committed to ensuring that the sector has sufficient high calibre teachers available to meet the increased demands resulting from these new requirements. One of the schemes, a Recruitment Incentive Scheme, offers a bonus payment of £20,000 to colleges and training providers who recruit a specialist graduate maths teacher or £30,000 for those colleges that are prepared to share their teaching expertise with nearby institutions.

Despite progress, with increasing numbers in A level mathematics and further mathematics, the fundamental issue of participation in mathematics post-16 and the associated achievements of young people in mathematics as they enter the post-16 arena remains a concern. Figure 7.10 shows that in 2013, over 40% of pupils still failed to achieve GCSE maths grades A* to C by age 16. Based on past performance, without intervention 90% of those who did not reach this basic standard by 16 will still not achieve this by age 19, thereby continuing to place an enormous burden on already stretched providers.

Fig. 7.10: GCSE performance by A*-C grade (2013)



Source: Tribal PLC

One key intervention has been the Maths Enhancement Programme (MEP). The MEP saw a cadre of 83 maths experts recruited and trained by NCETM as maths professional development leads. They were then shared across Association of Centres for Excellence in Teacher Training (ACETT) members to enable them to recruit, train and prepare over 2,000 teachers, who are currently delivering Functional Maths or other maths stepping stone qualifications, to deliver GCSE maths in the FE sector.

Hovever, findings from Curee's[612] strategic consultation Mathematics and English for ETF suggested that 53% of the teaching workforce possessed only a level 2 maths qualification, with a further 14% possessing a level 3. Only 17% had a degree or a post-graduate certificate in mathematics. We should not therefore be surprised, as Table 7.18 demonstrates, that the workforce does not feel adequately prepared to successfully introduce these extensive mathematics programmes.

Table 7.18: Maths Enhancement Programme responses from participants as to confidence in teaching GCSE maths following completion

Ready	Nearly ready	Not ready
32%	49%	19%

Source: Tribal PLC

The scale of the challenges outlined above are in themselves considerable, even if the teachers were working with a cohesive student cohort that was prepared to be cooperative and collaborative irrespective of ability and past experience. However, as articulated by the National Foundation for Educational Research (NFER)[613] in its recent report on STEM education, students' negative attitudes towards maths and their lack of awareness of the importance of the subject for their future study and careers further compounds the challenges in this area. Given that for many of these young people their experience of maths in school has been an uninspiring one, and one that has been marked as a 'failure', it is not surprising that these negative views are now emerging and acting as a further potential barrier for success post-16.

What next

Whilst Government has set the policy framework for improvement and has put in place the levers and drivers to secure sustainable change, there needs to be greater alignment between what happens in schools and the education and training sector. Also, more must be done to raise the subject knowledge and skills of the teaching workforce, whether it is through central intervention, regional, local or personal professional development.

Government intervention alone will not be enough; employers too must be more active if they genuinely want to help shape the skills of their future workforce. This activity must be at all points in the system: by working with schools and colleges to raise awareness, by working with Ofsted to help them shape what they monitor and report, by working with awarding organisations and Ofqual to help them devise qualifications and assessment instruments that develop and assess the skills they need in contexts that are relevant to the workplace.

Finally, students must also accept some responsibility for embracing the opportunities that these new maths developments offer them, seeing them as an investment in their future designed to broaden their horizons and not as a burden intended as punishment for earlier failures or missed opportunities.

611 Website accessed on 8 September 2014 (https://www.gov.uk/government/publications/further-education-workforce-strategy) **612** Curee – Centre for the Use or Research and Evidence in Education, March 2014 **613** NFER – Consultation on Science, Technology, Engineering and mathematics for the ETF, July 2014

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Part 2 - Engineering in Education and Training
8.0 AS, A levels and equivalent qualifications

The UK education qualifications system is fragmented. Nevertheless, in 2014 there were 114,110[614] entrants to A level or equivalent mathematics and 48,725[615] A level or equivalent entrants to physics across the UK.

8.1 Level 3 qualifications in England, Wales and Northern Ireland

Post-compulsory qualifications are also going through a lot of change at the moment. On 28 June 2013, the Raising the Participation Age legislation came into effect.[616] This legislation means that all Year 11 students in summer 2013 have to continue in education or training until the end of the academic year in which they became 17. From September 2015, they will have to participate until their 18th birthday.

Participation in education or training should consist of one of the following:

- full-time education, such as school or college (sometimes with a part time job alongside)
- an apprenticeship
- work with part-time accredited education or training alongside

Raising the age of participation should have beneficial results. Research by the National Centre for Universities and Business[617] shows that every additional year of schooling in a population leads to an increase in GDP in the long term of 0.2%.

However, there is still room for improvement. Ofsted has highlighted its concern that too many learners in 16-19 study programmes are not progressing from their prior attainment to higher level study: this was particularly an issue for those on level 1 and 2 courses.[618] Alongside this, analysis by the Institute for Public Policy Research[619] estimates that one in ten 16- to 18-year-olds are on courses that lead to low level qualifications, while a fifth of teenagers who got low level qualifications were not in work for further study by the time they were 20.[620]

The assessment of AS and A level exams is also changing. The main proposed changes include a de-coupling of AS level qualifications from A level qualifications, meaning that AS qualifications will no longer form part of the A level qualification and contribute 50% of the score.[621] In addition, in January 2013 the Government announced that both AS and A level qualifications are being moved to a linear structure, with exams being taken at the end of the course.[622] And, with the exception of art and design, all AS level qualifications listed for first teaching in 2015 will be exam-only qualifications.[623] Finally, it is proposed that the contribution of AS level qualifications to the UCAS tariff for university entrance be reduced to 40% in 2017.[624]

In addition, in order to put vocational qualifications on a par with academic qualifications, the Government has announced the introduction of Tech level qualifications,[625] backed by leading employers.[626] A list of approved Tech level qualifications can be accessed on the Government website.[627]

At the same time, a number of exam providers have begun to develop a range of baccalaureate qualifications, which include the AQA Bacc, the City and Guilds Tecbac and the Welsh Bacc.[628] This shows that there is support for an overarching baccalaureate qualification. The

614 This is a combination of A level maths plus equivalent Scottish qualifications (excluding those studying Scottish qualifications which are not comparable to A level A*-C grades) **615** This is a combination of A level physics plus equivalent Scottish qualifications (excluding those studying Scottish qualifications which are not comparable to A level A*-C grades) **616** *Interim Government Evidence for the Low Pay Commission's 2014 Report*, Department for Business, Innovation and Skills, October 2013, p63 **617** *Career Portfolios and the Labour Market for Graduates and Postgraduates in the UK*, National Centre for Universities and Business, April 2014, p4 **618** *Transforming 16 to 19 education and training: the early implementation of 16 to 19 study programmes*, Ofsted, September 2014, p5 **619** *Growing up and becoming an adult*, Institute for Public Policy Research, November 2013, p5 **620** *Growing up and becoming an adult*, Institute for Public Policy Research, November 2013, p5 **621** Website accessed on the 21 August 2014 (http://ofqual.gov.uk/news/gcse-a-level-as-qualification-updates-ofqual/) **622** Website accessed on the 21 August 2014 (http://ofqual.gov.uk/news/gcse-a-level-as-qualification-updates-ofqual/) **623** Website accessed on the 21 August 2014 (http://ofqual.gov.uk/news/gcse-a-level-as-qualification-updates-ofqual/) **624** Website accessed on the 21 August 2014 (http://www.telegraph.co.uk/education/educationnews/10781765/AS-level-exams-devalued-in-university-admissions-shake-up.html) **625** Website accessed on the 21 August 2014 (https://www.gov.uk/government/news/top-firms-back-new-tranche-of-tech-levels) **626** Website accessed on the 21 August 2014 (https://www.gov.uk/government/news/firms-back-tech-levels-helping-students-compete-in-global-race) **627** https://www.gov.uk/government/publications/vocational-qualifications-for-14-to-19-year-olds **628** *Qualifications matter: improving the curriculum and assessment for all The third report of the independent Skills Taskforce*, Labour's Policy Review, p6

Government is also introducing a technical level baccalaureate that will recognise achievement for students taking level 3 technical qualifications, level 3 maths and an extended project.[629]

Also relating to vocational education, the Government has launched applied general qualifications.[630] Applied general qualifications will be level 3 qualifications that cover a broad range of study in vocational areas. However, they will not count towards the new Technical Baccalaureate as they don't provide students with specialist knowledge and skills.[631]

The Russell Group is an alliance of 24 research-intensive universities.[632] It has identified those A level subjects which are facilitating subjects for entry into Higher Education (HE).[633] Facilitating subjects includes the following STEM subjects:

- mathematics
- further mathematics
- biology
- chemistry
- physics

Analysis by the Higher Education Funding Council for England (HEFCE) has also shown that students studying at least two facilitating A levels are more likely to progress to university than those students studying no facilitating A levels for each combination of A level grades examined.[634]

8.2 AS level entrant numbers

Table 8.0 shows the number of entrants to different AS level STEM subjects over a 10-year period. Overall, the number of entrants to all subjects has risen by a third (30.9%) over the period and by 5.0% in 2014. In an open letter to all schools, Ofqual identified that entrants to AS level courses are higher this year than in 2013, as a result of the removal of the January exam series.[635]

Looking at the different STEM subjects shows that four subjects had an increase of more than the average for all subjects (5.0%) in 2014. These were:

- computing: +30.3%
- further mathematics: +8.5%
- mathematics: +7.2%
- physics: +5.9%

Chemistry (3.6%), design and technology (2.0%), and biology (1.3%) have all had an increase in entrant numbers in 2014, albeit still below the average for all subjects. Finally, two STEM subjects saw a decline in entrant numbers over the last year: ICT (down 2.3%) and other science subjects (down 1.3%).

It is also worth noting that over 10 years, two STEM subjects have had particularly significant growth. These are further mathematics (385.4%) and mathematics (137.2%). However, two STEM subjects have had an equally marked decline in entrant numbers, falling by 29.0% (other science subjects) and 27.4% (ICT).

The Sixth Form Colleges' Association has identified that a fifth (22%) of colleges have dropped STEM courses as a result of funding cuts,[636] with science subjects being the worst hit.

Table 8.0: GCE AS level STEM subject entrant volumes (2005-2014) – all UK candidates

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Change over one year	Change over 10 years
Biology	71,346	72,246	73,572	72,239	79,112	83,408	102,532	102,387	103,905	105,251	1.3%	47.5%
Chemistry	49,951	50,855	52,835	54,157	58,473	62,232	79,874	82,390	85,631	88,673	3.6%	77.5%
Computing	10,247	9,208	8,719	7,821	7,564	7,223	8,097	7,719	8,886	11,582	30.3%	13.0%
ICT	23,444	21,790	20,422	19,266	19,696	19,910	21,100	18,961	17,421	17,027	-2.3%	-27.4%
Mathematics	68,178	70,805	77,387	84,613	103,312	112,847	141,392	148,550	150,787	161,711	7.2%	137.2%
Further mathematics	5,054	6,292	7,426	8,945	13,164	14,884	18,555	20,954	22,601	24,530	8.5%	385.4%
Physics	35,828	36,258	37,323	38,129	41,955	45,534	58,190	59,172	61,176	64,790	5.9%	80.8%
Other science subjects	9,053	9,801	9,343	9,529	6,947	6,873	7,064	6,550	6,518	6,432	-1.3%	-29.0%
Design and technology/ technology subjects	23,736	23,099	22,702	22,953	25,120	25,201	28,674	25,661	25,124	23,774	2.0%	0.2%
All subjects	1,079,566	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	5.0%	30.9%

Source: Joint Council for Qualifications (JCQ)

629 Website accessed on the 21 August 2014 (https://www.gov.uk/government/publications/technical-baccalaureate-measure-for-16-to-19-year-olds) 630 *16 to 19 performance tables: applied general qualifications 2016*, Department for Education, December 2013, p3 631 *16 to 19 performance tables: applied general qualifications 2016*, Department for Education, December 2013, p3 632 Website accessed on the 21 August 2014 (http://www.russellgroup.ac.uk/) 633 *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p7 634 *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p40 635 *Open letter to schools and colleges*, Ofqual, 26 June 2014, p2 636 *SFCA Funding Impact Survey 2014*, Sixth Form Colleges' Association, June 2014, p2

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Table 8.1 shows the number of entrants to different STEM subjects in 2014 by home nation. England had a lower proportion of entrants to physics than Wales or Northern Ireland (4.5% compared with 5.0% and 5.8%). However, England had a higher proportion of entrants to mathematics than Northern Ireland or Wales (11.6% against 10.2% and 9.6%).

In all three nations, mathematics is the STEM subject with most entrants as a percentage of entrants to all subjects. Northern Ireland, however, has a higher proportion of entrants to biology, chemistry and physics than England and Wales.

Table 8.2 shows the 10 subjects with the largest percentage increase in the number of entrants at AS level in 2014 compared with the previous year. Two STEM subjects are in this top 10 list. Of all the subjects, computing had the largest percentage increase (30.3%). Further mathematics had the tenth largest increase (8.5%). It is also worth noting that economics, while not a STEM subject, is very numerate and had the ninth largest increase in entrant numbers (8.7%).

Table 8.1: GCE AS level STEM subject entrant volumes by home nation (2014) – all UK candidates

	England		Wales		Northern Ireland	
	Number of entrants	Percentage of all subjects	Number of entrants	Percentage of all subjects	Number of entrants	Percentage of all subjects
Biology	96,252	7.3%	4,365	8.2%	4,634	10.1%
Chemistry	81,726	6.2%	3,708	7.0%	3,239	7.1%
Computing	10,800	0.8%	520	1.0%	262	0.6%
ICT	13,586	1.0%	1,502	2.8%	1,939	4.2%
Mathematics	151,945	11.6%	5,087	9.6%	4,679	10.2%
Further mathematics	23,848	1.8%	411	0.8%	271	0.6%
Physics	59,450	4.5%	2,672	5.0%	2,668	5.8%
Other science subjects	5,797	0.4%	521	1.0%	114	0.2%
Design and technology/technology subjects	21,249	1.6%	1,112	2.1%	1,413	3.1%
All subjects	1,314,086		53,097		45,751	

Source: Joint Council for Qualifications (JCQ)

Table 8.2: Top ten GCE AS level subjects as percentage increase in the number of entrants (2013/14) – all UK candidates

	2013	2014	Change over one year
Computing	8,886	11,582	30.3%
Irish	374	461	23.3%
Geography	47,586	55,677	17.0%
Spanish	12,136	13,958	15.0%
History	70,910	81,152	14.4%
Religious studies	34,679	38,927	12.3%
Political studies	20,170	22,335	10.7%
English	119,736	131,018	9.4%
Economics	40,311	43,812	8.7%
Further mathematics	22,601	24,530	8.5%

Source: Joint Council for Qualifications (JCQ)

8.2.1 AS level A-C[637] achievement rates

Figure 8.0 shows the A-C achievement rates for STEM subjects over a 10-year period. It shows that in 2014, the A-C achievement rate for all subjects was 61.4% and that the achievement rate has increased every year since 2005.

Of the STEM subjects, only two had an above average A-C pass rate in 2014. These were further mathematics (80.0%) and mathematics (67.0%). By comparison, only two in five (43.3%) entrants to computing achieved an A-C grade, which was only slightly better than ICT (46.4%) and design and technology (51.1%). Finally, it is worth noting that over half (58.1%) of entrants to physics got an A-C grade.

Table 8.3 shows the AS level A-C pass rate by gender for 2014 and the calculated number of students who are getting an A-C. It shows that female students have a higher A-C pass rate for all subjects than male students (64.1% against 58.4%). Looking at the different STEM subjects shows that for all but two – chemistry and other science subjects – female students had a higher A-C pass rate than male students.

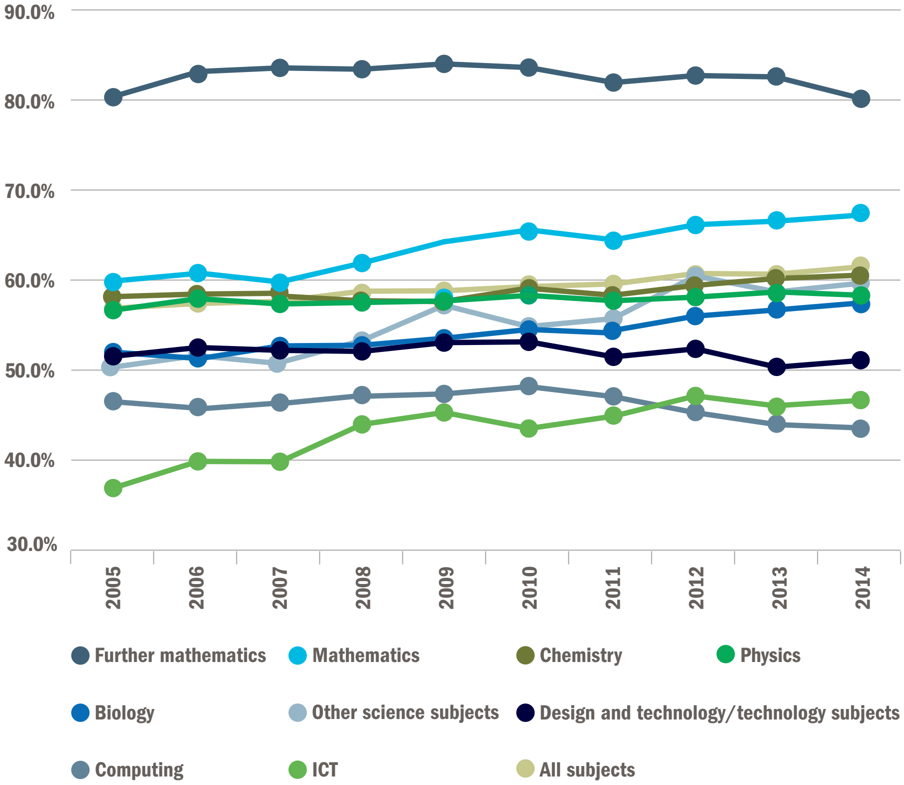
In mathematics, over two thirds of female students got an A-C (68.3%), compared with just under two thirds of male students (66.2%). However, only two in five (39.4%) entrants to AS mathematics are female. The A-C pass rate was higher for further mathematics; however, females outperformed males once again (81.3% to 79.5%). Female students make up less than a third (29.6%) of the further mathematics cohort.

Overall, 64,790 students were entered for physics. Of these, less than a quarter (23.7%) were female. The A-C pass rate for female students was 61.4%, compared with 57.1% for male students.

In Table 8.4 we show the proportion of female entrants to each of the STEM subjects for the last 10 years. The only STEM subject to have more than 50% female students in each year is biology, with the proportion ranging from 55.1% to 59.1%. Chemistry is close to gender parity with the proportion ranging from 47.0% to 49.7%.

By comparison, all the other STEM subjects are dominated by male students, and it is also notable that the proportion of female students for each subject was lower in 2014 than it was in 2005. For instance, only one in 10 (9.5%) computing entrants were female in 2014.

Fig. 8.0: GCE AS level STEM subject A-C achievement rates (2005-2014) – all UK candidates



Source: Joint Council for Qualifications (JCQ)

637 Grades A-E are passes at AS level. However, we purposely only analyse/group passes at grades A-C, as these are generally the grades required for entry into STEM honours degree courses

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Table 8.3: Number of GCE AS level A-C passes by gender (2014) – all UK candidates

	Male students			Female students				All students		
	Total number of male students	Percentage A-C for male students	Calculated number of male students obtaining a grade A-C	Total number of female students	Percentage A-C for female students	Calculated number of female students obtaining a grade A-C	Percentage of all entrants who are female	Total number of students	Percentage A-C for all students	Calculated number of all students obtaining a grade A-C
Biology	43,032	55.8%	24,012	62,219	58.3%	36,274	59.1%	105,251	57.3%	60,309
Chemistry	45,084	60.5%	27,276	43,589	60.1%	26,197	49.2%	88,673	60.3%	53,470
Computing	10,485	42.9%	4,498	1,097	46.7%	512	9.5%	11,582	43.3%	5,015
ICT	11,463	42.3%	4,849	5,564	54.9%	3,055	32.7%	17,027	46.4%	7,901
Mathematics	97,999	66.2%	64,875	63,712	68.3%	43,515	39.4%	161,711	67.0%	108,346
Further mathematics	17,276	79.5%	13,734	7,254	81.3%	5,898	29.6%	24,530	80.0%	19,624
Physics	49,457	57.1%	28,240	15,333	61.5%	9,430	23.7%	64,790	58.1%	37,643
Other science subjects	4,716	59.7%	2,815	1,716	59.1%	1,014	26.7%	6,432	59.6%	3,833
Design and technology/ technology subjects	14,539	46.4%	6,746	9,235	58.4%	5,393	38.8%	23,774	51.1%	12,149
All subjects	654,479	58.4%	382,216	758,455	64.1%	486,170	53.7%	1,412,934	61.4%	867,541

Source: Joint Council for Qualifications (JCQ)

Table 8.4: Percentage of female entrants to GCE AS level subjects (2005-2014) – all UK candidates

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Biology	59.0%	58.8%	58.1%	57.2%	56.7%	56.1%	55.1%	56.3%	57.3%	59.1%
Chemistry	49.7%	49.5%	49.5%	49.0%	48.2%	47.9%	47.0%	47.9%	48.3%	49.2%
Computing	11.1%	11.3%	11.0%	11.1%	10.2%	9.5%	9.5%	8.2%	8.7%	9.5%
ICT	36.9%	37.3%	38.2%	37.6%	37.0%	36.9%	36.4%	35.8%	34.3%	32.7%
Mathematics	40.0%	41.0%	41.4%	41.7%	41.8%	41.0%	40.9%	40.3%	39.5%	39.4%
Further mathematics	33.6%	35.0%	33.8%	34.7%	35.3%	34.8%	32.8%	31.7%	30.1%	29.6%
Physics	24.6%	24.5%	24.7%	24.1%	23.6%	23.7%	23.3%	23.4%	23.4%	23.7%
Other science subjects	32.0%	32.5%	33.6%	34.8%	29.7%	29.3%	27.6%	27.3%	27.3%	26.7%
Design and technology/technology subjects	40.5%	41.5%	41.5%	41.4%	42.4%	42.1%	42.2%	40.7%	40.2%	38.8%

Source: Joint Council for Qualifications (JCQ)

8.3 A level entrant numbers

Table 8.5 shows the number of entrants to different STEM A level subjects over a 10-year period. In 2014, the overall number of entries declined by 2.0% on the previous year. However, this may have been caused by the removal of the January exam series, which meant that students couldn't take one unit early.[638] Over the 10-year period, entries over all subjects have increased by 6.4%.

Looking at the different STEM subjects shows that in 2014 only ICT and design and technology had fewer entrants (down 9.0% and 12.5% respectively). In fact, ICT had the fifth-largest decline of all A level subjects in 2014. Conversely, entry numbers to computing increased 11.0% in the same period.

Concentrating specifically on mathematics shows an increase in entrants to 88,816 in 2014. Over the 10 years, entrants to mathematics have increased by 67.9% – the second largest increase for a STEM subject.

Further mathematics had the largest increase over 10 years, rising by 136.4% to 14,028.

Over 10 years, the proportion of students taking physics has risen by 30.5%, which is around half the increase of mathematics. However, it is still less than half as popular as maths, with 36,701 entrants in 2014 – 41.3% of the entrants to maths. Therefore, one way to increase the pool of students able to study engineering would be to encourage a higher proportion of students who are studying mathematics to also study physics.

Table 8.5: GCE A level STEM subject entrant numbers (2005-2014) – all UK candidates

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Change over one year	Change over 10 years
Biology	53,968	54,890	54,563	56,010	55,485	57,854	62,041	63,074	63,939	64,070	0.2%	18.7%
Chemistry	38,851	40,064	40,285	41,680	42,491	44,051	48,082	49,234	51,818	53,513	3.3%	37.7%
Computing	7,242	6,233	5,610	5,068	4,710	4,065	4,002	3,809	3,758	4,171	11.0%	-42.4%
ICT	14,883	14,208	13,360	12,277	11,948	12,186	11,960	11,088	10,419	9,479	-9.0%	-36.3%
Mathematics	52,897	55,982	60,093	65,593	72,475	77,001	82,995	85,714	88,060	88,816	0.9%	67.9%
Further mathematics	5,933	7,270	7,872	9,091	10,473	11,682	12,287	13,223	13,821	14,028	1.5%	136.4%
Physics	28,119	27,368	27,466	28,096	29,436	30,976	32,860	34,509	35,569	36,701	3.2%	30.5%
Other science subjects	4,414	4,209	4,544	4,555	4,496	3,361	3,277	3,375	3,477	3,486	0.3%	-21.0%
Design and technology/ technology subjects	17,914	18,684	17,417	17,396	17,442	18,417	18,249	17,105	15,641	13,691	-4.8%	-23.6%
All subjects	783,878	805,698	805,657	827,737	846,977	853,933	867,317	861,819	850,752	833,807	-2.0%	6.4%

Source: Joint Council for Qualifications (JCQ)

If we assume that students entered for A level exams in 2014 took AS level exams in the same subject in 2013, then Table 8.6 shows the proportion of male and female students progressing from AS level to A level.

Across all subjects, female students were slightly more likely to progress in subjects than male students (63.3% against 60.4%). For physics, however, 61.8% of male students progress, compared with 54.0% of female students. The progression rate for male and female students (60.0%) is below the average for all subjects (62.0%).

In contrast, the mathematics progression rate for male and female students is similar, with 59.7% of males and 58.9% of females moving from AS level to A level.

Computing is the only STEM subject where fewer than half (46.9%) of AS level students progress to A level.

638 *Open letter to schools and colleges*, Ofqual, 26 June 2014, p2

Table 8.6: Entrants to GCE A level STEM subjects compared with entrants in GCE AS level STEM subjects, by gender (2013/14) – all UK candidates

	Male students			Female students			All students		
	AS level entrant numbers 2013	A level entrant numbers 2014	A level entrant numbers as a proportion of AS level entrant numbers	AS level entrant numbers 2013	A level entrant numbers 2014	A level entrant numbers as a proportion of AS level entrant numbers	AS level entrant numbers 2013	A level entrant numbers 2014	A level entrant numbers as a proportion of AS level entrant numbers
Biology	44,384	26,346	59.4%	59,521	37,724	63.4%	103,905	64,070	61.7%
Chemistry	44,311	27,637	62.4%	41,320	25,876	62.6%	85,631	53,513	62.5%
Computing	8,114	3,857	47.5%	772	314	40.7%	8,886	4,171	46.9%
ICT	11,454	6,058	52.9%	5,967	3,421	57.3%	17,421	9,479	54.4%
Mathematics	91,209	54,442	59.7%	59,578	34,374	57.7%	150,787	88,816	58.9%
Further mathematics	15,800	10,053	63.6%	6,801	3,975	58.4%	22,601	14,028	62.1%
Physics	46,848	28,958	61.8%	14,328	7,743	54.0%	61,176	36,701	60.0%
Other science subjects	4,741	2,691	56.8%	1,777	795	44.7%	6,518	3,486	53.5%
Design and technology/ technology subjects	14,174	8,100	57.1%	9,140	5,591	61.2%	23,314	13,691	58.7%
All subjects	628,685	379,823	60.4%	716,824	453,984	63.3%	1,345,509	833,807	62.0%

Source: Joint Council for Qualifications (JCQ)

Table 8.7 shows the percentage of candidates in independent schools and state schools or colleges that took each STEM subject in 2013. Nearly half (45.9%) of candidates in independent schools took mathematics, compared with just over a quarter (28.6%) of students in the state sector. The proportion of candidates taking physics is lower, but again those in independent schools (18.6%) are more likely to take the subject than those in the state sector (11.2%).

Table 8.7: Percentage of GCE A level candidates that take each STEM subject by school type (2013)

	Independent school	State school or FE College
Biology	26.0%	21.3%
Chemistry	25.3%	17.0%
Computing	0.6%	1.4%
ICT	1.6%	3.1%
Mathematics	45.9%	28.6%
Further mathematics	10.8%	4.1%
Physics	18.6%	11.2%
Other science subjects	0.9%	1.7%
Design and technology/technology subjects	5.0%	4.7%

Source: Independent Schools Council[639]

639 *A comparison of A-level results in 2013 between independent schools and state schools and FE colleges in England*, Independent Schools Council, p1

Table 8.8 shows the number of students entered for different STEM A level exams in 2014 by home nation. The proportion of students taking mathematics varies, with students in England (10.7%) and Wales (10.5%) more likely to take the subject than students in Northern Ireland (9.7%). However, students in Northern Ireland (4.9%) are more likely to be taking physics than students in England (4.4%) or Wales (4.4%).

Mathematics claimed the highest proportion of STEM entrants in England and Wales, but for Northern Ireland it was for biology.

The Guardian newspaper has also highlighted regional variation in the take up of maths and science across England, with those in London, the East Midlands and the South East the most likely to take these subjects in 2012/13.[640] The analysis also showed that 52 schools and colleges in England failed to enter any students for any of the five following subjects:

- mathematics
- further mathematics
- biology
- chemistry
- physics

In addition, 79 schools and colleges didn't enter any students for A level mathematics and 306 didn't enter any students for A level physics.

Table 8.8: GCE A level STEM subject entrant volumes by home nation (2014) – all UK candidates

	England		Wales		Northern Ireland	
	Number of entrants	Percentage of all subjects	Number of entrants	Percentage of all subjects	Number of entrants	Percentage of all subjects
Biology	58,111	7.6%	2,801	7.9%	3,158	10.0%
Chemistry	49,151	6.4%	2,517	7.1%	1,845	5.8%
Computing	3,826	0.5%	239	0.7%	106	0.3%
ICT	7,171	0.9%	874	2.5%	1,434	4.5%
Mathematics	82,024	10.7%	3,727	10.5%	3,065	9.7%
Further mathematics	13,402	1.7%	435	1.2%	191	0.6%
Physics	33,599	4.4%	1,553	4.4%	1,549	4.9%
Other science subjects	3,131	0.4%	298	0.8%	57	0.2%
Design and technology/technology subjects	12,016	1.6%	736	2.1%	939	3.0%
All subjects	766,715		35,492		31,600	

Source: Joint Council for Qualifications (JCQ)

640 Website accessed on the 26 August 2014 (http://www.theguardian.com/education/2014/jul/17/schools-fail-enter-pupils-science-maths-a-levels)

Table 8.9 shows the top 10 A level subjects, based on the highest percentage increase from 2013 to 2014. Five of the top 10 subjects are STEM subjects, with computing having the second largest increase (11.0%), followed by chemistry (3.3%), physics (3.2%), further mathematics (1.5%) and mathematics (0.9%).

Economics, which is a numerate subject, also made it into the top 10.

Table 8.9: Top 10 GCE A level subjects as percentage increase in the number of entrants (2013/14) – all UK candidates

	2013	2014	Change over one year
All other subjects	10,746	11,936	11.1%
Computing	3,758	4,171	11.0%
Religious studies	23,354	24,213	3.7%
Chemistry	51,818	53,513	3.3%
Physics	35,569	36,701	3.2%
Classical subjects	6,443	6,615	2.7%
Economics	26,139	26,612	1.8%
Further mathematics	13,821	14,028	1.5%
Mathematics	88,060	88,816	0.9%
Geography	32,872	33,007	0.4%

Source: Joint Council for Qualifications (JCQ)

8.3.1 A level A*[641]-C[642] achievement rates

The proportion of entrants getting A*-C for different STEM subjects over 10 years is shown in Table 8.10. It shows that, across all subjects, three quarters (76.7%) of entrants got an A level at grade A*-C in 2014. However, only three of the STEM subjects had an above-average A*-C pass rate. These were further mathematics (87.8%), mathematics (80.5%) and chemistry (78.0%). The pass rate for physics was just below average at 72.2%.

The STEM subject with the lowest A*-C pass rate in 2014 was ICT, at 60.6%. This was just ahead of computing, which had a pass rate of 61.3%.

Table 8.10: Proportion achieving grade A*-C at GCE A level (2005-2014) – all UK candidates

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Further mathematics	86.6%	87.9%	88.5%	88.9%	88.9%	89.8%	89.5%	89.4%	89.9%	87.8%
Mathematics	77.9%	79.9%	80.7%	81.3%	81.8%	81.7%	81.8%	81.6%	81.3%	80.5%
Chemistry	73.1%	74.2%	75.2%	76.3%	76.2%	75.8%	78.2%	79.1%	79.5%	78.0%
Physics	68.1%	68.9%	70.2%	70.6%	70.8%	72.9%	73.5%	74.0%	73.9%	72.2%
Biology	65.0%	66.3%	67.7%	69.2%	70.2%	70.3%	73.3%	73.7%	73.7%	72.0%
Design and technology/technology subjects	64.8%	67.6%	68.6%	68.6%	69.1%	69.6%	70.2%	69.9%	70.5%	68.8%
Computing	56.2%	57.8%	58.7%	59.0%	59.9%	61.3%	62.6%	60.8%	61.1%	61.3%
ICT	49.0%	50.6%	53.0%	55.8%	56.9%	60.2%	60.6%	62.8%	65.1%	60.6%
Other science subjects	63.0%	64.9%	67.4%	66.2%	69.0%	76.3%	75.2%	76.4%	76.3%	76.0%
All subjects	69.9%	71.3%	72.8%	73.9%	75.1%	75.4%	76.2%	76.6%	77.2%	76.7%

Source: Joint Council for Qualifications (JCQ)

641 A new A* grade was introduced for A levels in 2010 642 Grades A*-E are passes at A level. However, we purposely only analyse/group passes at grades A*-C, as these are generally the grades required for entry into STEM honours degree courses.

Table 8.11 shows the number of male and female students entered for different STEM A level subjects in 2014 and the number and percentage of students getting A*-C grades. Overall, there were more female students than male (453,984 to 379,823) and the A*-C pass rate for female students was higher than the comparable pass rate for male students (78.9% to 74.0%).

The table also show that in each of the STEM subjects listed, female students had a higher A*-C pass rate than male students but that, with the exception of biological sciences, significantly more male students achieved an A*-C grade. Biological sciences was the only STEM subject were there were more female entrants (58.9%) than there were male entrants (41.1%).

Table 8.12 shows the proportion of female entrants to different STEM A level courses over a 10 year period. It shows that biological sciences has had a majority of female entrants for each of the 10 years, with the proportion running from a low point of 56.4% to a high of 59.1%.

All the other STEM subjects had a majority of male students. For physics, around a fifth of students each year were female with the highest proportion (22.2%) achieved in both 2007 and 2009.

Finally, computing has the lowest proportion of female entrants each year. In 2014, this was 7.5%: an increase on the 10 year low of 6.5% which was recorded in 2013.

Table 8.11: Number of GCE A level A*-C passes by gender (2014) – all UK candidates

	Male students			Female students				All students		
	Total number of male students	Percentage A*-C for male students	Calculated number of male students obtaining a grade A*-C	Total number of female students	Percentage A*-C for female students	Calculated number of female students obtaining a grade A*-C	Percentage of all entrants who are female	Total number of all students	Percentage A*-C for all students	Calculated number of all students obtaining a grade A*-C
Biology	26,346	70.9%	18,679	37,724	72.8%	27,463	58.9%	64,070	72.0%	46,130
Chemistry	27,637	77.0%	21,280	25,876	79.1%	20,468	48.4%	53,513	78.0%	41,740
Computing	3,857	61.1%	2,357	314	64.6%	203	7.5%	4,171	61.3%	2,557
ICT	6,058	56.9%	3,447	3,421	67.2%	2,299	36.1%	9,479	60.6%	5,744
Mathematics	54,442	79.8%	43,445	34,374	81.6%	28,049	38.7%	88,816	80.5%	71,497
Further mathematics	10,053	87.3%	8,776	3,975	89.0%	3,538	28.3%	14,028	87.8%	12,317
Physics	28,958	71.1%	20,589	7,743	76.4%	5,916	21.1%	36,701	72.2%	26,498
Other science subjects	2,691	74.8%	2,013	795	80.1%	637	22.8%	3,486	76.0%	2,649
Design and technology/ technology subjects	8,100	65.0%	5,265	5,591	74.4%	4,160	40.8%	13,691	68.8%	9,419
All subjects	379,823	74.0%	281,069	453,984	78.9%	358,193	54.4%	833,807	76.7%	639,530

Source: Joint Council for Qualifications (JCQ)

Table 8.12: Percentage of female entrants for STEM GCE A level courses (2005-2014) – all UK candidates

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Biology	59.1%	58.8%	58.7%	58.1%	57.3%	56.4%	56.6%	56.5%	57.8%	58.9%
Chemistry	49.4%	49.1%	49.8%	48.7%	48.4%	47.8%	47.3%	47.2%	47.9%	48.4%
Computing	11.3%	9.7%	10.2%	9.5%	9.6%	8.9%	7.5%	7.8%	6.5%	7.5%
ICT	35.5%	36.3%	37.3%	38.0%	38.6%	38.1%	39.1%	38.6%	37.7%	36.1%
Mathematics	38.1%	39.1%	40.0%	39.4%	40.6%	40.6%	40.0%	40.0%	39.3%	38.7%
Further mathematics	28.6%	29.8%	29.4%	30.4%	31.3%	31.9%	31.2%	30.0%	28.6%	28.3%
Physics	22.0%	21.8%	22.2%	21.9%	22.2%	21.5%	20.8%	21.3%	20.7%	21.1%
Other science subjects	26.9%	27.1%	27.7%	27.0%	27.8%	21.5%	22.8%	22.6%	23.1%	22.8%
Design and technology/ technology subjects	39.1%	40.7%	41.9%	41.3%	41.5%	43.7%	42.2%	42.7%	42.3%	40.8%

Source: Joint Council for Qualifications (JCQ)

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Table 8.13 shows the 2013 A*-C pass rate for A level subjects in different types of schools. Overall, the A*-C pass rate for all subjects in independent schools was 90.5% compared with 75.4% for state schools and Further Education Colleges. For all STEM A level subjects, the A*-C pass rate for independent schools was higher than the corresponding pass rate for state schools or Further Education Colleges.

Table 8.13: Percentage of GCE A level candidates that achieve A*-C grade, by school type (2013)

		A*-C pass rate
Biological sciences	Independent school	87.5%
	State school or FE College	72.0%
Chemistry	Independent school	91.1%
	State school or FE College	77.5%
Physics	Independent school	86.9%
	State school or FE College	71.8%
Other science	Independent school	87.7%
	State school or FE College	72.0%
Mathematics	Independent school	92.0%
	State school or FE College	79.7%
Further mathematics	Independent school	94.7%
	State school or FE College	89.5%
Design and technology	Independent school	87.0%
	State school or FE College	67.7%
Computer studies	Independent school	77.6%
	State school or FE College	62.2%
ICT	Independent school	70.9%
	State school or FE College	62.6%
All subjects	Independent school	90.5%
	State school or FE College	75.4%

Source: Independent Schools Council[643]

8.4 Vocational qualifications

Vocational qualifications are an important source of STEM learning at Key Stage 5. Analysis of labour force statistics in 2013 revealed that university graduates who only studied vocational qualifications at sixth form or college were more likely to be employed that those who studied purely academic qualifications.[644]

Table 8.14 shows the number of completions in level 3 STEM BTEC subjects over a 10-year period. Overall, completions of all BTEC subjects increased by 390.8% to 350,043.

It also shows that in 2013/14 there were 16,318 completions in engineering, which was 23.9% higher than the previous year. Only 2.5% of those completing were female.

There were 3,894 completions for construction in 2013/14, which was only just higher than the previous year (1.3%). However the percentage of females was higher than for engineering at 7.8%.

The Sutton trust has shown that graduates (all ages and both male and female) who had BTEC qualifications had an average full-time employment rate of 80%, compared with 74% for those graduates who only had A levels.[645] They also showed that almost two in five BTEC learners are aged at least 27 when they achieve their degree, compared with around one in ten for A level learners.[646]

643 *A comparison of A-level results in 2013 between independent schools and state schools and FE colleges in England*, Independent Schools Council, p1 644 *Higher Ambitions Background Report*, The Sutton Trust, July 2014, p4 645 *Higher Ambitions Background Report*, The Sutton Trust, July 2014, p4 646 *Higher Ambitions Background Report*, The Sutton Trust, July 2014, p4

Table 8.14: Number of students completing selected BTEC 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 one year	Change over 10 years
Biology	UK	50	76	129	145	291	730	760	499	610	660	8.2%	1,220.0%
	International	0	0	0	0	0	0	0	0	0	0		
	Female	32	48	75	80	157	378	397	269	367	403	9.8%	1,159.4%
	Aged under 19	37	48	89	97	233	617	657	429	511	570	11.5%	1,440.5%
	Aged 19-24	9	21	34	45	55	110	99	70	98	90	-8.2%	900.0%
	Aged 25+	4	7	6	3	3	3	4	0	1	0		
	Total	**50**	**76**	**129**	**145**	**291**	**730**	**760**	**499**	**610**	**660**	**8.2%**	**1,220.0%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Percentage female	64.0%	63.2%	58.1%	55.2%	54.0%	51.8%	52.2%	53.9%	60.2%	61.1%	1.5%	-4.5%
Chemistry	UK	17	13	23	27	82	82	68	53	56	70	25.0%	311.8%
	International	0	0	0	0	0	0	0	0	0	0		
	Female	6	8	7	12	36	29	30	23	23	34	47.8%	466.7%
	Aged under 19	5	2	3	10	47	51	56	33	37	44	18.9%	780.0%
	Aged 19-24	10	4	13	11	24	21	11	15	18	20	11.1%	100.0%
	Aged 25+	2	7	7	6	11	10	1	5	1	6	500.0%	200.0%
	Total	**17**	**13**	**23**	**27**	**82**	**82**	**68**	**53**	**56**	**70**	**25.0%**	**311.8%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Percentage female	35.3%	61.5%	30.4%	44.4%	43.9%	35.4%	44.1%	43.4%	41.1%	48.6%	18.2%	37.7%
Physics	UK	0	3	2	18	32	28	31	16	21	36	71.4%	
	International	0	0	0	0	0	0	0	0	0	0		
	Female	0	0	2	7	12	8	5	2	4	13	225.0%	
	Aged under 19	0	1	1	6	17	14	28	15	13	29	123.1%	
	Aged 19-24	0	2	1	12	11	13	3	1	8	7	-12.5%	
	Aged 25+	0	0	0	0	4	1	0	0	0	0		
	Total	**0**	**3**	**2**	**18**	**32**	**28**	**31**	**16**	**21**	**36**	**71.4%**	
	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%	90.0%	
Engineering	UK	4,350	3,829	4,199	4,643	5,796	7,364	7,501	9,335	13,025	15,912	22.2%	265.8%
	International	216	369	161	136	105	73	88	265	146	406	178.1%	88.0%
	Female	172	203	176	177	210	308	314	409	527	755	43.3%	339.0%
	Aged under 19	987	1,414	1,866	2,240	2,754	3,226	3,522	5,133	7,638	9,786	28.1%	891.5%
	Aged 19-24	2,586	2,235	2,068	2,128	2,632	3,597	3,505	3,727	4,832	5,700	18.0%	120.4%
	Aged 25+	990	545	425	411	514	614	562	740	700	830	18.6%	-16.2%
	Total	**4,566**	**4,198**	**4,360**	**4,779**	**5,901**	**7,437**	**7,589**	**9,600**	**13,171**	**16,318**	**23.9%**	**257.4%**
	Percentage non-UK	4.7%	8.8%	3.7%	2.8%	1.8%	1.0%	1.2%	2.8%	1.1%	2.5%	127.3%	-46.8%
	Percentage female	3.8%	4.8%	4.0%	3.7%	3.6%	4.1%	4.1%	4.3%	4.0%	4.6%	15.0%	21.1%
Construction	UK	1,847	2,573	2,891	3,586	3,943	3,958	3,099	3,504	3,797	3,790	-0.2%	105.2%
	International	39	32	113	61	47	37	34	44	46	104	126.1%	166.7%
	Female	199	286	371	416	457	373	290	291	316	305	-3.5%	53.3%
	Aged under 19	577	916	1,084	1,443	1,678	1,707	1,415	1,639	1,802	1,774	-1.6%	207.5%
	Aged 19-24	890	1,165	1,342	1,610	1,727	1,637	1,266	1,442	1,522	1,552	2.0%	74.4%
	Aged 25+	419	523	577	594	582	651	452	467	518	567	9.5%	35.3%
	Total	**1,886**	**2,605**	**3,004**	**3,647**	**3,990**	**3,995**	**3,133**	**3,548**	**3,843**	**3,894**	**1.3%**	**106.5%**
	Percentage non-UK	2.1%	1.2%	3.8%	1.7%	1.2%	0.9%	1.1%	1.2%	1.2%	2.7%	125.0%	28.6%
	Percentage female	10.6%	11.0%	12.4%	11.4%	11.5%	9.3%	9.3%	8.2%	8.2%	7.8%	-4.9%	-26.4%
All subjects (including STEM and non-STEM)	UK	69,266	86,521	106,983	124,385	148,243	179,941	210,967	254,761	314,434	346,489	10.2%	400.2%
	International	2,061	2,144	1,959	2,051	2,064	1,629	1,782	3,693	2,559	3,554	38.9%	72.4%
	Female	30,722	38,754	48,471	55,951	67,105	81,135	95,905	117,429	143,334	157,519	9.9%	412.7%
	Aged under 19	32,487	44,718	56,770	68,419	86,481	106,817	131,064	169,483	218,253	253,278	16.0%	679.6%
	Aged 19-24	32,508	37,811	46,010	51,915	57,757	68,288	75,215	82,010	91,213	89,697	-1.7%	175.9%
	Aged 25+	6,254	6,071	6,135	6,089	6,051	6,450	6,452	6,948	7,516	7,052	-6.2%	12.8%
	Total	71,327	88,665	108,942	126,436	150,307	181,570	212,749	258,454	316,993	350,043	10.4%	390.8%
	Percentage non-UK	2.9%	2.4%	1.8%	1.6%	1.4%	0.9%	0.8%	1.4%	0.8%	1.0%	25.0%	-65.5%
	Percentage female	43.1%	43.7%	44.5%	44.3%	44.6%	44.7%	45.1%	45.4%	45.2%	45.0%	-0.4%	4.4%

Source: Pearson

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Table 8.15 shows that at level 3, in 2012/13, there were 13,322 completions in vocational subjects, of which 7,138 were in ICT/computing.

Table 8.15: Number of students completing other selected vocational STEM subjects at level 3, by gender and age (2004/05-2012/13) – all domiciles

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over nine years
ICT/computing	UK	0	0	0	0	82	1,986	3,998	5,663	7,135	26.0%	
	International	0	0	0	0	0	4	2	2	3	50.0%	
	Female	0	0	0	0	18	690	1,497	2,023	2,461	21.7%	
	Aged under 19	0	0	0	0	56	1,687	3,401	4,978	6,458	29.7%	
	Aged 19-24	0	0	0	0	22	300	593	685	676	-1.3%	
	Aged 25+	0	0	0	0	4	3	6	2	4	100.0%	
	Total	0	0	0	0	82	1,990	4,000	5,665	7,138	26.0%	
	Percentage non UK					0.0%	0.2%	0.1%	0.0%	0.0%	0.0%	
	Percentage female					22.0%	34.7%	37.4%	35.7%	34.5%	-3.4%	
All subjects (including STEM and non-STEM)	UK	339	983	2,674	3,380	4,562	7,578	9,979	11,789	13,319	13.0%	3,828.9%
	International	0	8	0	0	0	4	2	2	3	50.0%	
	Female	220	546	1,619	2,004	2,678	3,913	5,000	5,610	6,008	7.1%	2,630.9%
	Aged under 19	214	681	1,957	2,433	3,239	5,844	7,795	9,815	11,675	19.0%	5,355.6%
	Aged 19-24	98	271	664	860	1,202	1,614	2,089	1,938	1,634	-15.7%	1,567.3%
	Aged 25+	27	39	53	87	121	124	97	38	13	-65.8%	-51.9%
	Total	339	991	2,674	3,380	4,562	7,582	9,981	11,791	13,322	13.0%	3,829.8%
	Percentage non UK	0.0%	0.8%	0.0%	0.0%	0.0%	0.1%	0.0%	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%	-5.3%	-30.5%

Source: OCR

8.5 Scottish qualifications

In Scotland, Highers and Advanced Highers are broadly equivalent to AS and A levels in the rest of the UK. For many, one year of Highers is sufficient to gain entry into four-year Scottish honours degrees,[647] while others opt to complete a further year of Advanced Highers in order to bridge the gap between Further Education and university more thoroughly.[648] Students are expected to take between three and five Highers in S5, the fifth year of secondary education and, if desired, specialise in 2 or 3 Advanced Highers in S6 with the prospect of direct entry into the second year of an honours degree or subject exemption.[649]

The background to the overall changes in the system of qualifications as well as societal considerations is detailed in Section 7.9.

A new system of Highers and Advanced Highers is set to replace the current one by August 2015. It is intended to provide a greater depth of learning that is closer to the objectives of Education Scotland's Curriculum for Excellence (CfE) and better prepares them for further study, training or employment.

In this year's Highers, the proportions of entrants gaining an A grade (equivalent to A level grades A*-C) in biology (25%), human biology (20.8%), physics (27.4%) and mathematics (25.3%) were below the overall figure of 27.7%. However, those in chemistry (30.1%); chemistry – revised (35.3%); and physics – revised (36%); were all greater: significantly so in the case of the two with revised curricula.

At Advanced Highers, the proportion of A-C grades (equivalent to A level grades A*-C) in core STEM subjects – such as biology (73%), chemistry (76.4%), physics (80.3%) and mathematics (70.1%) – was below the overall figure of 81%. Only revised curriculum chemistry (81.3%), applied mathematics (81.8%) and computing (84.1%) were higher.

This trend is in contrast to the A level results from the rest of the UK, in which students in STEM subjects were more successful than the overall figure, except in biology, physics and other science.

Table 8.16: Attainment in selected STEM Higher qualifications (2014) – Scotland

Subjects[650, 651]	Number A grade	Percentage A grade	Total entries
Biology	2,547	25.0%	10,197
Chemistry	3,222	30.1%	10,716
Chemistry (revised)	248	35.3%	702
Computing	1,079	24.1%	4,468
Human biology	820	20.8%	3,943
Information systems	123	11.6%	1,059
Mathematics	5,536	25.3%	21,851
Physics	2,490	27.4%	9,098
Physics (revised)	400	36.0%	1,111
Product design	303	12.8%	2,369
Technological studies	291	37.7%	772
All subjects	53,175	27.7%	191,850

Source: SQA

Table 8.17: Attainment in selected STEM Advanced Higher qualifications (2014) – Scotland

Subjects[652, 653]	Number A-C grade	Percentage A-C grade	Total entries
Applied mathematics	283	81.8%	346
Biology	1,837	73.0%	2,518
Chemistry	1,829	76.4%	2,393
Chemistry (revised)	226	81.3%	278
Computing	370	84.1%	440
Mathematics	2,414	70.1%	3,443
Physics	1,458	80.3%	1,815
All subjects	18,171	81.0%	22,430

Source: SQA

647 *Expert Group Report for Award Seeking Admission to the UCAS Tariff Scottish Highers and Advanced Highers*, UCAS, July 2008, p18 648 *Expert Group Report for Award Seeking Admission to the UCAS Tariff Scottish Highers and Advanced Highers*, UCAS, July 2008, p9 649 *Expert Group Report for Award Seeking Admission to the UCAS Tariff Scottish Highers and Advanced Highers*, UCAS, July 2008, p18 650 Excludes those with fewer than 100 A grades 651 National Course (Higher) statistics relate to information as of August and are therefore subject to change later in the year. These statistics are course-based analyses, ie results are dependent on both the learner's course assessment result (where applicable) and their successful completion of the related units. 652 Excludes those with fewer than 100 A-C grades 653 National Course (Advanced Higher) statistics relate to information as of August and are therefore subject to change later in the year. These statistics are course-based analyses, ie results are dependent on both the learner's course assessment result (where applicable) and their successful completion of the related units.

8.6 More girls, more teachers, more engineers

Authored by Peter Main, Education Advisor, Institute of Physics

Essentially everyone that achieves an A level in physics goes to university, most to study a subject for which physics is useful. By far the most popular destination is engineering. It follows that, so far as increasing numbers in engineering and the physical sciences is concerned, there is little point squabbling about the students who have already elected to choose physics. Rather, the task should be to increase progression to A level physics from GCSE, a bottleneck restricting access to many subjects in Higher Education. In particular, the pitifully low ratio of girls taking the subject post-16 means that they have no access to the broad range of possible – and lucrative – careers that physics allows.

In the late 1980s, the ratio of girls taking physics was 23%, falling to 21% for the most recent data (see Figure 8.1). Over this thirty year period, there has been initiative after initiative to persuade more girls into physics and engineering. These approaches have failed to make an impact. It is clearly time to stop blaming the girls for some inadequacy in failing to choose these subjects and start to look at the barriers that prevent them from doing so.

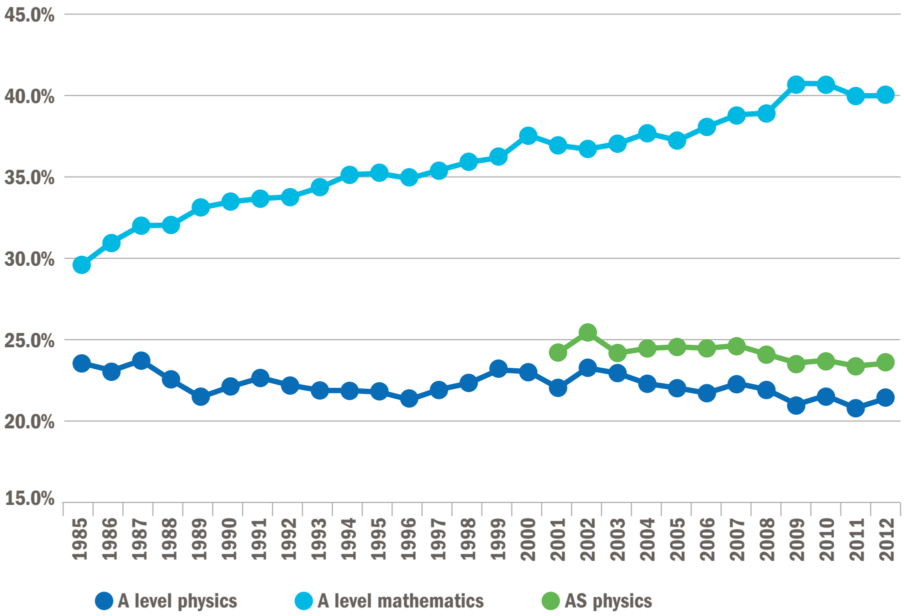
In 2012, the Institute of Physics realised that the availability of the national pupil database allowed tracking of A level pupils back to the schools where they took their GCSEs. In the report *It's different for girls*,[654] we showed that the girls who progressed to A levels were four times more likely to have physics in their portfolio if they attended a single-gender independent school than if they were at a state-funded, co-educational establishment (see Figure 8.2). Almost one half (49%) of the latter schools did not progress one single girl to A level physics in 2011.

The type of school that a girl attends clearly has a massive effect on her subject choice; many more would chose physics in a different school environment. With that idea in mind, we followed up that work with a second report, *Closing Doors*,[655] published in 2013. We considered six A level subjects, each gendered in terms of national progression: there were 3 "boys' subjects" – economics, mathematics and physics – alongside three "girls' subjects" – biology, English and psychology. For each school in the country, we awarded +1 if, in terms of their progression to A levels, they were less gendered than the national figures for each subject and -1 if they were more, so that each school received a mark between -6 and +6.

The results were startling. Eighty-one percent of state-funded, mixed schools were, on average, either reinforcing or exacerbating the (dismal) national ratios. The saddening picture is that gendering of all subjects is much worse in mixed schools than in their single gender equivalents. It also helps to have a sixth form; schools that stop teaching at age 16 are less likely to counter gender stereotyping. Note that, as publicly-funded bodies, schools have a Gender Equality Duty to combat this type of bias. Unfortunately, few schools seem to take that responsibility seriously.

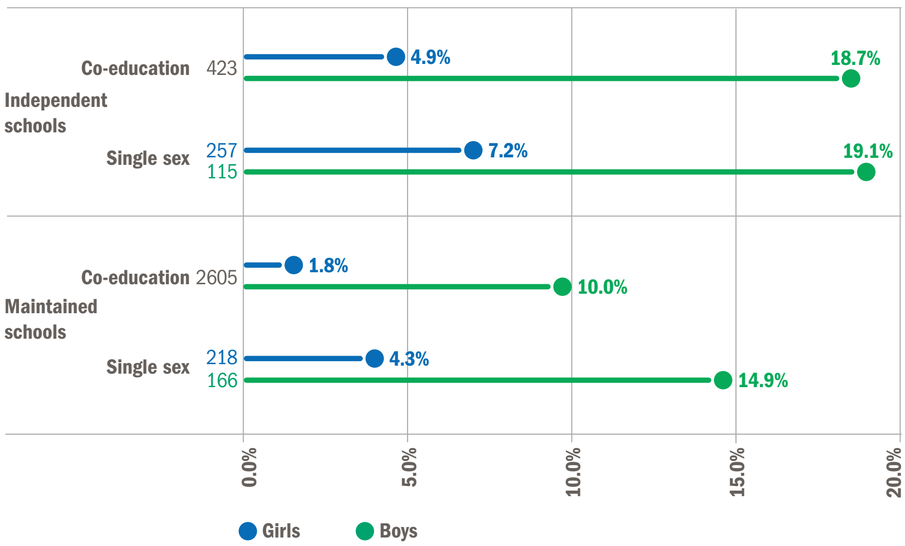
More positively, some state-funded schools do buck the trend: 27 achieved a score of +6, indicating that they were more balanced than

Fig. 8.1: The proportion of girls taking A level mathematics and AS and A level physics (1985-2012)



Source: Institute of Physics

Fig. 8.2: Percentage of girls and boys who went on to take physics A level by type of school (2011)



Source: Institute of Physics

654 http://www.iop.org/publications/iop/2012/page_58292.html 655 http://www.iop.org/publications/iop/2013/page_62090.html

the national ratios in each of the 6 subjects. Another interesting feature of the data is illustrated in Figure 8.3, which shows the average ratio of girls progressing to A level physics plotted against the sets of schools with the various marks -6 to +6. In order to beat the national figure of 21%, schools need to be producing better balance in essentially all the other subjects too. Improving the gender balance in physics requires improving gender balance across all subjects; the culture of the school is driving behaviour.

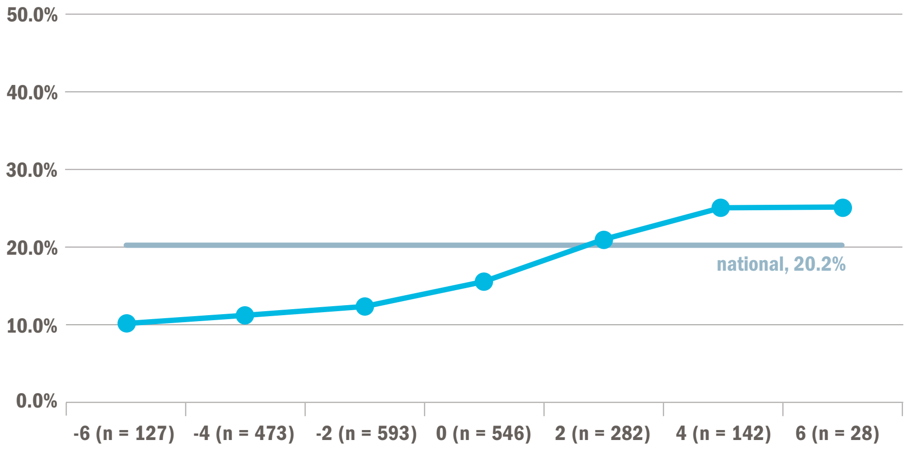
Two other recent research projects have shed light on the factors that influence subject choice. Aspires,[657] led by Prof Louise Archer at King's College, and UPMAP,[658] led by Prof Michael Reiss at the Institute of Education, both involved longitudinal studies of children pre-GCSE. The outputs from these projects are rich but both indicate that an important factor in encouraging participation in science subjects is what Louise Archer has called "science capital" the presence of a significant other, usually a family member, who is positive about science. The projects also confirm that traditional outreach, involving role models and one-off events, are highly unlikely to change anyone's choices.

One cannot change a student's family and it is difficult to imagine an immediate change in the reinforcement of gender stereotyping we all experience from the media. Attempts at change must therefore take place within schools and this is the approach we have taken in the Institute. In a suite of novel pilot projects co-funded by Government and the Drayson Foundation, we use the new evidence to make a difference, or at least to determine which approach is likely be most effective in making a difference.

The projects fall into four categories. The first aims to increase the confidence and resilience of girls, in part by encouraging awareness of the barriers to their participation in physics and engineering. The second builds upon research around classroom management and involves working with physics teachers to make lessons more gender neutral. And the third deals with the issue of the whole school culture; we will establish partnerships with schools to work with teachers in all subjects to address issues of gender balance, unconscious bias etc. This approach is undoubtedly ambitious but is firmly rooted in the evidence. These three projects together we call *Improving Gender Balance* and form a new strand of the on-going Stimulating Physics Network (SPN).

The fourth strand is called *Opening Doors* and is funded by the Government Equality Office. We work with local networks of schools to set up a programme of site visits between schools to

Fig. 8.3: The average percentage of girls progressing to A level physics vs. the gender progression score across 6 subjects[656]



Source: Institute of Physics

investigate issues around gender stereotyping. The visiting team will include teachers from the other schools. The reports from these visits will be used to compile a code of practice for schools with the possible establishment of a quality mark analogous to *Athena SWAN* in the HE sector.

The one proven method of increasing the number and proportion of girls doing physics is to improve teaching. This is consistent with research, which indicates that girls are more sensitive than boys to bad teaching, and is also reflected in the results from the SPN, which supports non-specialist teachers: the effect of improving the confidence and knowledge base of the teachers is to increase progression to A level physics for both boys and girls but with an improved gender ratio.

In the long term, we must recruit more specialist teachers. In recent years, the Government has done a great deal: the introduction of targets for physics, not "science" teachers; the introduction of substantial bursaries and scholarships (the Institute runs the scheme for physics); and the establishment of a new programme of physics with mathematics. These initiatives raised recruitment to an all-time high of around 900 in 2012, although the teething problems of the new School Direct (SD) route into teacher training led to lower figures in 2013.

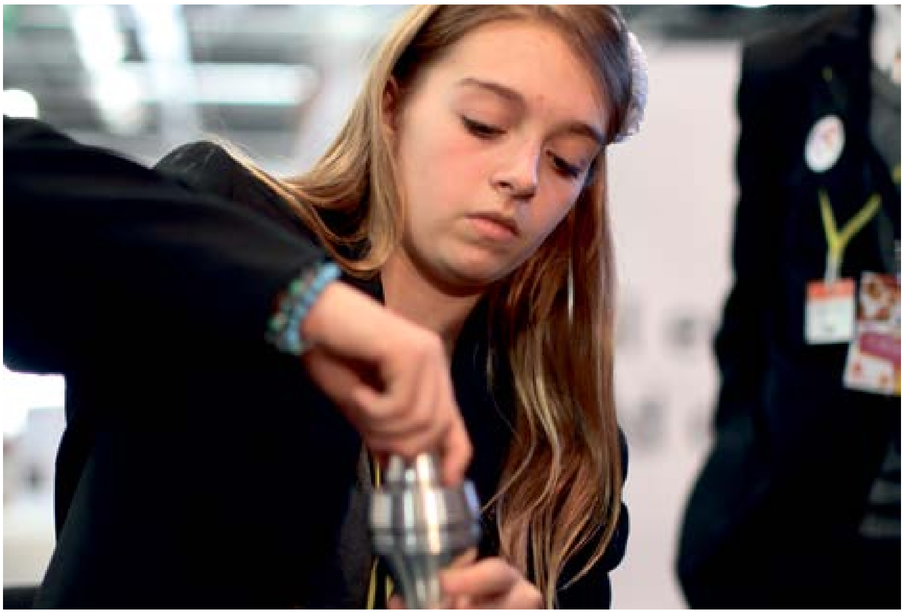
Despite this hiccup, teacher training figures are running at historically high levels – but they are still too low! Three years ago, the Institute estimated that 1,000 new teachers would be required for the next 15 years to bring the number of teachers of the three main sciences into balance. Given that there are only 4,000 physics graduates a year, it is implausible to expect this number of teachers to emerge from that source. However, there are far more engineering graduates and they make fine physics teachers, particularly along the physics with maths route. Currently, however, relatively few engineers choose teaching.

What prevents engineers becoming teachers? The predominant reason is that they are not encouraged to do so either by their university departments or, generally, by their professional bodies. An engineer in teaching is seen as a loss to the profession. I feel this view is mistaken on two grounds. First, engineering graduates pursue other occupations; surely it is better for an engineer to become a teacher than an accountant. Second, what better recruitment tool is there for engineering than someone in the classroom who has a passion for the subject? Career changers may be better still with their experience of "real world" engineering. If the engineering professional bodies could agree to promote teaching strongly to their members, they would be rewarded with more specialist teachers, hence more A level physicists and hence more engineering students and more of them girls.

In summary, the last two years has seen much better understanding of the reasons why girls do or do not choose physics and engineering and a number of novel, evidence-based approaches are being piloted. But the one improvement we are certain works is to have more high-quality, specialist teachers. And the best way to achieve that is for the engineering community to realise that an engineer teaching physics in a school is a valuable commodity for both the country and for engineering.

656 http://www.ioe.ac.uk/research/departments/cpat/4814.html 657 http://www.kcl.ac.uk/sspp/departments/education/research/aspires/index.aspx 658 http://www.ioe.ac.uk/research/departments/cpat/4814.html

Part 2 – Engineering in Education and Training
9.0 The Further Education sector



In 2012/13, there were approximately 10,331,900[659 660 661] qualification aims in the FE sector. Of these, about 1,250,600 qualification aims were in engineering-related Sector Subject Areas, which means roughly one in eight qualification aims is engineering-related. Information and communication technology was the largest Sector Subject Area, with around 534,700 learners, followed by engineering and manufacturing technologies (437,900) and construction, planning and the built environment (278,000).

The Further Education (FE) sector is a vibrant and diverse sector. Research by the Department for Business, Innovation and Skills[662] has shown that FE Colleges tend to operate within very localised catchment areas. The majority of recruitment to colleges is within five miles of the institution. This means that colleges have to be responsive to the needs of a very localised economy.

Despite this vibrancy, the remit of the FE sector is currently unclear. It delivers academic qualifications such as A level and Higher Education. However, it also offers vocational qualifications including apprenticeships.[663] FE also has a remedial role teaching 16- to 18-year-olds who leave school either functionally illiterate (14% in 2011) or functionally innumerate (28% in 2011).[664] Ofsted has identified that foundation mathematics is one of the weakest subjects in FE Colleges.[665]

At an individual level, vocational education generates a significant financial return for students. The Net Present Value benefits associated with a man completing a level 3 apprenticeship is £115,269-£155,560 over a level 2 qualification. It has also been estimated that FE students aged 19+ will generate an extra £75 billion for the UK economy over their lifetime.

659 This data includes both academic and vocational qualifications **660** This value is the sum of rounded data which has been added together and then rounded to the nearest hundred. Therefore there will be errors in the values and they are for guidance purpose only **661** See table 9.3 for further details on this analysis **662** *Competition issues in the Further Education sector*, Department for Business, Innovation and Skills, October 2013, p5 **663** *Transforming Further Education: A new mission to deliver excellence in technical education The second report of the independent Skills Taskforce*, labour Party, 2013, p2-3 **664** *Professionalism in Further Education Final Report of the Independent Review Panel*, The Lord Lingfield Kt, MEd DLitt FCGI DL, October 2012, p18 **665** *The report of Her Majesty's Chief Inspector of Education, Children's Services and Skills*, Ofsted, 2013, p20

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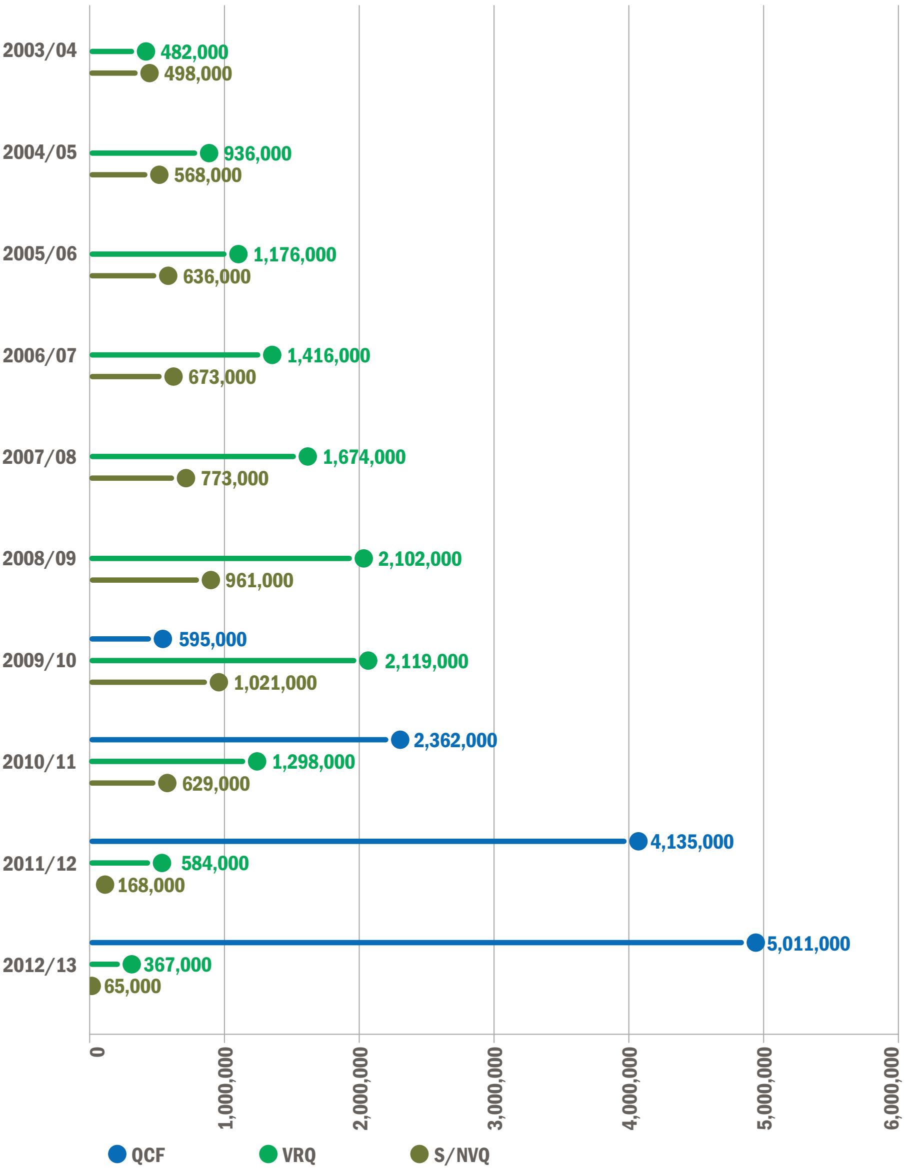
Provisional data from the Government shows that in 2012/13 there were 3.7 million learners engaged in Government-funded education or training in the FE and skills sector.[666] However, Figure 9.0 shows that in 2012/13 there were five million QCF achievements, plus 367,000 VRQ achievements and 65,000 S/NVQ achievements. This means that an unknown proportion of students are taking multiple qualifications at the same time. Figure 9.0 also shows the changing profile of qualifications over 10 years. The number of S/NVQ and VRQ qualifications has declined since 2009/10. This reduction can be directly attributed to the QCF qualification being introduced.[667] From September 2009, all newly regulated qualifications are approved as QCF qualifications.

Overall there are 391 colleges in the UK; the breakdown of colleges is shown in Table 9.0. Within England, there are 339 colleges, of which 218 are General Further Education Colleges and 93 are Sixth Form Colleges. Of the devolved nations, Scotland has the most colleges (30), followed by Wales (16) and Northern Ireland (6).

Fig. 9.0: Changing profile of qualification achievements (2003/04-2012/13) – UK[668 669 670 671]



Source: The Data Service

Table 9.0: Number of colleges by college type and home nation (2014) – UK

Colleges in England	**339**
General Further Education Colleges	218
Sixth Form Colleges	93
Land-based Colleges	15
Art, design and performing arts Colleges	3
Specialist designated Colleges	10
Colleges in Scotland	**30**
Colleges in Wales	**16**
Colleges in Northern Ireland	**6**
Colleges in the UK	**391**

Source: Association of Colleges[672]

On 30 April 2014,[673] the launch of the first new FE College for 20 years was announced. Prospects College will be incorporated on 1 September 2014 and will provide technical education in engineering, aviation, rail and construction. A college in North Wales has received an investment of £20 million to assist them in meeting the demands of the new nuclear power station on Anglesey.[674]

Responsibility for vocational education has been devolved to the Scottish, Welsh and Northern Irish assemblies. The English, Welsh and Northern Irish systems are relatively similar but the Scottish FE sector has many differences.[675] However at the time of going to print Ofqual announced changes to the regulation of vocational qualification in England.

Colleges in the UK run 1,300 businesses that are open to the public a cover a wide range of activities.[676]

Similar to the academic sector, the vocational sector in England is going through a period of considerable change. In July 2013, the Skills Funding Agency removed public funding for 1,800 qualifications and a further 1,000 qualifications were removed in January 2014.[677] A further 5,000 qualifications will be removed by the introduction of new business rules in November 2014.[678]

666 *The report of Her Majesty's Chief Inspector of Education, Children's Services and Skills*, Ofsted, 2013, p7 667 *Vocational Qualifications*, Department for Business, Innovation and Skills, 27 March 2014, p1 668 Figures show the number of NVQs notified to Ofqual plus the number of SVQs notified to the Vocational Qualifications Database 669 S/NVQ figures may not agree with previous years' SFRs due to amendments to original data submitted by Awarding Organisations to Ofqual 670 Figures show the number of VRQ achievements reported by participating Awarding Organisations to the Vocational Qualifications Database 671 Figures show the number of QCF achievements reported by participating Awarding Organisations to the Vocational Qualifications Database 672 Website accessed on the 5 August 2014 (http://www.aoc.co.uk/about-colleges/research-and-stats/key-further-education-statistics) 673 Website accessed on the 5 August 2014 (https://www.gov.uk/government/publications/prospects-college-of-advanced-technology-new-specialist-technical-college) 674 Website accessed on the 14 October 2014 (http://www.bbc.co.uk/news/uk-wales-north-west-wales-29364926) 675 *Spotlight on VET United Kingdom 2012/13*, Cedefop, p3 676 *College Key Facts 2013/14*, Association of Colleges, 2013, p14 677 *Getting the Job Done: The Government's Reform Plan for Vocational Qualifications, Department for Business*, Innovation and Skills, March 2014, p8 678 *Further Education Workforce Strategy The Governments Strategy to Support Workforce Excellence in Further Education Colleges and Training Providers*, Department for Business, Innovation and Skills, March 2014, p24

The need for this rationalisation of qualifications is shown in Table 9.1, which reveals that between 2007/08 and 2011/12, the number of regulated qualifications rose from just under 10 thousand (9,700) to 20,500 in 2011/12. This increase was driven by a rise, over the period, of 11,800 regulated QCF qualifications.

However, it is worth noting that, even with this massive reduction in the number of qualifications, England's vocational system will still have a large number of qualifications compared with our competitors. In November 2013, Nigel Whitehead showed that there were 19,000 regulated vocational qualifications but that 90% of achievements were in just 1,780 qualifications.[679] By comparison, Germany has just 330 qualifications.[680]

As well as having a large number of qualifications, the UK also has a large number of awarding bodies, at 168.[681] However, the three largest awarding bodies (Pearson, City and Guilds and OCR) account for over half the market and the 50 largest awarding bodies account for 97% of the market.[682] One further complication is that awarding bodies and education provider can set their own entry requirements for each qualification, meaning that there is no automatic route for progression from one qualification framework level to the next.[683]

The Government has also announced the introduction of new Tech level qualifications for students aged 14-19.[685] These qualifications are backed by businesses and trade associations and are seen as being vocational equivalents to A levels. The Government has published a list of approved Tech level qualifications.[686]

The Deputy Prime Minister has stated that the Government[687] intends to launch an online one stop shop, similar to UCAS, for college courses, apprenticeships and Traineeships. The impact this will have on the FE sector can't be determined at this stage, but it has the potential to improve vocational careers guidance for those students who don't want to go into Higher Education.

Table 9.1: Number of regulated qualifications by type (2007/08-2011/12)

Qualification type	2007/08	2008/09	2009/10	2010/11	2011/12
Basic skills	100	100	100	100	100
Diploma	50	150	200	200	200
English for speakers of other languages	150	150	150	200	200
Entry level	300	300	350	350	350
Functional skills	100	100	250	200	200
GCE A level	450	450	450	300	300
GCE AS level	450	450	450	250	250
General Certificate of Secondary Education	450	700	750	800	650
General National Vocational Qualification	50	0	0	0	0
Higher level	500	550	600	550	500
Key skills	350	350	350	400	400
National Vocational Qualification	2,000	1,900	1,750	1,600	1,400
Occupational qualification	100	100	100	100	100
Other general qualification	600	650	750	750	800
Principle learning	50	100	200	200	200
QCF	1,000	2,450	6,100	9,700	12,800
Vocationally Related Qualification	2,950	2,950	2,750	2,400	2,100
Total	9,700	11,500	15,300	18,100	20,500

Source: Ofqual[684]

The Government has also announced the introduction of an FE Commissioner whose remit will be to tackle poor performance in the FE sector.[688] In particular, the Commissioner will review any college that:

- has been graded as inadequate by Ofsted
- fails to meet national minimum standards of performance sent by the Department for Business, Innovation and Skills
- receives an inadequate assessment for financial health or management by the Skills Funding Agency

Another change that will affect the FE sector is the extension of Free School Meals. Maintained and academy sixth forms were already required to provide Free School Meals to disadvantaged students over the age of 16. However, from September 2014, this will be extended to disadvantaged students on FE courses.[689]

679 *Review of Adult Vocational Qualifications in England*, Nigel Whitehead, November 2013, p9 680 *Up To The Job*, Demos, 2014, p59 681 *A statement of support for vocational qualifications offered outside the United Kingdom by awarding organisations recognised by Ofqual*, Department for Business, Innovation and skills, April 2014, p7 682 *Review of Adult Vocational Qualifications in England*, Nigel Whitehead, November 2013, p14 683 *Spotlight on VET United Kingdom 2012/13*, Cedefop, p2 684 *Annual Qualifications Market Report 2013 Main Report*, Ofqual, September 2013, p27 685 Website accessed on the 5 August 2014 (https://www.gov.uk/government/news/firms-back-tech-levels-helping-students-compete-in-global-race) 686 The list of approved Tech level qualifications can be accessed at https://www.gov.uk/government/publications/vocational-qualifications-for-14-to-19-year-olds 687 Website accessed on the 5 August 2014 (http://www.bbc.co.uk/news/uk-politics-26363534) 688 Website accessed on the 5 August 2014 (https://www.gov.uk/government/news/new-fe-commissioner-to-tackle-poor-performing-fe-colleges) 689 *Further Education free meals Departmental advice for Further Education funded institutions, Department for Education*, 16 April 2014, p3

9.1 Financial returns of FE

One aspect of the FE sector that is sometimes overlooked is its impact on the UK's balance of payments. The Government has estimated that in 2011 the value of UK education exports in the FE sector was around £1.2 billion.[690] It recognises the importance of education exports and has launched a strategy to boost exports for British schools, universities, colleges and education businesses with the aim of generating an additional £3 billion of contracts by 2018.[691]

Individual learners also benefit from vocational qualifications. Table 9.2 shows the benefits associated with taking different vocational qualifications at level 1 to 3 for male and female students. It shows, for example that the highest Net Present Value benefits associated with a level 3 qualification, compared with a level 2 qualification, is an apprenticeship for men. This carries a benefit of £115,269-£155,560 compared with only £6,476-£12,489 for women. However, for women the highest Net Present Value is for NVQs at £31,258-£61,293 compared with £26,817-£38,310 for men.

London Econometrics has also shown that there is a large variation in apprenticeship pay by age. Average apprenticeship pay stands at around £6.05 per hour. But looking at the different age groups, it is £3.88 per hour for under-19s, compared with £8.15 for those aged 25 or older.[696] The Department for Business, Innovation and Skills also shown that apprenticeship pay varied by home nation in 2012. In England, the median gross hourly pay was £6.09,[697] compared with £6.29 in Wales[698] and £6.15 in Northern Ireland.[699]

Employers and the UK Government benefit from the improved productivity of staff that comes from vocational training. The Centre for Economic and Business Research estimates that in 2012/13, the typical apprentice graduate had increased productivity per week of £401 in construction and planning and £414 in engineering and manufacturing. This compares with £83 in the retail sector and £268 in business, administration and legal.[700]

The Royal Society has also projected that between 2013 and 2022, apprenticeships in England could contribute £3.4 billion in net productivity gains.[701]

Finally, it has been estimated that students aged 19+ in FE, over their lifetimes, generate an extra £75 billion for the UK economy.[702]

Table 9.2: Individual rates of return associated with vocational qualifications attainment

Level	Calculation used	Gender	Apprenticeship	RSA	City and Guilds	BTEC	NVQ
Level 1	Net Present Value[692]	Male	*[693]	*	£47,872-£72,498	*	£8,434-£16,597
		Female	*	£43,880-£76,392	£16,016-£31,183	*	£18,316-£36,335
	Internal Rate of Return[694]	Male	*	*	341%-529%	*	22%-29%
		Female	*	435%-613%	424%-846%	*	289%-582%
Level 2	Net Present Value	Male	£54,528-£78,298	*	£56,244-£85,591	£43,126-£54,749	£11,495-£23,047
		Female	£14,977-£32,177	£32,929-£52,656	£8,187-£16,207	£27,783-£50,276	£21,284-£43,335
	Internal Rate of Return	Male	49%-64%	*	67%-94%	36%-38%	23%-40%
		Female	24%-42%	51%-71%	65%-124%	63%-99%	70%-125%
Level 3	Net Present Value	Male	£115,269-£155,560	*	£65,375-£93,973	£59,943-£74,423	£26,817-£38,310
		Female	£6,476-£12,489	£29,481-£47,237	£12,056-£23,071	£25,698-£41,885	£31,258-£61,293
	Internal Rate of Return	Male	78%-96%	*	87%-110%	46%-54%	63%-83%
		Female	15%-23%	91%-119%	80%-119%	67%-100%	67%-106%

Source: Department for Business, Innovation and Skills[695]

690 *Industrial Strategy: government and industry in partnership*, HM Government, July 2013, p22 691 Website accessed on the 5 August 2014 (https://www.gov.uk/government/news/new-push-to-grow-uks-175-billion-education-exports-industry) 692 The Net Present Value is defined as the present value of the benefits minus the present value of the costs associated with particular activity. For further information see http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Net_present_value.html 693 *indicates that it was not possible to provide a robust estimate of NPV and IRR, due to small sample size or the rate of return could not be calculated 694 The internal rate of return (IRR) is a rate of return used in budgeting to measure and compare the profitability of investments. For further information see http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Internal_rate_of_return.html 695 *The Impact of Further Education Learning*, Department for Business, January 2013, p15 696 *An International Comparison of Apprentice pay: Final Report*, London Economics, October 2013, p193 697 *Apprenticeship Pay Survey 2012: Research Findings*, Department for Business, Innovation and Skills, October 2013, p8 698 *Apprenticeship Pay Survey 2012: Research Findings*, Department for Business, Innovation and Skills, October 2013, p48 699 *Apprenticeship Pay Survey 2012: Research Findings*, Department for Business, Innovation and Skills, October 2013, p77 700 *Up To The Job*, Demos, 2014, p31 701 *Vision for science and mathematics education*, Royal Society, 2014, p42 702 *College Key Facts 2013/14*, Association of Colleges, 2013, p16

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9.2 Participation in FE[703 704 705 706 707]

Table 9.3 shows the overall level of participation in FE education for all aims and qualifications for the STEM Sector Subject Areas and all Sector Subject Areas. It shows that in 2012/13 there were approximately 10,331,900 qualification aims, including 1,251 for the three engineering related Sector Subject Areas. The largest number of aims was in information and communication technology, at just over half a million (about 534,700). However, it is worth noting that, within information and communication technology, some learners will be learning how to use software, which is not engineering, and some will be practitioners, which is engineering-related.

Engineering and manufacturing technologies is the second largest engineering-related Sector Subject Area, with about 437,900 aims in 2012/13. Construction, planning and the build environment had approximately 278,000 participants in 2012/13, which is less than the number studying science and mathematics (about 338,400).

Table 9.4 looks at participation in different Sector Subject Areas by level of award for 2012/13. It shows that for information and communication technology awards are skewed towards entry level (50,700), level 1 (167,500) and level 2 (118,700). There are also 112,600 participants on other aims.

For engineering and manufacturing technologies, over half (247,300) of the 437,900 participants were at level 2, although around a quarter (120,600) were at level 3. For construction, planning and the built environment, levels 1 and 2 dominate (78,500 and 140,000 respectively).

Table 9.3: Overall participation (aims) in FE, all levels and qualifications, for STEM Sector Subject Areas and all Sector Subject Areas (2005/06-2012/13)[708] – England[709]

	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Construction, planning and the built environment	265,700	281,600	327,500	343,000	305,600	292,700	297,700	278,000
Engineering and manufacturing technologies	370,000	344,900	389,500	463,000	434,900	426,500	450,500	437,900
Information and communication technology	1,137,000	775,000	711,000	660,900	539,400	487,400	514,000	534,700
Subtotal – all engineering related Sector Subject Areas	1,772,700	1,401,500	1,428,000	1,466,900	1,279,900	1,206,500	1,262,200	1,250,600
Science and mathematics	306,700	302,400	300,500	305,200	322,000	320,300	322,800	338,400
Total[710]	10,061,100	8,489,000	8,665,700	9,371,600	8,955,900	9,008,000	9,913,800	10,331,900

Source: The Data Service

Table 9.4: Overall participation (aims) in FE for STEM Sector Subject Areas and all Sector Subject Areas, by level (2012/13) – England[711 712]

	Entry level	Level 1	Level 2	Level 3	Level 4	Level 5	Other level[713]	Total[714]
Construction, planning and the built environment	9,400	78,500	140,000	37,900	1,700	0	10,500	278,000
Engineering and manufacturing technologies	6,500	54,400	247,300	120,600	900	0	8,200	437,900
Information and communication technology	50,700	167,500	118,700	84,500	800	0	112,600	534,700
Subtotal – all engineering related Sector Subject Areas	66,600	300,400	506,000	243,000	3,400	0	131,300	1,250,600
Science and mathematics	200	5,200	82,200	240,900	0	0	9,900	338,400
Total	1,086,900	2,703,400	3,384,900	1,951,100	47,500	1,800	1,156,400	10,331,900

Source: The Data Service

703 Qualifications included in this section are Community Learning, Apprenticeships, Education and Training and Workplace Learning 704 Sector Subject Areas which are classed as NULL, not applicable or unknown have been excluded from this analysis 705 Only aims with 100 or more enrolments per year have been included in the statistical release used 706 This analysis of aims shows the number of learners studying that qualification for that year. The learner will be counted for each qualification they are studying and so can be counted more than once 707 This section includes all courses taught in colleges, including academic courses 708 The academic year for vocational qualifications runs from 1 October to 30 September 709 Within the statistical release values less than five were suppressed. All other values were rounded to the nearest ten. The data provided in this section is the sum of these rounded values, which has then in turn been rounded to the nearest hundred. There will be a margin of error in the data 710 Total is the sum of all known Sector Subject Areas 711 Within the statistical release values less than five were suppressed. All other values were rounded to the nearest ten. The data provided in this section is the sum of these rounded values, which has then in turn been rounded to the nearest hundred. There will be a margin of error in the data 712 A lower level of data suppression has been applied to this data than in Table 9.3 as fewer cells have been summed to create the values. 713 Qualification either has no level or may be taken at several levels. 714 Total is the sum of all known Sector Subject Areas

Recognising vocational pathways to professional registration

The engineering profession has always supported and driven high quality vocational pathways to professional registration, and has welcomed the Government's recent changes to the performance tables related to Tech level qualifications.[715] The requirement for the professional engineering institutions to formally recognise such qualifications will ensure that they align with UK-SPEC and the ICT*Tech* Standard, enabling the approval of more pathways that lead to Engineering Technician (EngTech), ICT Technician (ICT*Tech*) and Incorporated Engineer (IEng) registration.

UK-SPEC and the ICTTech Standard 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, has supported Awarding Organisations to ensure that Tech level qualifications align with UK-SPEC and the ICT*Tech* Standard. Those qualifications that have formally gained 'approved for the purposes of professional registration' status can now be recognised through use of the Engineering Council Approved Qualification logo. All approved qualifications are listed on the Engineering Council's website.[716]

Engineering Council approved qualification

Engineering Council cymhwyster cymeradwy

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 '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 National Vocational Qualifications[717 718 719]

N/SVQs were introduced in 1987 and recognise the level of skill and knowledge needed to demonstrate competency in the area of work related to the subject studied. Candidates must pass a performance-based assessment, usually in a work environment. It should be noted, however, that N/SVQs are not related to a specific course of study. N/SVQ level 3 qualifications also form a substantial element of the Advanced/Modern Apprenticeship. Since their introduction and up to the end of September 2013, 10.4 million N/SVQs have been awarded.[720]

The number of NVQs awarded in the UK has declined from nearly a million (979,000) in 2009/10 to just 28,700 in 2012/13. This reduction can be directly attributed to the QCF qualification being introduced.[721] From September 2009, all newly regulated qualifications are approved as QCF qualifications.

Table 9.5 shows that in total, there were 17,900 NVQ achievements in engineering-related Sector Subject Areas in 2012/13. This was a decrease of two thirds (66.9%) on the previous year. Of these 17,900 engineering-related achievements, 13,900 were in engineering and manufacturing technologies.

715 https://www.gov.uk/government/publications/vocational-qualifications-for-14-to-19-year-olds **716** www.engc.org.uk/techdb **717** Numbers rounded to nearest 100 **718** Numbers may not add up to row and column totals due to rounding and the apportioning of unknown values **719** The database for measuring NVQ achievements is very good, but it is not comprehensive **720** Website accessed on the 7 August 2014 (https://www.gov.uk/government/statistical-data-sets/fe-data-library-vocational-qualifications--2) **721** *Vocational Qualifications*, Department for Business, Innovation and Skills, 27 March 2014, p1

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Table 9.5: Achievements of NVQs by Sector Subject Area (2003/04-2012/13) – UK

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over ten years
Engineering and manufacturing technologies	81,300	88,900	94,600	92,400	93,900	135,000	144,300	115,400	41,000	13,900	-66.1%	-82.9%
Construction, planning and the built environment	48,500	52,800	55,400	74,000	99,100	116,500	93,300	40,300	11,400	3,500	-69.3%	-92.8%
Information and communication technology	9,200	8,500	12,600	16,600	27,200	35,300	35,400	10,500	1,600	500	-68.8%	-94.6%
Subtotal – all engineering related Sector Subject Areas	139,000	150,200	162,600	183,000	220,200	286,800	273,000	166,200	54,000	17,900	-66.9%	-87.1%
Science and mathematics	300	400	400	300	200	300	300	100	100	-[722]		
Total	470,100	538,500	598,600	630,400	727,900	922,900	979,000	587,800	128,800	28,700	-77.7%	-93.9%

Source: The Data Service

The level of N/SVQ qualifications for different Sector Subject Areas in 2012/13 is shown in Table 9.6. Overall, 59.1% of qualifications were at level 3+. The proportion is very similar for all engineering-related Sector Subject Areas, at 59.6%. However, looking at individual Sector Subject Areas shows that 87.5% of achievements in information and communication technology were at level 3+, compared with 52.5% in construction, planning and the built environment.

The proportion of male and female achievements is shown in Table 9.7. Overall, two in five (39.6%) achievements are from female students. By comparison, a quarter (25.0%) of achievements in information and communication technology were by women. For construction, planning and the built environment, 1.3% of achievements were by women, and for engineering and manufacturing technology it was 5.2%.

Table 9.6: N/SVQ achievements by Sector Subject Area and level of award (2012/13) – UK

	Total achievements	Level 1	Level 2	Level 3	Levels 4 and 5	Percentage of achievements which are level 3+
Engineering and manufacturing technologies	19,400	300	7,200	11,700	200	61.3%
Construction, planning and the built environment	8,000	100	3,700	3,700	500	52.5%
Information and communication technology	800	-[723]	100	700	-	87.5%
Subtotal – all engineering related Sector Subject Areas	28,200	400	11,000	16,100	700	59.6%
Science and mathematics	-	-	-	-	-	
All achievements	65,100	1,400	25,300	33,900	4,600	59.1%

Source: The Data Service

722 - = zero, or less than 50 723 - = zero, or less than 50

9.4 Vocationally Related Qualifications[725] [726] [727] [728] [729]

VRQs, such as National Certificates and Diplomas, provide the knowledge and practical skills required for a job through a programme of structured learning. VRQs are usually assessed through assignments, projects and sometimes written tests. As well being a standalone qualification, VRQs are often, but not always, a component of apprenticeships. Since their introduction in 2001/02 there have been 12.4 million VRQ achievements.[730] As a direct result of the introduction of the QCF framework, there has been a reduction from 43[731] organisations awarding VRQs to 36.[732]

Table 9.8 shows that the total number of VRQ achievements in engineering-related Sector Subject Areas was just over a quarter of a million (262,600). However, the bulk of these achievements were in information and communication technology (224,100). By comparison, there were 10,100 achievements in construction, planning and the built environment and 28,400 in engineering and manufacturing technologies. However, half (49.3%) of qualifications in engineering and manufacturing technologies were level 3, compared with a fifth (19.8%) in construction, planning and the built environment and just 2.8% in information and communication technology.

Nearly half (47.7%) of all VRQs were achieved by women (Table 9.9), compared with 41.8% in the engineering-related Sector Subject Areas. However, examining the data by individual Sector Subject Areas shows that 48.0% of achievements in information and communication technology were by females, compared with just 4.0% for construction, planning and the built environment and 6.3% for engineering and manufacturing technologies.

Table 9.7: N/SVQ achievements by Sector Subject Area and gender (2012/13) – UK

	Total achievements	Male	Female	Percentage female
Engineering and manufacturing technologies	19,400	18,400	1,000	5.2%
Construction, planning and the built environment	8,000	7,800	100	1.3%
Information and communication technology	800	600	200	25.0%
Subtotal – all engineering related Sector Subject Areas	28,200	26,800	1,300	4.6%
Science and mathematics	-[724]	-	-	
All NVQs	65,100	39,300	25,800	39.6%

Source: The Data Service

Table 9.8: All VRQ achievements (as reported by participating awarding bodies) by Sector Subject Area and level (2012/13) – UK

	Total achievements	Level 1	Level 2	Level 3	Percentage of VRQs at level 3
Engineering and manufacturing technologies	28,400	700	13,600	14,000	49.3%
Construction, planning and the built environment	10,100	3,400	4,600	2,000	19.8%
Information and communication technology	224,100	1,600	216,200	6,300	2.8%
Subtotal – all engineering related Sector Subject Areas	262,600	5,700	234,400	22,300	8.5%
Science and mathematics	18,500	-[733]	18,500	-	0.0%
All VRQ achievements	367,000	15,200	303,300	48,500	13.2%

Source: The Data Service

Table 9.9: All VRQ achievements (as reported by participating awarding bodies) by Sector Subject Area and gender (2012/13) – UK

	Total achievements	Male	Female	Percentage female
Engineering and manufacturing technologies	28,400	26,500	1,800	6.3%
Construction, planning and the built environment	10,100	9,700	400	4.0%
Information and communication technology	224,100	116,600	107,500	48.0%
Subtotal – all engineering related Sector Subject Areas	262,600	152,800	109,700	41.8%
Science and mathematics	18,500	9,500	9,000	48.6%
All VRQ achievements	367,000	192,100	174,900	47.7%

Source: The Data Service

724 - = zero, or less than 50 **725** The VRQ achievements in this section relate to those submitted by the 37 awarding organisations and therefore are not complete UK estimates **726** This section includes all courses taught in colleges, including academic courses **727** Numbers rounded to nearest 100 **728** Numbers may not add up to row and column totals due to rounding and the apportioning of unknown values **729** The database for measuring VRQ achievements is very good, but it is not comprehensive **730** Website accessed on the 7 August 2014 (https://www.gov.uk/government/statistical-data-sets/fe-data-library-vocational-qualifications--2) **731** *Engineering UK 2014 The state of engineering*, EngineeringUK, December 2013, p90 **732** *Vocational Qualifications*, Department for Business, Innovation and Skills, 27 March 2014, p1 **733** - = zero, or less than 50

9.5 Qualifications and Credit Framework[734 735 736 737]

As mentioned previously, Government education policy changes have led to a significant shift towards the uptake of qualifications from the QCF. There are three different types of QCF qualifications:

- Award – 1-12 credits
- Certificates – 13-36 credits
- Diploma – at least 37 credits

Each credit usually represents 10 hours of learning. Qualifications are made up from a series of units that can have a variable number of credits. Units and qualifications are also awarded a level ranging from entry level to level 8. The title of a qualification denotes both its size, level[738] and difficulty.[739]

Table 9.10 shows the number of QCF achievements in different Sector Subject Areas by level. It shows that overall, one in five (19.7%) of all achievements are at level 3+. However, when you look at all the engineering Sector Subject Areas, it is slightly below average at 18.8%. Amongst the different engineering Sector Subject Areas, nearly a quarter (23.9%) of the 225,100 achievements in construction, planning and the built environment were at level 3+, compared with 18.0% of the 289,800 achievements for engineering and manufacturing technologies. Information and communication technology is the largest of the engineering-related Sector Subject Areas, with 310,500 achievements, but only 15.9% of them are at level 3+.

It is also worth considering that there are 157,100 achievements in science and mathematics, but of these 137,300 are at level 2.

Overall, nearly half (46.8%) of all QCF achievements are from female students (Table 9.11). However, for all the engineering-related Sector Subject Areas, the comparable figure is one in five (19.4%). Within the different engineering Sector Subject Areas, two in five (40.6%) information and communication technology achievements are female, compared with one in ten (9.7%) for engineering and manufacturing technologies and 2.6% for construction, planning and the built environment.

Table 9.10: All QCF achievements by Sector Subject Area and level of award (2012/13) – UK

	Total achievements	Entry level	Level 1	Level 2	Level 3	Levels 4-8	Percentage of QCFs at level 3+
Engineering and manufacturing technologies	289,800	4,900	46,200	186,500	48,400	3,800	18.0%
Construction, planning and the built environment	225,100	6,000	63,100	102,200	50,000	3,800	23.9%
Information and communication technology	310,500	28,600	97,500	134,900	47,600	1,900	15.9%
Subtotal – all engineering related Sector Subject Areas	825,400	39,500	206,800	423,600	146,000	9,500	18.8%
Science and mathematics	157,100	-[740]	1,700	137,300	18,000	100	11.5%
All QCF achievements	5,011,500	361,800	1,151,800	2,508,400	893,100	96,300	19.7%

Source: The Data Service

Table 9.11: All QCF achievements by Sector Subject Area and gender (2012/13) – UK

	Total achievements	Male	Female	Percentage female
Engineering and manufacturing technologies	289,800	261,600	28,200	9.7%
Construction, planning and the built environment	225,100	219,300	5,800	2.6%
Information and communication technology	310,500	184,500	126,000	40.6%
Subtotal – all engineering related Sector Subject Areas	825,400	665,400	160,000	19.4%
Science and mathematics	157,100	80,000	77,100	49.1%
All QCF achievements	5,011,500	2,668,200	2,343,300	46.8%

Source: The Data Service

734 The database for measuring QCF achievements is very good, but it is not comprehensive 735 78 awarding organisations provided data on QCF achievements 736 Numbers may not add up to row and column totals due to rounding and the apportioning of unknown values 737 The database for measuring VRQ achievements is very good, but it is not comprehensive 738 Website accessed on the 7 August 2014 (http://ofqual.gov.uk/qualifications-and-assessments/qualification-frameworks/) 739 *Vocational Qualifications*, Department for Business, Innovation and Skills, 27 March 2014, p4 740 - = zero, or less than 50

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Table 9.12 shows the breakdown of achievements by Sector Subject Area and age. Overall, nearly two thirds (61.7%) of achievements were from students aged 24 or under. For science and mathematics, nearly all (99.6%) students were aged 24 or less, compared with just over half (57.4%) of those in engineering-related Sector Subject Areas. Engineering and manufacturing technologies was the engineering-related Sector Subject Area with the highest proportion of students aged 24 or less (62.0%).

Of the 5.0 million Qualifications and Credit Framework (QCF) achievements in 2012/13, 2.1 million were Awards, 1.8 million were Certificates and 1.1 million were Diplomas.[745] In the engineering-related Sector Subject Areas, 31.4% were Awards, 32.8% were Certificates and 35.8% were Diplomas. This means that engineering achievements are more likely than average to result from longer courses.

9.6 FE workforce

Table 9.13 shows the number of FE teachers in engineering-related Sector Subject Areas over a six year period. Between 2010/11 and 2011/12, the number of FE teachers for engineering-related Sector Subject Areas declined by a fifth (-20.2%). Information and communication technology had the largest decline (-25.5%), followed by engineering and manufacturing technologies (-19.2%) and construction, planning and the built environment (-16.3%). At the same time, the number of FE staff teaching science and mathematics in 2011/12 fell to 4,690 – down over a quarter (-26%) in one year.

Table 9.12: All QCF achievements by Sector Subject Area and age (2012/13) – UK[741]

	Total achievements	Under 19[742]	19-24	25+[743]	Age unknown	Percentage of achievements amongst those aged under 25
Engineering and manufacturing technologies	289,800	117,300	62,300	110,200	-[744]	62.0%
Construction, planning and the built environment	225,100	85,900	38,800	100,200	200	55.4%
Information and communication technology	310,500	131,100	38,100	140,100	1,400	54.5%
Subtotal – all engineering related Sector Subject Areas	825,400	334,300	139,200	350,500	1,600	57.4%
Science and mathematics	157,100	154,200	2,200	800	-	99.6%
All QCF achievements	5,011,500	2,271,400	820,000	1,885,900	34,400	61.7%

Source: The Data Service

Table 9.13: Sector Subject Areas taught by FE teaching staff (2006/07-2011/12) – England

Subject taught	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	Change over one year	Change over six years
Engineering and manufacturing technologies	5,016	7,079	7,574	6,776	5,935	4,795	-19.2%	-4.4%
Construction, planning and the built environment	4,399	6,710	6,903	6,444	5,542	4,638	-16.3%	5.4%
Information and communication technology	5,024	7,417	7,229	6,247	5,003	3,725	-25.5%	-25.9%
Sub-total for all engineering-related Sector Subject Areas	14,439	21,206	21,706	19,467	16,480	13,158	-20.2%	-8.9%
Engineering-related Sector Subject Areas as a percentage of all teaching staff	16.2%	15.6%	15.7%	15.9%	15.5%	15.9%	1.0%	-1.9%
Science and mathematics	6,547	8,114	8,166	7,197	6,339	4,690	-26.0%	-28.4%
Total for all Sector Subject Areas	89,152	135,606	138,222	122,578	106,053	82,593	-22.1%	-7.4%

Source: LLUK and LSIS Further Education College Workforce Data for England

741 Academic Age is age of the person at the start of the academic year, eg academic age in 2012/13 would be age on 31 August 2012 742 Includes those with academic ages from 12 to 15 743 Includes those with academic ages from 60 to 90 744 - = zero, or less than 50 745 *Vocational Qualifications*, Department for Business, Innovation and Skills, 27 March 2014, p1

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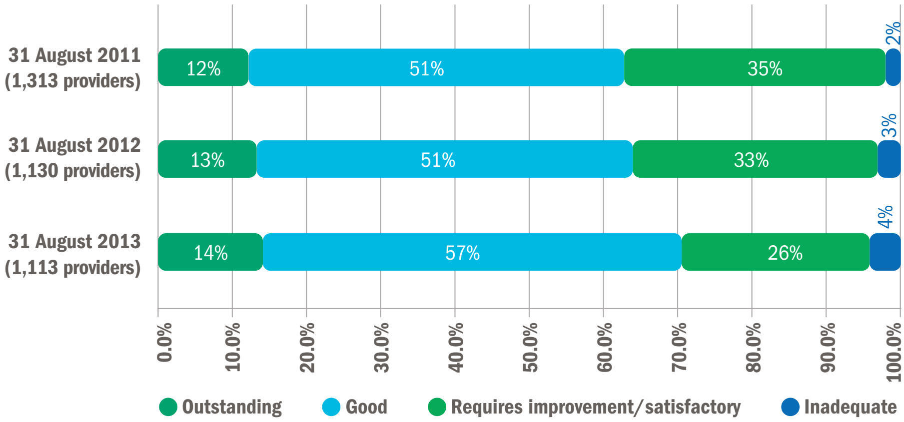
The Department for Business, Innovation and Skills has stated that "recruitment and retention data for the workforce reveal significant and growing difficulties in filling vacancies in some key occupational groups, especially maths, science and engineering. The sector also has difficulty in attracting the best new graduates."[746] This suggests that the decline in FE teachers in engineering-related Sector Subject Areas is unlikely to be reversed in the near future. This is supported by data in Section 7[747] which showed that the number of those entering physics and mathematics initial teacher training is still not meeting Government targets, and therefore that this shortage of staff to teach STEM subjects also affects the compulsory schools sector. Furthermore, Ofsted, in its 2012/13 report on FE education and skills providers, revealed that 30% of FE education and skills providers were deemed inadequate or in need of improvement – although this is an improvement from 37% in August 2011 (See Figure 9.1).

The underlying dynamics and necessary steps for improvement were addressed in a 2012 report by the UK Commission for Employment and Skills. The report claimed that, given the international market now inherent in FE and Higher Education "attracting and retaining the best and brightest educators – particularly STEM and modern language teachers – in sufficient numbers remains a key challenge for the sector. This can be achieved by putting initiatives in place to boost supply and attracting new talent from the UK, the EU, and international labour markets."[749]

The Government's priority, therefore, is to improve the professionalism and quality of FE teachers by encouraging continuing professional development (CPD) and the attraction of high-quality graduates.[750] The Department for Business, Innovation and Skills has instituted a range of incentives including training bursaries designed to "attract and retain new high quality graduates to become teachers in the Further Education sector."[751] These are available to UK and EU graduates who train to teach those with special educational needs (SEN) or mathematics and English to GCSE and level 3. The mathematics bursaries are available to those with Third Class Honours degrees (with a B in A level mathematics) or above.[752] This is bolstered by the 'Golden Hello' programme which pays £7,500 to graduates teaching mathematics in FE in their second year of work, rising to £10,000 following early professional development involving special educational needs (SEN) learners.[753, 754] The Government has also announced funding for FE Centres of Excellence in Teacher Training (CETT) in order to assess, improve and deliver teacher training in mathematics, English and SEN.[755] Additionally, in August 2014, measures of support for the FE mathematics teachers training in the classroom was announced, with flexible grants of £20,000 per mathematics graduate available to colleges and training providers to best meet the needs of each individual trainee.[756]

The Government is also aiming, specifically, to improve the status and professionalism of vocational teachers by supporting the Education and Training Foundation (formerly the FE Guild),[757] Institute of Education (IoE) and Association of Employment and Learning Providers (AELP) in their development of the Teach Too programme, which seeks to encourage those in industry to teach part-time and to enable teachers to spend time in industry.[758] All of this is designed to address the difficulties faced by FE learning providers in recruiting teaching staff and maintaining their skills in order to deliver STEM provision.

Fig. 9.1: Most recent overall effectiveness of Further Education and skills providers inspected over time (August 2011-August 2013) – England



Source: Ofsted[748]

746 *Further Education Workforce Strategy*, Department for Business, Innovation and Skills, March 2014, p6; www.gov.uk/government/uploads/system/uploads/attachment_data/file/326000/bis-14-679-further-education-workforce-strategy-the-government-strategy-support-workforce-excellence-in-further-education.pdf 747 See Section 7.10.1 for further details 748 *Further Education and skills*, Ofsted, 2013, p9; www.ofsted.gov.uk/sites/default/files/documents/ar201213/Ofsted%20Annual%20Report%20201213%20FE%20and%20Skills.pdf 749 *Sector Skills Insights: Education*, UK Commission for Employment and Skills, August 2012, piv; www.gov.uk/government/uploads/system/uploads/attachment_data/file/303992/Sector_Skills_Insights_Education_evidence_report_57.pdf 750 *Further Education Workforce Strategy*, Department for Business, Innovation and Skills, March 2014, p13 751 *Further Education Initial Teacher Training Bursary Guide Academic Year 2014/15*, Department for Business, Innovation and Skills, April 2014, p3 752 "PhDs will attract the same bursary award as a 1st class honours degree; and Master's degrees will attract the same bursary award as a 2:1 (*Further Education Initial Teacher Training Bursary Guide Academic Year 2014/15*, Department for Business, Innovation and Skills, April 2014, p9) 753 *Mathematics Teachers Golden Hello Scheme*, Department for Business, Innovation and Skills, 2014, p1 754 *Further Education Workforce Strategy*, Department for Business, Innovation and Skills, March 2014, p13 755 *Further Education Workforce Strategy*, Department for Business, Innovation and Skills, March 2014, p14 756 *Support for Further Education sector to develop maths teachers of the future*, Department for Business, Innovation and Skills, August 2014; Website accessed on 12th September 2014 (www.gov.uk/government/news/support-for-further-education-sector-to-develop-maths-teachers-of-the-future) 757 *'FE Guild' becomes Education and Training Foundation, Education and Training Foundation*, May 2013; Website accessed 12th September 2014 (www.et-foundation.co.uk/news/fe-guild-becomes-education-training-foundation) 758 *Vision for science and mathematics education*, Royal Society, 2014, p42

9.6.1 FE workforce salaries

Figure 9.2 shows that the average salary for teaching staff in the FE sector in 2011/12 was £29,696. In the engineering-related Sector Subject Areas, only information and communication technology staff had an above average salary (£29,961), with engineering and manufacturing technologies staff (£29,346), and construction, planning and the built environment staff (£29,321) both slightly below average. By comparison, staff teaching science and mathematics had the second highest average salary, at £31,998.

The importance of FE salaries is shown by the Lingfield review of FE professionalism which states that "we must observe, nevertheless, that the average salaries of FE staff, relative to their counterparts in schools and universities, appear to have declined substantially over time, and particularly sharply so in the last decade."[759] Having been 10-15 percentage points above secondary school teachers and 20 points below university lecturers from 1974, this changed abruptly from 2001, with FE wage rises of 27% against 53% for the others. As a result, FE lecturers' pay settled at "six to eight percentage points below school teachers and about 27 percentage points below university lecturers."[760]

9.7 Vocational engineering qualifications in the FE sector

Authored by Rhys Morgan, Director, Engineering and Education, Royal Academy of Engineering

The FE sector is one of the least understood and most complex sectors in the education system. This is because of its wide-ranging objectives, from supporting students with learning difficulties and providing a second chance to young people who did not achieve sufficiently high grades at Key Stage 4, through advanced vocational pathways for progression to employment and/or Higher Education, undergraduate degree programmes and other higher learning, to lifelong and recreational learning for adults, to educational support for rehabilitation of offenders in prisons. The sector also caters for professional development of people in work.

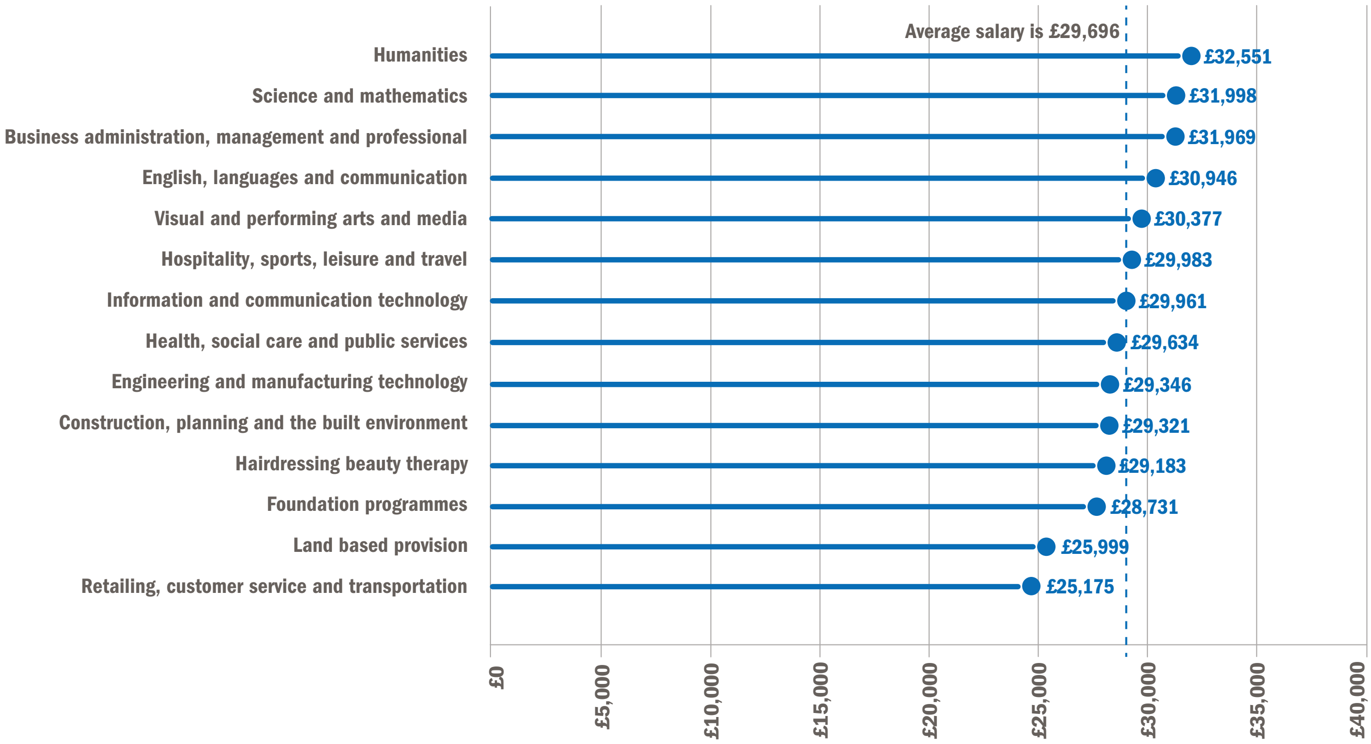
Previous analysis from the Academy shows there are over 1,500 providers who are contracted to provide publicly-funded provision within the sector, with an underlying provider base of over 5,000. These providers range from very large General Further Education Colleges with a student base of over 100,000 to small private companies serving 20 to 30 learners. They include large and small independent training providers, specialist colleges serving learners with special needs, voluntary organisations delivering social inclusion through adult education and training, employers training their own staff, prisons and Local Authorities serving community needs.

Qualifications in the sector are funded either by the public purse or through private (typically employer or individual) funding. The privately funded training market is significantly larger than the publicly funded market[761] with the following typical contributions:

- employers in England spent £40.5 billion a year on training
- Public investment was approximately £2.7 billion

Qualifications that are paid for through the public purse are regulated to ensure they meet appropriate standards. Ofqual, the regulator for England, produces its annual qualification market report for England, Wales and Northern Ireland.[762] This provides a fascinating insight into the most popular publically funded qualifications and subject areas across the whole of FE. This section provides some highlights from the data.

Fig. 9.2: Average full-time teaching staff pay by subject taught (2011/12) – England



Source: LSIS Further Education College Workforce Data for England

759 *Professionalism in Further Education Final Report of the Independent Review Panel*, The Lord Lingfield Kt, MEd DLitt FCGI DL, October 2012, p32; www.gov.uk/government/uploads/system/uploads/attachment_data/file/34641/12-1198-professionalism-in-further-education-final.pdf **760** *Professionalism in Further Education Final Report of the Independent Review Panel*, The Lord Lingfield Kt, MEd DLitt FCGI DL, October 2012, p32 **761** *Review of Adult Vocational Qualifications in England*. UK Commission for Employment and Skills. 2013 **762** http://ofqual.gov.uk/standards/statistics/annual-qualification-market-report-england-wales-northern-ireland/

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In 2013:

- 23,600 regulated qualifications were on offer from 176 awarding organisations across all subject areas
- The number of available qualifications increased by 3,000 (15%) from 2012
- In total, some 17.88 million certificates were awarded in 2013: an increase of 4% on the previous year and 15% over a five-year period
- 17% of qualifications (approximately 4,000 on the register) accounted for 90% of certificates awarded (excluding GCSEs, AS and A levels)
- 20 awarding organisations accounted for over 90% of all certificates awarded
- There were nearly 13,000 qualifications in which at least one certificate was awarded, accounting for 54% of the qualifications on offer

Looking at the number of qualifications other than GCSE, AS and A level for different Sector Subject Areas (ignoring preparation for life and work), the following data is highlighted:

- Health, public services and care has the highest number of certificates awarded at 1.025 million
- Information and communication technology was fifth highest with 633,000 certificates awarded
- Engineering and manufacturing technologies was ranked eighth, with 441,000 certificates awarded
- Construction, planning and the built environment was tenth, with 243,000 certificates achieved

Within the engineering and manufacturing technologies Sector Subject Area, the awarding organisations with the highest number of certificates were as follows:

- Chartered Institute of Environmental Health 94,950 (22%)
- City and Guilds 86,650 (20%)
- Excellence, Achievement and Learning (EAL) 81,150 (18%)
- Pearson 73,050 (17%)
- IMI Awards Ltd 47,600 (11%)

For Construction, planning and the built environment, the following awarding organisations had the highest number of awards:

- Cskills Awards 95,450 (39%)
- City and Guilds 89,750 (37%)
- Pearson 37,600 (15%)
- Ascentis 10,050 (4%)
- Excellence, Achievement and Learning (EAL) 2,950 (1%)

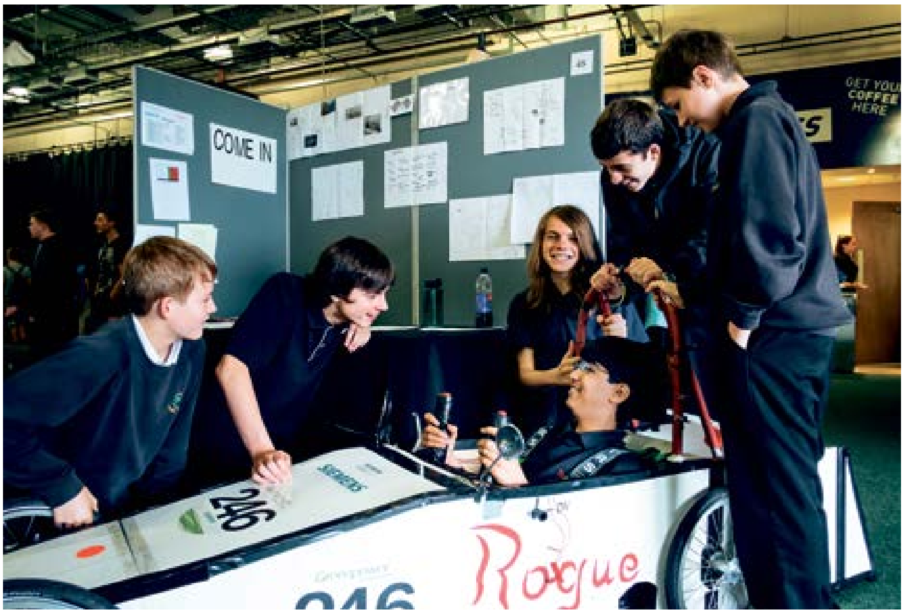
Finally, within the information and communication technology Sector Subject Area, the awarding organisations with the highest number of certificates were as follows:

- OCR 296,300 (47%)
- Pearson 166,850 (26%)
- BCS, The Chartered Institute for IT 83,900 (13%)
- City & Guilds 40,950 (6%)
- Ascentis 19,350 (3%)

Engineering, construction and ICT qualifications feature in a number of the most popular qualifications for apprenticeships. These include:

- Pearson BTEC level 3 Diploma in professional competence for IT and telecoms professionals
- City & Guilds level 3 NVQ in electrotechnical Services – Advanced Apprenticeship
- EAL level 2 NVQ Diploma in performing manufacturing operations (QCF)
- City & Guilds level 3 Certificate in electrotechnical technology
- City & Guilds level 2 Certificate in electrotechnical technology
- Pearson BTEC level 3 Certificate in ICT systems and principles (QCF)
- IMIAL level 3 Diploma in light vehicle maintenance and repair principles (QCF)

Part 2 - Engineering in Education and Training
10.0 Apprenticeships



We have shown that engineering enterprises will need to recruit around 56,000 engineering technicians per year between 2012 and 2022.[763] Apprentices form an important part of meeting this demand for technicians. However, with the number of level 3 apprenticeship achievements from England, Scotland and Wales[764] at just 25,978 in 2012/13, there is a shortfall of 30,000.

Apprenticeship Programme Achievements in England have increased across all Sector Subject Areas by a massive 413.0% over 10 years, totalling 252,900. However, all three engineering-related Sector Subject Areas have had below average growth. Engineering and manufacturing technologies is the largest of these three Sector Subject Areas, with a total of 37,180 achievements across all levels in 2012/13 (a rise of 258.9%). By comparison, construction, planning and the built environment had the lowest growth over 10 years (151.7%) – but with 9,060 achievements in 2012/13, it is still the second largest Sector Subject Area. Finally, information and communication technology grew by 206.9% to reach 7,580 achievements in 2012/13. In addition to the achievements in England, it is important to recognise the contribution of the devolved nations. In 2012/13, there were 6,334 achievements in engineering-related apprenticeship frameworks in Scotland, while Wales had 3,580 achievements in engineering-related Sector Subject Areas.

10.1 Apprenticeships in England

Apprenticeships are a form of vocational training where learners work alongside experienced staff to gain job-specific skills and receive on- and off the- job training. Learners gain skills necessary to succeed in their chosen career and earn money at the same time. Apprentices must spend a substantial period of time doing the job they are developing a competence in – usually 30 hours per week – in addition to learning time.[765]

An apprenticeship is not a qualification in itself but a framework that contains separately certified elements, which vary by level. There are three broad levels of apprenticeship:

- Intermediate Apprenticeships
  Apprentices work towards work-based learning qualifications such as an NVQ level 2, functional skills and, in most cases, a relevant knowledge-based qualification such as a BTEC. These provide the skills needed for their chosen career and allow entry to an Advanced Apprenticeship.
- Advanced Apprenticeships
  Advanced Apprentices work towards work-based learning qualifications such as an NVQ level 3, functional skills and, in most cases, a relevant knowledge-based certificate such as a BTEC. To start this programme, the applicant should ideally have five GCSEs (grade C or above) or have completed an apprenticeship.
- Higher Apprenticeships
  Higher Apprentices work towards work-based learning qualifications such as an NVQ level 4 and, in some cases, a knowledge-based qualification such as a Foundation Degree.

In the Engineering UK report 2014,[766] we showed that the Government was planning to introduce graduate and postgraduate apprenticeships in a number of areas including advanced engineering. In this year's report, we can confirm that the Government is spending £20 million over two years to support apprenticeships up to postgraduate level.[767]

763 For further details please see Section 15.3.1 **764** Achievements data for Northern Ireland is not available **765** *Funding Rules 2012/13*, Skills Funding Agency, April 2012, p27 **766** *Engineering UK 2014 The state of engineering*, EngineeringUK, December 2013, p104 **767** *Budget 2014*, HM Treasury, March 2014, p85

As well as having graduate and postgraduate apprenticeships, it should also be recognised that apprentices can progress to Higher Education (HE). However progression to HE varies by apprenticeship framework. For example, of the 2005/06 apprenticeship cohort, 37% of those doing an engineering framework at advanced level progressed to HE. By comparison, the progression rate for electrotechnical apprentices was just 1%.[768] Female students were more likely to progress to full-time HE within four to seven years of starting their apprenticeship than male students.[769] However, some employers don't realise that their apprentices have the potential to progress to HE and this could represent a lost pool of talent.[770]

Like academic education, vocational education is going through a period of change. One key change has been the introduction of Trailblazer Apprenticeships, which will put employers and professional bodies at the heart of development of new apprenticeships.[771] In October 2013,[772] the Government announced the first eight sectors to develop Trailblazer Apprenticeships:

- aerospace
- automotive
- digital industries
- electrotechnical
- energy and utilities
- financial services
- food and drink manufacturing
- life sciences and industrial sciences

At around the same time, the Government also announced that 60 employers were signed up for Trailblazer Apprenticeships.[773]

Phase two Trailblazer Apprenticeships were announced in March 2014. This covers a further 29 sectors,[774] with phase 3 Trailblazer Apprenticeships announced in September 2014.[775]

The Government is also strengthening the maths and English requirements of those students on Trailblazer Apprenticeships. All apprentices working at level 2 will be required to study maths and English to level 2 if they have not already achieved qualifications at that level.[776 777]

The Department for Business, Innovation and Skills (BIS) has found that just over a quarter (28%) of level 2 apprentices enrolled in November 2011 were studying for their first full level 2 qualification.[778] BIS research also showed that 12% of level 3 apprentices had a prior qualification at level 2, while half (50%) already had a prior qualification at level 3 or above.[779]

Another major change affecting the apprenticeships sector is the introduction of Traineeships. In last year's report,[780] we showed that the three key elements of a Traineeship were as follows:

- A focused period of work preparation training. This centres on areas such as CV writing, interview preparation, job search, self-discipline and inter-personal skills.
- A substantial, high quality work placement to give the young person meaningful work experience, and a chance to develop workplace skills and prove themselves to an employer.
- English and maths for young people who have not achieved a GCSE grade C or equivalent (level 2).

The target group of students for Traineeships is people who:[781]

- are not currently in a job and have little work experience, but who are focused on work or the prospect of it
- are 16-19 and qualified below level 3 or 19-24 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

While on a Traineeship, the young people are exempt from the National Minimum Wage but, where they qualify, they can access the 16-19 Bursary Fund and learning and learner support arrangements for 19- to 24-year-olds.[782]

Based on the first three quarters of 2013/14,[783] 7,400 young people started a Traineeship.[784] In May 2014, the Government announced changes to expand Traineeships, which included changes in benefit rules.[785]

In addition to the introduction of graduate level apprenticeships, Trailblazer Apprenticeships and Traineeships, the Government has also changed the assessment point for apprenticeships, moving the assessment to the end of the apprenticeship programme.[786]

Demos[787] has shown that there is potential scope for increasing the number of apprentices. For example, its research shows that if London had a proportion of apprentices similar to the rest of the country, it would have an additional 30,000 apprentices. In contrast, the Government has shown that only 44% of companies plan to take on an apprentice over the next five years.[788]

It should also be noted that, compared with other advanced economies, apprentices are less common in the UK. For example, Switzerland has 43 level 3 apprentices per thousand employed people and Germany has 40, compared with six in the UK.[789] Looking specifically at physical and engineering technicians, in the UK 1.1% of the workforce was at technician level, compared with an EU average of 2.4% and a German average of nearly 3%.[790] The Institute of Public Policy Research has also shown that the UK has a higher density of level 2 apprentices than most other European countries.[791] The Government has recognised the low number of engineering technicians and in June 2013 the Prime Minister announced a new initiative to create 100,000 registered engineering technicians by 2018.[792]

There is high demand for apprenticeship places from potential apprentices. Research by the Institute for Employment Studies[793] has shown that on average there are around 15 applications per apprenticeship vacancy and that some apprenticeships schemes, for example BT, get 100 applicants per apprenticeship vacancy. However, research has shown that 70% of apprentices are not people starting new jobs but existing workers who were already working for that employer.[794] It should also be noted that female apprentices are more likely to have been working for their employer prior to the commencement of their apprenticeship than male apprentices.[795] Finally, it is worth noting that the majority of apprentices work in small and medium sized enterprises.[796] If the UK is to drive the growth in engineering technicians[797] that engineering enterprises require, then any changes to the apprenticeship system must also work for small and medium sized companies.

768 *Progression of Apprentices to Higher Education – Cohort Update*, Department for Business, Innovation and Skills, May 2014, p9 **769** *Progression of Apprentices to Higher Education – Cohort Update*, Department for Business, Innovation and Skills, May 2014, p10 **770** *The Road Less Travelled Experiences of employers that support progression of Advanced Apprentices to Higher Education,* CFE, 2011, p5 **771** *The Future of Apprenticeships in England: Implementation Plan*, Her Majesties Government, October 2013, p23-25 **772** *The Future of Apprenticeships in England: Implementation Plan*, Her Majesties Government, October 2013, p23-25 **773** Website accessed on the 7 August 2014 (https://www.gov.uk/government/news/pm-announces-new-work-training-schemes-for-young-people-and-a-new-era-of-apprenticeships) **774** For details of which sectors are covered in phase 2 of Trailblazer Apprenticeships please see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287276/bis-14-p194-future-of-apprenticeships-in-england-guidance-for-trailblazers-revised-version-2.pdf **775** Website accessed on 7 August 2014 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287276/bis-14-p194-future-of-apprenticeships-in-england-guidance-for-trailblazers-revised-version-2.pdf **776** *The Future of Apprenticeships in England: Implementation Plan*, Her Majesties Government, October 2013, p14 **777** See Section 7.12 for more details **778** *Prior Qualifications of Adult Apprentices 2011/2012*, Department for Business, Innovation and Skills, November 2013, p5 **779** *Prior Qualifications of Adult Apprentices 2011/2012*, Department for Business, Innovation and Skills, November 2013, p6 **780** *Engineering UK 2014 The state of engineering*, EngineeringUK, December 2013, p106 **781** *Traineeships Supporting young people to develop the skills for apprenticeships and sustainable employment Framework for delivery 2014 to 2015*, Department for Education and Department for Business, Innovation and Skills, May 2014, p5 **782** *Traineeships Supporting young people to develop the skills for apprenticeships and sustainable employment Framework for delivery 2014 to 2015*, Department for Education and Department for Business, Innovation and Skills, May 2014, p8 **783** August 2013 to April 2014 **784** *Traineeship data*, Skills Funding Agency and Department for Business, Innovation and Skills, 26 June **785** Website accessed on 7 August 2014 (https://www.gov.uk/government/news/traineeships-set-to-deliver-for-more-young-people) **786** *The Future of Apprenticeships in England: Implementation Plan*, Her Majesties Government, October 2013, p17 **787** Up To The Job, Demos, 2014, p11 **788** Website accessed on 8 August 2014 (https://www.gov.uk/government/news/almost-half-of-all-firms-set-to-hire-apprentices-by-2019) **789** *Real Apprenticeships Creating a revolution in English skills*, Boston Consulting Group for the Sutton Trust, October 2013, p13 **790** *The Economics of Registration Schemes*, Gatsby Foundation, August 2013, p10 **791** *Review of Apprenticeships Interim Report and Consultation Document*, Department for Employment and Learning, January 2014, p27 **792** *Professor John Perkins' Review of Engineering Skills*, Department for Business, Innovation and Skills, November 2013, p30 **793** *Research into under-representation*, by gender and race, in Apprenticeships, Institute for Employment Studies, 2013, p99 **794** *A revolution in apprenticeships: a something-for-something deal with employers*. The Husbands Review of Vocational Education and Training, Labour party, 2013 p2 **795** *Research into under-representation*, by gender and race, in Apprenticeships, Institute for Employment Studies, 2013, p51 **796** *The Future of Apprenticeships in England: Implementation Plan*, Her Majesties Government, October 2013, p7 **797** See Section 15.3.1 for further details on the demand for engineering technicians

This box contains a summary of the main changes to apprenticeship programmes in England, which has been provided by the Department for Business, Innovation and skills.

The apprenticeships programme in England

- The apprenticeships programme is employer demand-led.
- Apprenticeships are real jobs with training.
- The locations and sectors where apprenticeships are available are determined by employers offering apprenticeships and recruiting apprentices.

Apprenticeship reforms

Apprenticeships already deliver strong returns for the economy, employers and apprentices; we want to ensure that they become more rigorous and responsive to the needs of employers

- **By 2017/18 all apprenticeship starts will be on new employer-designed standards.**
  - We are working with leading employers through our Trailblazers to design these standards. The first 11 new apprenticeship standards were published on 4 Mar 2014, and a second phase of Trailblazers was launched. In total, more than 400 employers in 37 sectors are involved. In August, a further 40 Trailblazer standards were published. Phase 3 of Trailblazers is due to be launched shortly.
- **We are putting employers in the driving seat of designing apprenticeships**
  - Trailblazers are groups of employers who collaborate to design world-class standards for the apprenticeships in their sector.
  - Businesses that are competitors in the market place recognise the need to work together to ensure that apprenticeship training gives their workforce the skills they need.
- **Our reforms are simplifying the system, making it easier for businesses, including smaller businesses, to engage**
  - In the past, apprenticeships have been based on frameworks that run to hundreds of pages, often written in complex and technical language.
  - The new standards are no longer than two sides. They are written by employers in language they understand.
  - This will make apprenticeships accessible to a wider range of businesses, including smaller businesses.
- **We are dramatically raising the quality of apprenticeships**
  - Employers designing apprenticeships will mean that they focus on the skills that our workforce needs to support growth.
  - Introducing more rigorous testing at the end of the apprenticeship and grading will ensure that all apprentices have the skills that employers require.

Facts

- Phase 1 of Trailblazers covered eight sectors and involved more than 60 leading employers who have designed the first eleven apprenticeship standards in occupations from aircraft fitter to software engineer and maintenance engineers – (list Annex A)
- Phase 2 of Trailblazers covers a further 29 sectors and involves more than 340 leading employers. They have developed 40 Trailblazer standards which include aircraft maintenance, light vehicle maintenance and repair, rail design technician and land-based engineering technician – (list at Annex B)

Funding Reforms

- We are planning to route funding for apprenticeship training via employers in the future, to give them greater control and purchasing power over apprenticeship training. We believe this approach has the potential to lead to a transformational change in the way employers engage with the apprenticeship system.
- We have made considerable efforts to ensure that any new funding model will work for small businesses. In the reformed system our aim is to make it as easy and attractive as possible for employers to carry out any required functions themselves. We have consulted further on the preferred funding mechanism.
- The deadline for responses was 1 May, and we will consider the feedback from both consultations, along with evidence from stakeholder discussions, published research and survey data before making a final decision on how apprenticeship funding will be channelled in the future.
- We will be trialling a funding model via standard-based apprenticeships started in academic year 2014/15. This will be based on Government contributing £2 for every £1 the employer contributes to the external training and assessment costs of the apprentice, with additional incentive payments for small businesses, and relating to the employment of 16- to 18-year-old apprentices and successful completion.

Higher Apprenticeships

- Government is to provide £40 million to deliver an additional 20,000 higher apprenticeship starts in England over the academic years 2013/14 and 2014/15. The Budget announced £10 million in 2014-15 and 2015-16 for new support for employer investment in apprenticeships up to postgraduate level.
- Investment in more Higher Apprenticeships will help to develop the skills needed to improve productivity and support British industry to compete internationally.
- Higher Apprenticeships are important to a number of Industrial Strategies, including Information Economy, Professional and Business Services, Nuclear, UK Life Sciences, Aerospace and Automotive. Higher Apprenticeships already exist in some of these sectors, such as **Aero-Manufacturing Engineering (level 6)** and **Broadcast Engineering (level 6)**.

The Apprenticeship Grant for Employers (AGE)

- We have announced £85 million in 2014-15 and 2015-16 to extend the Apprenticeship Grant for Employers scheme (AGE). This will fund over 100,000 additional incentive payments for employers to take on young apprentices (16-24) providing a major boost to their job prospects.
- From January 2015, the extension will be focused on companies with fewer than 50 employees, as opposed to those with fewer than 1,000 employees currently.

KEY DATA

- There have been over 1.8 million apprenticeship starts this Parliament.
- Final data in the 2012/13 academic year show that 138,700 apprentices participated in the engineering and manufacturing technologies Sector Subject Area, an increase of 10.3% on 2011/12.
- There were 868,700 people undertaking an apprenticeship in the 2012/13 academic year – the highest recorded in modern history.

Background

- The Richard Review was published in November 2012, setting out recommendations for how we should reform apprenticeships.
- Following a public consultation, in October 2013, we published *Future of Apprenticeships in England: Implementation Plan*.
- This set out our plans for delivering reforms to apprenticeships and announced the Phase 1 Trailblazers.
- In March 2014, we agreed and published the first eleven apprenticeship standards developed by the Phase 1 Trailblazers and announced the Phase 2 Trailblazers.
- In August 2014 40 Phase 2 apprenticeship standards were published.

10.1.1 Top ten Apprenticeship Programme Achievements by Sector Framework

Table 10.0 looks at specific Apprenticeship Framework Codes, each one of which represents an individual apprenticeship. Each one of these Apprenticeship Framework Codes is then one of multiple apprenticeships that map to a Sector Subject Area. The table shows that the 10 most popular Apprenticeship Framework Codes represent two thirds (69.2%) of all Framework Achievements. Indeed health and social care, on its own, represents 13.0% of all Framework Achievements.

The only engineering Framework in the top 10 most popular Frameworks was industrial applications, which had 10,070 achievements.

Table 10.0: Top 10 Apprenticeship Programme Achievements by Sector Framework Code (2012/13) – England[798 799]

Framework	Number of achievements	Cumulative percentage of all achievements
Health and social care	32,770	13.0%
Customer service	25,020	22.9%
Business administration	23,550	32.2%
Management	21,550	40.7%
Hospitality and catering	15,740	46.9%
Children's care learning and development	14,510	52.6%
Retail	14,190	58.3%
Industrial applications	10,070	62.2%
Hairdressing	10,030	66.2%
Active leisure and learning	7,600	69.2%
All framework achievements	252,900	

Source: The Data Service

798 Full-year numbers are a count of the number of achievements at any point during the year. Learners achieving more than one framework will appear more than once. 799 Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred.

10.1.2 Programme starts[800]

The Data Service publishes statistics on the number of Apprenticeship Programme Starts by Sector Subject Areas.[801] This enables us to look at the number of people starting STEM apprenticeships in general and, more specifically, those starting engineering-related apprenticeships.

Table 10.1 shows the number of Apprenticeship Programme Starts by Sector Subject Area over 10 years. Overall, the number of programme starts increased by 163.5% over the period 2003/04 to 2012/13, but in the last year it has fallen by 2.0%. Looking at all engineering-related Sector Subject Areas shows that the number of starts only increased by 43.9%, to 94,260, over 10 years and actually fell by 7.7% in 2012/13.

The 10-year trend for different engineering-related Sector Subject Areas shows that starts in construction, planning and the built environment have declined by a third (34.0%), compared with a rise of 70.6% for engineering and manufacturing technologies. The largest increase was for information and communication technology (145.6%), but it was still below the growth rate for all Sector Subject Areas.

Apprenticeship Programme Starts, over a 10-year period, by Sector Subject Area and level are shown in Table 10.2. Overall, the number of apprenticeships across all Sector Subject Areas has declined by 2.0% in the last year. However, looking at changes by level shows that Intermediate Apprenticeships, which are the majority of all apprenticeships, declined by 11.0%, compared with a rise of 10.5% in Advanced Apprenticeships and an increase of 164.9% for Higher Apprenticeships. For all engineering-related Sector Subject Areas, the decrease in Intermediate Apprenticeships was above average (down by 15.8%), while the increase in Advanced Apprenticeships (5.2%) and Higher Apprenticeships (125.8%) was below average.

Looking at specific engineering-related Sector Subject Areas in 2012/13 shows a decline of 3.5% in the number of Intermediate Apprenticeships in construction, planning and the built environment, and a 4.2% rise in the number of Advanced Apprenticeships. In the same year, there were 60 Apprenticeship Programme Starts at Higher Apprenticeship level. Overall, 23.8% of apprenticeships were at level 3+ in 2012/13, slightly higher than the 21.0% achieved in 2003/04.

For engineering and manufacturing technologies, the number of starts at Intermediate Apprenticeship level declined by 15.0% in 2012/13. For Advanced Apprenticeships, the number of starts increased by 14.3% to 27,470, while there were also 220 starts in Higher Apprenticeships, a rise of 83.3%. However, over ten years, the proportion of Apprenticeship Programme Starts at level 3+ has declined from over half (52.9%) in 2003/04 to just over two in five (41.7%) in 2012/13.

Overall, the number of Apprenticeship Programme Starts in information and communication technology declined by nearly a quarter (23.8%) in 2012/13. Intermediate Apprenticeships declined by more than a third (35.5%), compared with a decline of 16.5% for Advanced Apprenticeships. However, Higher Apprenticeships increased by 121.1% to 420. Over ten years, the proportion of level 3+ apprenticeships has almost doubled, from 31.5% in 2003/04 to 61.5% in 2012/13.

Table 10.1: Apprenticeship Programme Starts by Sector Subject Area (2003/04-2012/13) – England[802 803]

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
Construction, planning and the built environment	20,810	25,000	21,090	27,300	27,200	23,440	20,550	22,420	13,920	13,730	-1.4%	-34.0%
Engineering and manufacturing technologies	38,930	38,280	35,090	37,240	47,220	42,770	42,520	54,640	69,730	66,410	-4.8%	70.6%
Information and communication technology	5,750	6,060	6,490	5,790	6,760	8,820	12,570	19,520	18,520	14,120	-23.8%	145.6%
Subtotal – all engineering related Sector Subject Areas	65,490	69,340	62,670	70,330	81,180	75,030	75,640	96,580	102,170	94,260	-7.7%	43.9%
All engineering related Sector Subject Areas as a proportion of all Sector Subject Areas	33.8%	36.7%	35.8%	38.1%	36.1%	31.3%	27.0%	21.1%	19.6%	18.5%	-5.6%	-45.3%
Science and mathematics	-[804]	-	-	-	-	-	-	10	370	320	-13.5%	
All Sector Subject Areas	193,600	189,000	175,000	184,400	224,800	239,900	279,700	457,200	520,600	510,200	-2.0%	163.5%

Source: The Data Service

800 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%. More information on the Single ILR is available at: http://webarchive.nationalarchives.gov.uk/20140107201041/http://www.thedataservice.org.uk/NR/rdonlyres/C05DCDD5-67EE-4AD0-88B9-BEBC8F7F3300/0/SILR_Effects_SFR_Learners_June12.pdf 801 Sector Subject Areas are a classification of business areas as determined by the Qualification and Curriculum Authority (QCA) 802 Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred. 803 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. 804 – Indicates a base value of less than 5

Table 10.2: Apprenticeship Programme Starts by Sector Subject Area and level (2003/04-2012/13) – England[805 806 807]

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
Construction, planning and the built environment	Intermediate Apprenticeship	16,440	19,810	15,220	20,330	21,020	16,890	14,760	16,020	10,850	10,470	-3.5%	-36.3%
	Advanced Apprenticeship	4,360	5,190	5,870	6,970	6,180	6,560	5,790	6,400	3,080	3,210	4.2%	-26.4%
	Higher Apprenticeship	0	0	0	-[808]	-	-	-	-	-	60		
	All apprenticeships	20,810	25,000	21,090	27,300	27,200	23,440	20,550	22,420	13,920	13,730	-1.4%	-34.0%
	Percentage level 3+	21.0%	20.8%	27.8%	25.5%	22.7%	28.0%	28.2%	28.5%	22.1%	23.8%	12.7%	13.3%
Engineering and manufacturing technologies	Intermediate Apprenticeship	18,330	19,630	19,420	19,180	25,020	22,220	22,620	32,220	45,570	38,720	-15.0%	111.2%
	Advanced Apprenticeship	20,610	18,650	15,670	18,000	22,200	20,540	19,850	22,340	24,040	27,470	14.3%	33.3%
	Higher Apprenticeship	0	0	0	60	-	10	50	80	120	220	83.3%	
	All apprenticeships	38,930	38,280	35,090	37,240	47,220	42,770	42,520	54,640	69,730	66,410	-4.8%	70.6%
	Percentage level 3+	52.9%	48.7%	44.7%	48.5%	47.0%	48.0%	46.8%	41.0%	34.6%	41.7%	20.5%	-21.2%
Information and communication technology	Intermediate Apprenticeship	3,940	4,500	3,310	3,810	4,130	5,000	5,720	8,640	8,430	5,440	-35.5%	38.1%
	Advanced Apprenticeship	1,810	1,560	3,180	1,950	2,570	3,770	6,710	10,830	9,910	8,270	-16.5%	356.9%
	Higher Apprenticeship	0	0	0	20	60	60	140	60	190	420	121.1%	
	All apprenticeships	5,750	6,060	6,490	5,790	6,760	8,820	12,570	19,520	18,520	14,120	-23.8%	145.6%
	Percentage level 3+	31.5%	25.7%	49.0%	34.0%	38.9%	43.4%	54.5%	55.8%	54.5%	61.5%	12.8%	95.2%
Sub-total all engineering related Sector Subject Areas	Intermediate Apprenticeship	38,710	43,940	37,950	43,320	50,170	44,110	43,100	56,880	64,850	54,630	-15.8%	41.1%
	Advanced Apprenticeship	26,780	25,400	24,720	26,920	30,950	30,870	32,350	39,570	37,030	38,950	5.2%	45.4%
	Higher Apprenticeship	0	0	0	80	60	70	190	140	310	700	125.8%	
	All apprenticeships	65,490	69,340	62,670	70,330	81,180	75,030	75,640	96,580	102,170	94,260	-7.7%	43.9%
	Percentage level 3+	40.9%	36.6%	39.4%	38.4%	38.2%	41.2%	43.0%	41.1%	36.5%	42.1%	15.3%	2.9%
Science and mathematics	Intermediate Apprenticeship	-	-	-	-	-	-	-	-	90	70	-22.2%	
	Advanced Apprenticeship	-	-	-	-	-	-	-	10	280	250	-10.7%	
	Higher Apprenticeship	-	-	-	-	-	-	-	10	-	-		
	All apprenticeships	-	-	-	-	-	-	-	10	370	250	-32.4%	
	Percentage level 3+	0	0	0	0	0	0	0	100.0%	75.7%	100.0%	32.1%	
All Sector Subject Areas	Intermediate Apprenticeship	136,600	135,100	122,800	127,400	151,800	158,500	190,500	301,100	329,000	292,800	-11.0%	114.3%
	Advanced Apprenticeship	57,000	53,900	52,100	56,900	72,900	81,300	87,700	153,900	187,900	207,700	10.5%	264.4%
	Higher Apprenticeship	0	0	0	100	100	200	1,500	2,200	3,700	9,800	164.9%	
	All apprenticeships	193,600	189,000	175,000	184,400	224,800	239,900	279,700	457,200	520,600	510,200	-2.0%	163.5%
	Percentage level 3+	29.4%	28.5%	29.8%	30.9%	32.5%	34.0%	31.9%	34.1%	36.8%	42.6%	15.8%	44.9%

Source: The Data Service

805 Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred. 806 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. 807 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%. 808 - Indicates a base value of less than 5

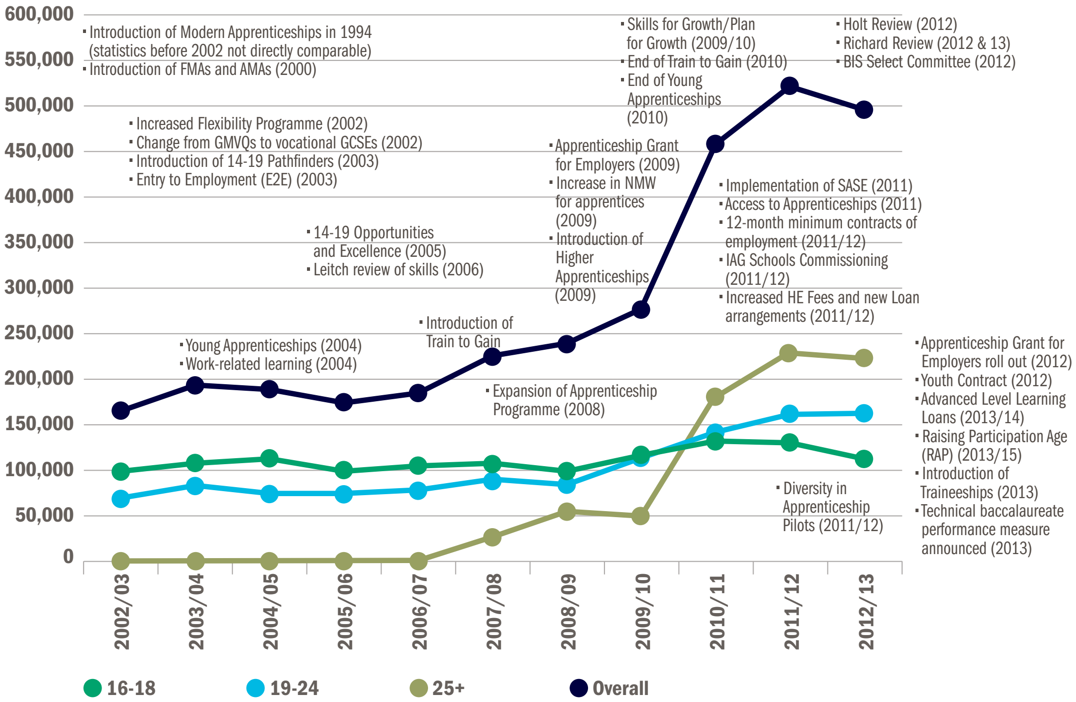
Figure 10.0 shows the impact that different policy initiatives have had on Apprenticeship Programme Starts by age. From a base of 300 amongst the cohort aged 25+ in 2006/07, the number of starts has risen very rapidly: by 2009/10, it had become the largest age cohort and by 2012/13 it reached 230,300. Between 2002/03 and 2012/13, the number of Apprenticeship Programme Starts for those aged 16-18 decreased, while the number of starts amongst those aged 19-24 almost doubled.

The Institute for Employment Studies has also shown that the mean starting aged for intermediate apprentices in 2007/08 was 20.1 years, but by 2011/12 this had risen to 26.8 years. For advanced and higher level apprentices, the mean age in 2007/08 was 22.3 but by 2011/12 it had reached 28.8 years.[810]

Table 10.3 shows the age of Apprenticeship Programme Starts by level and Sector Subject Area for 2012/13. Just over a third (38.6%) of starts for Intermediate Apprenticeships across all Sector Subject Areas were from students aged 25+. The comparable figure for Advanced Apprenticeships is just over a half (53.2%) and for Higher Apprenticeships it is over two thirds (69.4%). However, the proportions for all engineering-related Sector Subject Areas are lower, at a third (32.5%) for Intermediate Apprenticeships, just over a fifth (22.1%) for Advanced Apprenticeships and one in ten (10.0%) for Higher Apprenticeships.

The different engineering-related Sector Subject Areas fall into two distinct groups. One in 11 (9.0%) intermediate apprentices for construction, planning and the built environment were aged 25+, compared with 14.0% for Advanced Apprenticeships and a third (33.3%) for Higher Apprenticeships. By comparison, for engineering and manufacturing technologies and information and communication technology, over a third (38.0% and 38.4% respectively) of Intermediate Apprenticeship starts are aged 25+. For Advanced Apprenticeships, around a fifth (21.5%) of those starting engineering and manufacturing technologies and about a quarter (27.3%) starting information and communication technology apprenticeships were aged 25+. For Higher Apprenticeships, the proportion of over-25s is very low for both engineering and manufacturing technologies and information and communication technology (9.1% and 7.1% respectively).

Fig. 10.0: Apprenticeship starts and policy initiatives by age (2002/03-2012/13)



Source: Institute for Employment Studies[809]

809 *Research into under-representation, by gender and race, in Apprenticeships*, Institute for Employment Studies, 2013, p7 **810** *Research into under-representation, by gender and race, in Apprenticeships*, Institute for Employment Studies, 2013, p35

Table 10.3: Apprenticeship Programme Starts by Sector Subject Area, level and age (2012/13) – England[811]

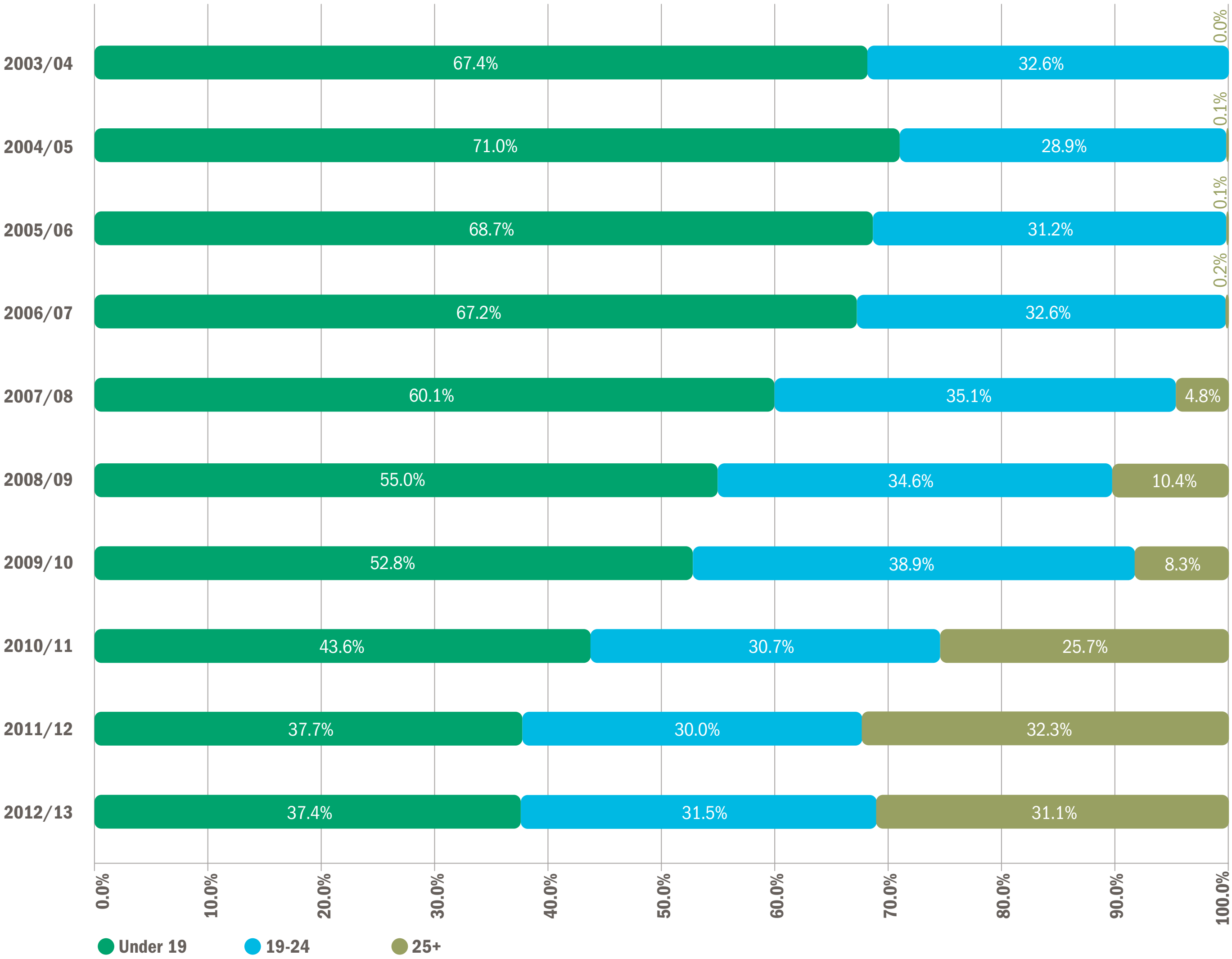
	Age	Intermediate Apprenticeship	Advanced Apprenticeship	Higher Apprenticeship	All apprenticeships
Construction, planning and the built environment	Under 19	6,530	1,280	10	7,820
	19-24	3,000	1,480	30	4,510
	25+	940	450	20	1,410
	All ages	10,470	3,210	60	13,730
	Percentage of all apprentices aged 25+	9.0%	14.0%	33.3%	10.3%
Engineering and manufacturing technologies	Under 19	13,580	11,160	90	24,820
	19-24	10,410	10,420	110	20,950
	25+	14,730	5,900	20	20,640
	All ages	38,720	27,470	220	66,410
	Percentage of all apprentices aged 25+	38.0%	21.5%	9.1%	31.1%
Information and communication technology	Under 19	1,790	3,020	130	4,940
	19-24	1,560	2,990	260	4,810
	25+	2,090	2,260	30	4,380
	All ages	5,440	8,270	420	14,120
	Percentage of all apprentices aged 25+	38.4%	27.3%	7.1%	31.0%
Sub-total all engineering related Sector Subject Areas	Under 19	21,900	15,460	230	37,580
	19-24	14,970	14,890	400	30,270
	25+	17,760	8,610	70	26,430
	All ages	54,630	38,950	700	94,260
	Percentage of all apprentices aged 25+	32.5%	22.1%	10.0%	28.0%
Science and mathematics	Under 19	10	120	-[812]	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	80,900	33,100	600	114,500
	19-24	99,000	63,900	2,400	165,400
	25+	112,900	110,600	6,800	230,300
	All ages	292,800	207,700	9,800	510,200
	Percentage of all apprentices aged 25+	38.6%	53.2%	69.4%	45.1%

Source: The Data Service

811 Age is calculated based on age at start of the programme rather than based on 31 August. 812 - Indicates a base value of less than 5

The proportion of Apprenticeship Programme Starts by age over a 10-year period is shown in Figure 10.1. The proportion of under-19s starting apprenticeships fell from two thirds (67.4%) in 2003/04 to a third (37.4%) in 2012/13. At the same time, the proportion of over-25s starting apprenticeships rose from 0.1% in 2004/05 to 31.1% in 2012/13. Table 10.3 shows that in 2012/13, most of the over 25s were enrolled on Intermediate Apprenticeships.

Fig. 10.1: Apprenticeship Programme Starts in engineering and manufacturing technologies by age (2003/04-2012/13) – England[813 814 815 816]



Source: The Data Service

813 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. 814 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%. 815 Age is calculated based on age at start of the programme rather than based on 31 August. 816 Values less than 5 have been set to zero for this chart

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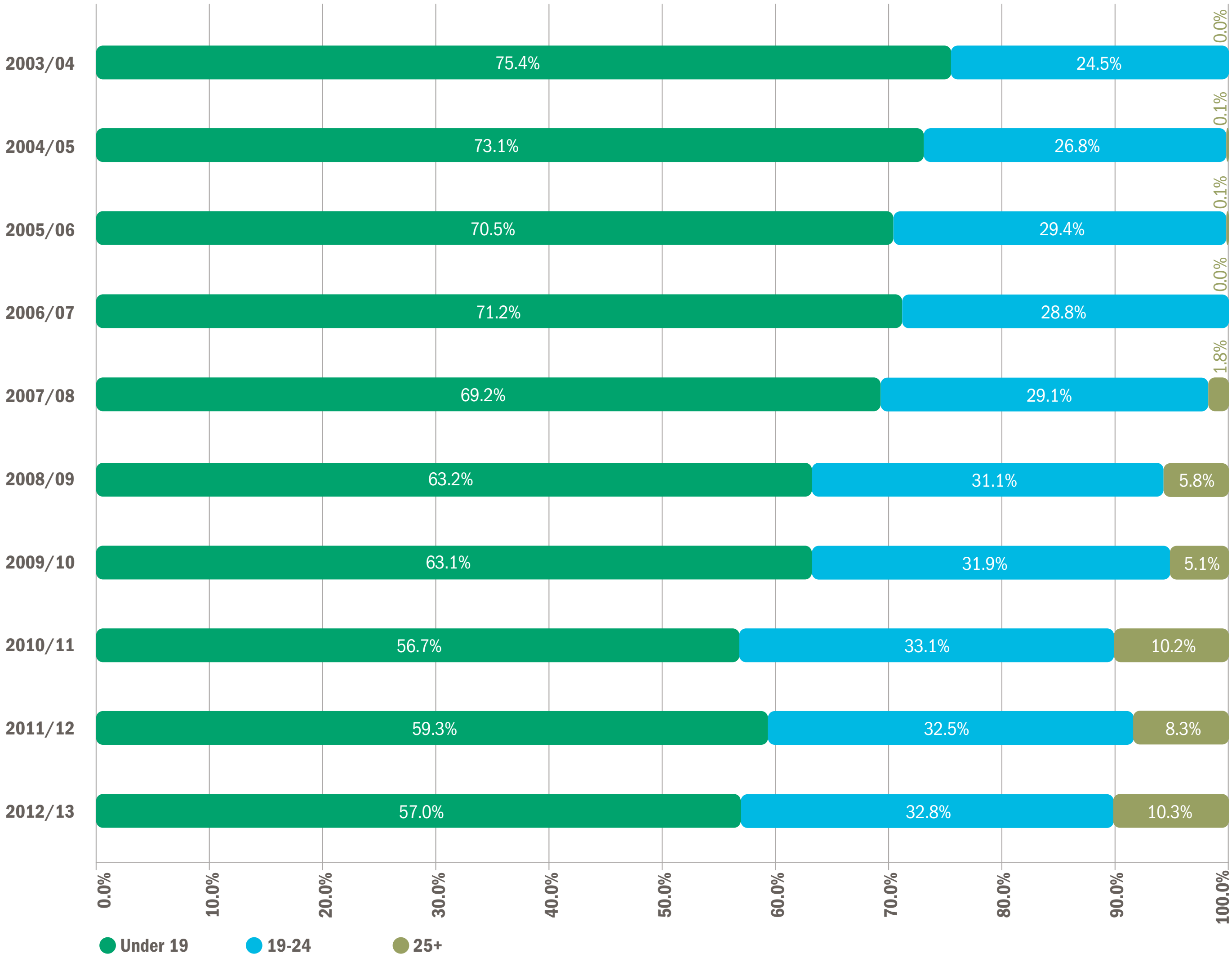
The proportion of Apprenticeship Programme Starts in construction, planning and the built environment for under-19s fell from three quarters (75.4%) in 2003/04 to over half (57.0%) in 2012/13 (Figure 10.2). At the same time, the proportion of 16- to 24-year-olds starting apprenticeships in this subject grew from 24.5% in 2003/04 to 32.8% in 2012/13. However, over-25s accounted for only one in ten (10.3%) starts in 2012/13.

Fig. 10.2: Apprenticeship Programme Starts in construction, planning and the built environment by age (2003/04-2012/13) – England[817 818 819 820]

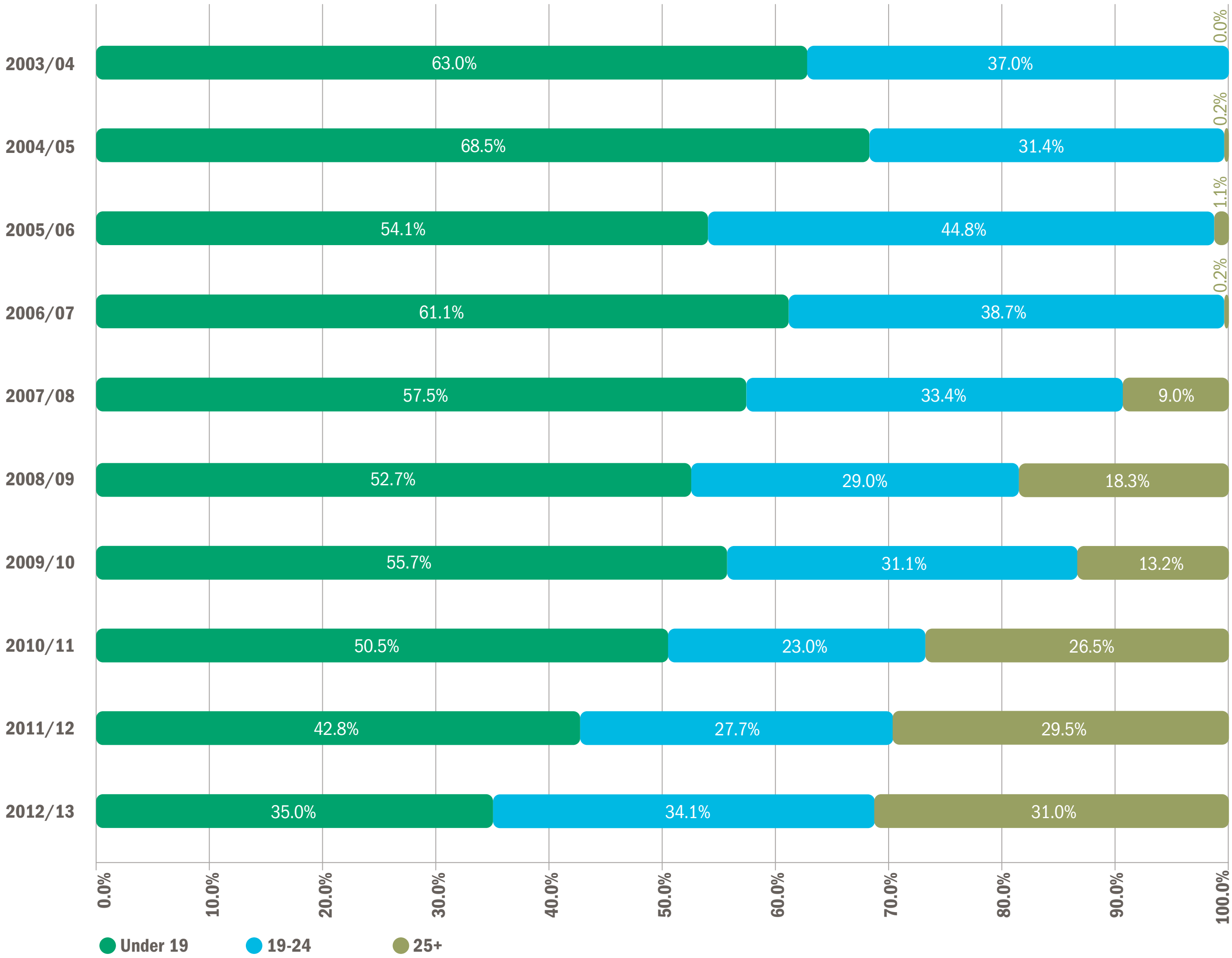


Source: The Data Service

817 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. 818 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%. 819 Age is calculated based on age at start of the programme rather than based on 31 August. 820 Values less than 5 have been set to zero for this chart

In 2003/04, under-19s accounted for two thirds (63.0%) of Apprenticeship Programme Starts in information and communication technology, with one third (37.0%) made up of the 19-24 age group (Figure 10.3). By 2012/13, the profile had changed so that approximately a third of starts came from each of the three age categories (under-19s at 35.0%, 19- to 24-year-olds at 34.1% and over-25s at 31.0%). Table 10.3 shows that in 2012/13, 2,090 students starting Intermediate Apprenticeships were over 25. For Advanced Apprenticeships, the comparable figure was 2,260.

Fig. 10.3: Apprenticeship Programme Starts in information and communication technology by age (2003/04-2012/13) – England[821 822 823 824]



Source: The Data Service

821 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. 822 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%. 823 Age is calculated based on age at start of the programme rather than based on 31 August. 824 Values less than 5 have been set to zero for this chart

Table 10.4 shows the number of Apprenticeship Programme Starts by Sector Subject Area and region in 2012/13. Construction, planning and the built environment was most popular in the North West, with 2,170 starts, followed by the South West (1,980). For engineering and manufacturing technologies, the South East had the most starts (10,380), followed by the West Midlands (9,730) and the North West (9,250). For information and communication technology, the highest number of starts was in the South East (2,580), followed by the North West (13,340) and the South West (1,900).

At the time of going to print, the provisional[830] 2013/14 figures for Apprenticeship Programme Starts, August to April, were as follows:

- construction, planning and the built environment – 13,320
- engineering and manufacturing technologies – 51,320
- information and communication technology – 9,240

Table 10.4: Apprenticeship Programme Starts by region and Sector Subject Area (2012/13) – England[825 826 827 828]

	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	1,190	2,170	1,490	1,220	1,300	990	980	1,800	1,980	13,100
Engineering and manufacturing technologies	4,650	9,250	7,560	6,580	9,730	5,880	4,190	10,380	7,300	65,500
Information and communication technology	970	1,920	1,750	850	1,750	1,090	1,210	2,580	1,900	14,000
Sub-total all engineering related Sector Subject Areas	6,810	13,340	10,800	8,650	12,780	7,960	6,380	14,760	11,180	92,600
Science and mathematics	30	80	40	20	30	60	-[829]	40	20	300
All Sector Subject Areas	35,870	84,180	59,900	49,010	62,430	46,220	45,070	68,960	52,540	504,200

Source: The Data Service

825 Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred. 826 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. 827 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 828 These figures are based on the geographic boundaries of regions as of May 2010 829 - Indicates a base value of less than 5 830 Provisional data is taken from an operational information system which is designed to support the funding of providers and there are some important limitations. The size of revision to individual estimates that arise from the data lag in provisional data can vary greatly. They tend to be around 2 to 3 percent but have been as much as 15 percent. Provisional data can also increase or decrease in the final full-year data.

10.1.3 Apprenticeship participation

Table 10.5 shows participation in funded apprenticeships by Sector Subject Area for the last two years. Although participation across all Sector Subject Areas has increased by 7.7%, participation across engineering-related Sector Subject Areas has declined by 3.5%. Construction planning and the built environment was down by 15.6% and information and communication technology fell by 2.7%. Engineering and manufacturing technologies, however, bucked the trend and grew by 10.3%. Finally, the table shows that in 2012/13 just over a fifth (22.1%) of all participation was in engineering-related Sector Subject Areas.

Table 10.6 shows participation rates for apprenticeships by region and Sector Subject Area in 2012/13. Construction, planning and the built environment saw the largest level of participation in the North West (4,590), followed by the South West (3,770) and the South East (3,550).

For engineering and manufacturing technologies, the largest number of participants was in the South East (21,470), followed by the North West (19,710) and the West Midlands (19,270).

Table 10.5: Funded apprenticeship participation by Sector Subject Area (2011/12-2012/13) – England[831 832]

	2011/12	2012/13	Change over one year
Construction, planning and the built environment	32,650	27,570	-15.6%
Engineering and manufacturing technologies	125,740	138,700	10.3%
Information and communication technology	26,630	25,920	-2.7%
Sub-total all engineering related Sector Subject Areas	185,020	192,190	3.9%
All engineering related Sector Subject Areas as a proportion of all Sector Subject Areas	22.9%	22.1%	-3.5%
Science and mathematics	370	620	67.6%
All Sector Subject Areas	806,500	868,700	7.7%

Source: The Data Service

For information and communication technology, the highest level of participation was in the South West (4,580), followed by the North West (3,420) and Yorkshire and the Humber (3,390).

This means that the North West had the largest level of participation for construction, planning and the built environment and the second largest participation for engineering and manufacturing technologies and information and communication technology.

At the same time, it is also interesting to note that London has the lowest level of apprenticeship participation for both construction, planning and the built environment (1,970) and for engineering and manufacturing technologies (9,070). Similarly, if you look at all Sector Subject Areas, London has the second lowest level of participation (77,110), with only the North East being smaller (61,230).

Table 10.6: Apprenticeship participation by region and Sector Subject Area (2012/13) – England[833 834 835 836 837]

	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	2,270	4,590	2,920	2,670	2,670	2,300	1,970	3,550	3,770	26,700
Engineering and manufacturing technologies	9,990	19,710	15,640	13,490	19,270	12,470	9,070	21,470	15,690	136,800
Information and communication technology	1,590	3,420	3,390	1,480	2,890	2,120	2,330	3,910	4,580	25,700
Sub-total all engineering related Sector Subject Areas	13,850	27,720	21,950	17,640	24,830	16,890	13,370	28,930	24,040	189,200
Science and mathematics	60	140	90	30	60	90	10	90	50	600
All Sector Subject Areas	61,230	143,810	103,820	80,810	103,730	78,970	77,110	116,960	92,280	858,700

Source: The Data Service

831 Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred. **832** Totals do not sum as an Apprentice can participate in more than one Sector Subject Area in one academic year. **833** Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred. **834** 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. **835** 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 **836** These figures are based on the geographic boundaries of regions as of May 2010 **837** 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 10.7 shows some experimental statistics from The Data Service on the duration of apprenticeships in different Sector Subject Areas and by level for 2011/12. The adjusted measure is a better measure of apprenticeship duration, as those with some prior attainment are excluded from the figures. It shows that for all Sector Subject Areas, the adjusted average length of an Advanced and Higher Apprenticeship is 16 months.

Comparing the different engineering-related Sector Subject Areas to this overall figure shows that the comparable figure for construction, planning and the built environment is 28 months, while for engineering and manufacturing technologies it is 27 months – both of which are well above the average. However, for information and communication technology the adjusted average is 11 months – below the average for all Sector Subject Areas.

Table 10.7: Apprenticeship Framework Achievements by average length of stay (months), length and Sector Subject Area (2011/12) – England[838 839]

	Level	Average length of stay (months)[840]	Average length of stay (months – adjusted)[841]
Construction, planning and the built environment	Intermediate Apprenticeship	19	19
	Advanced and Higher Apprenticeship	26	28
	All apprenticeships	**22**	**23**
Engineering and manufacturing technologies	Intermediate Apprenticeship	13	13
	Advanced and Higher Apprenticeship	25	27
	All apprenticeships	**17**	**17**
Information and communication technology	Intermediate Apprenticeship	9	10
	Advanced and Higher Apprenticeship	10	11
	All apprenticeships	**10**	**10**
Science and mathematics	Intermediate Apprenticeship	-	-
	Advanced and Higher Apprenticeship	7	-
	All apprenticeships	7	-
All Sector Subject Areas	Intermediate Apprenticeship	11	11
	Advanced and Higher Apprenticeship	16	16
	All apprenticeships	**12**	**13**

Source: The Data Service

838 This data is not part of the main National Statistics First Release 839 Average length captures the time registered on a programme will not necessarily reflect the guided learning hours or the actual length of time in learning. For these reasons, and given other key factors, it should be seen as contributory information to any broader assessment of the apprenticeship experience and quality. 840 Average length captures the time registered on a programme. This will not necessarily reflect the guided learning hours or the actual length of time in learning. For these reasons, and given other key factors, it should be seen as contributory information to any broader assessment of the apprenticeship experience and quality. 841 The adjusted measure is intended to exclude those apprentices with some prior attainment, as they are unlikely to be fully funded. It does not account for breaks in courses or transfers onto other courses, which could also affect the length of time taken to complete an apprenticeship. The adjusted measure is a more accurate reflection of the average apprenticeship length, however The Data Service is continuing work to improve the accuracy of this measure.

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10.1.4 Framework Achievements[842]

Table 10.8 shows the number of achievements in different Sector Subject Areas over a 10-year period. The methodology for counting Framework Achievements changed in 2011/12, reducing overall learner numbers by around 2%. Despite this, the table shows that over the 10-year period, there has been growth in all apprenticeship achievements of 413.0%, with achievements rising from 49,300 in 2003/04 to 252,900 in 2012/13.

Looking at all engineering-related Sector Subject Areas over 10 years shows growth at around half the rate of that for all achievements (+227.6% compared with +413.0%). In addition, if you just look at changes in the last year, the decline in all engineering-related Sector Subject Areas is around double that of all achievements (-4.8% compared with -2.1%). The result of this is that in 2003/04, engineering-related Sector Subject Areas contributed a third (33.3%) of all achievements, but by 2012/13 this had declined to a fifth (21.3%).

Looking at specific engineering-related Sector Subject Areas shows that engineering and manufacturing technologies had the highest growth over 10 years (+258.9%) – but this is still behind the growth for all achievements. In addition, it is the only one of the three engineering-related Sector Subject Areas to have grown in 2012/13 (up 7.6%). In fact, in all of the last 10 years it has been the largest of the engineering-related Sector Subject Areas.

Information and communication technology grew by 206.9% over the period. However, it was the smallest of the three engineering-related Sector Subject Areas in each of the 10 years. In 2012/13, the number of achievements in information and communication technology fell by a fifth (-19.4%).

Construction, planning and the built environment had the lowest growth of the three engineering-related Sector Subject Areas over 10 years (+151.7%). In addition, the number of achievements in 2012/13 fell by over a quarter (-28.1%).

Table 10.8: Apprenticeship achievements by Sector Subject Area (2003/04-2012/13) – England[843]

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
Construction, planning and the built environment	3,600	6,900	12,070	16,160	17,080	18,980	16,890	14,240	12,600	9,060	-28.1%	151.7%
Engineering and manufacturing technologies	10,360	15,330	22,310	23,640	22,500	26,230	30,030	31,190	34,550	37,180	7.6%	258.9%
Information and communication technology	2,470	2,870	3,930	4,140	4,820	5,670	7,770	10,510	9,400	7,580	-19.4%	206.9%
Sub-total all engineering related Sector Subject Areas	16,430	25,100	38,310	43,940	44,400	50,880	54,690	55,940	56,550	53,820	-4.8%	227.6%
All engineering related Sector Subject Areas as a proportion of all Sector Subject Areas	33.3%	37.4%	38.8%	39.3%	39.4%	35.5%	31.9%	27.9%	21.9%	21.3%	-2.7%	-36.0%
Science and mathematics	-	-	-	-	-	-	-	-	10	120	1,100.0%	
All Sector Subject Areas	49,300	67,200	98,700	111,800	112,600	143,400	171,500	200,300	258,400	252,900	-2.1%	413.0%

Source: The Data Service

842 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%. 843 Volumes are rounded to the nearest ten except for the grand totals which are rounded to the nearest hundred.

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 industry, which needs to harness technical talent.

The engineering profession has welcomed the introduction and development of a wide range of Trailblazer Apprenticeships,[844] whereby the standards set by employers will align with the established and respected UK Standard for Professional Engineering Competence (UK-SPEC).[845]

The development of phase 1 and 2 Trailblazer Apprenticeships has demonstrated a clear change in approach by employers. Although the underpinning qualifications to develop technical knowledge and competence have generally remained in place or been enhanced, the step change comes through inclusion of professional behaviours within the new standards.

This approach to creating and underpinning apprenticeship standards with UK-SPEC 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 now be recognised through use of the Engineering Council Approved Apprenticeship logo. All approved qualifications and apprenticeships are listed on the Engineering Council's website.[846]

Engineering Council approved qualification

Engineering Council cymhwyster cymeradwy

The ability for individuals to identify approved pathways, and to more readily achieve professional registration upon completion, will provide an opportunity to attract and develop a pipeline of younger professionally-registered technicians and engineers in the future.

Achieving registered status through demonstrating the standards of competence and commitment in UK-SPEC 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 'tradeability' 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.

The 10-year trend in Apprenticeship Achievements by level and Sector Subject Area is shown in Table 10.9. Across all Sector Subject Areas over 10 years there has been an increase of 379.4% in Intermediate Apprenticeship achievements, while Advanced Apprenticeships have increased by 468.9%. However, looking at just 2012/13 shows that Intermediate Apprenticeships declined by 9.3%, compared with a 12.2% rise of Advanced Apprenticeships.

Across all engineering-related Sector Subject Areas, Intermediate Apprenticeships have increased by 327.1%, while Advanced Apprenticeships have increased by 134.3%. This therefore shows that while growth in engineering-related Apprenticeship Achievements has been below average, Advanced Apprenticeships has performed particularly poorly in comparison to all achievements.

Examining achievements in engineering and manufacturing technologies shows that intermediate level achievements have increased by 564.5% over 10 years, which is well above the average for all achievements. However, Advanced Apprenticeships have only increased by 96.9%, which is well below the average for all achievements. The net effect has been that in 2003/04, two thirds (65.5%) of all achievements were at level 3+, but by 2012/13 this had declined to a third (36.0%).

Overall, Apprenticeship Achievements for construction, planning and the built environment have increased by 151.7% over 10 years. Intermediate Apprenticeship Achievements have increased by just above the average for the Sector Subject Area (158.3%), compared with 137.0% for Advanced Apprenticeships. The proportion of achievements at level 3+ was 30.0% in 2003/04 and has fluctuated over the 10 years to reach 28.3% in 2012/13. Finally, it should be noted that in the last year achievements in Advanced Apprenticeships have declined by 41.0%, while Intermediate Apprenticeships have declined by 21.3%.

The 10-year trend for information and communication technology is different to the other two engineering-related Sector Subject Areas. Advanced Apprenticeships have increased by 498.6% over 10 years, which is well above average for all achievements, while Intermediate Apprenticeship achievements have increased by 89.9%, which is well below the average for all Sector Subject Areas. The net effect has been that the proportion of achievements at level 3+ has almost doubled from 27.9% in 2003/04 to 55.1% in 2012/13.

844 https://www.gov.uk/government/publications/future-of-apprenticeships-in-england-guidance-for-trailblazers **845** www.engc.org.uk/ukspec **846** www.engc.org.uk/techdb

Table 10.9: Apprenticeship achievements by Sector Subject Area and level (2003/04-2012/13) – England[847]

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
Construction, planning and the built environment	Intermediate Apprenticeship	2,520	5,570	9,660	12,330	12,370	13,650	11,340	9,110	8,270	6,510	-21.3%	158.3%
	Advanced Apprenticeship	1,080	1,330	2,410	3,830	4,710	5,340	5,550	5,130	4,340	2,560	-41.0%	137.0%
	Higher Apprenticeship	0	0	0	0	-[848]	-	-	-	-	-		
	All apprenticeships	3,600	6,900	12,070	16,160	17,080	18,980	16,890	14,240	12,600	9,060	-28.1%	151.7%
	Percentage level 3+	30.0%	19.3%	20.0%	23.7%	27.6%	28.1%	32.9%	36.0%	34.4%	28.3%	-17.7%	-5.7%
Engineering and manufacturing technologies	Intermediate Apprenticeship	3,580	6,900	10,410	11,600	11,180	13,870	15,300	15,830	20,130	23,790	18.2%	564.5%
	Advanced Apprenticeship	6,790	8,430	11,910	12,040	11,320	12,350	14,720	15,360	14,400	13,370	-7.2%	96.9%
	Higher Apprenticeship	0	0	0	0	-	10	20	-	20	20	0.0%	
	All apprenticeships	10,360	15,330	22,310	23,640	22,500	26,230	30,030	31,190	34,550	37,180	7.6%	258.9%
	Percentage level 3+	65.5%	55.0%	53.4%	50.9%	50.3%	47.1%	49.1%	49.2%	41.7%	36.0%	-13.7%	-45.0%
Information and communication technology	Intermediate Apprenticeship	1,790	1,790	2,800	3,020	2,540	3,290	3,930	4,130	4,680	3,400	-27.4%	89.9%
	Advanced Apprenticeship	690	1,090	1,140	1,120	2,290	2,380	3,830	6,320	4,680	4,130	-11.8%	498.6%
	Higher Apprenticeship	0	0	0	0	-	-	20	60	40	50	25.0%	
	All apprenticeships	2,470	2,870	3,930	4,140	4,820	5,670	7,770	10,510	9,400	7,580	-19.4%	206.9%
	Percentage level 3+	27.9%	38.0%	29.0%	27.1%	47.5%	42.0%	49.5%	60.7%	50.2%	55.1%	9.8%	97.5%
Sub-total all engineering related Sector Subject Areas	Intermediate Apprenticeship	7,890	14,260	22,870	26,950	26,090	30,810	30,570	29,070	33,080	33,700	1.9%	327.1%
	Advanced Apprenticeship	8,560	10,850	15,460	16,990	18,320	20,070	24,100	26,810	23,420	20,060	-14.3%	134.3%
	Higher Apprenticeship	0	0	0	0	-	10	40	60	60	70	16.7%	
	All apprenticeships	16,430	25,100	38,310	43,940	44,400	50,880	54,690	55,940	56,550	53,820	-4.8%	227.6%
	Percentage level 3+	52.1%	43.2%	40.4%	38.7%	41.3%	39.5%	44.1%	48.0%	41.5%	37.4%	-9.9%	-28.2%
Science and mathematics	Intermediate Apprenticeship	-	-	-	-	-	-	-	-	-	50		
	Advanced Apprenticeship	-	-	-	-	-	-	-	-	10	60	500.0%	
	Higher Apprenticeship	0	0	0	0	0	0	0	0	0	-		
	All apprenticeships	-	-	-	-	-	-	-	-	10	120	1100.0%	
	Percentage level 3+									100.0%	50.0%	-50.0%	
All Sector Subject Areas	Intermediate Apprenticeship	32,600	48,400	70,300	78,400	76,300	98,100	111,900	131,700	172,400	156,300	-9.3%	379.4%
	Advanced Apprenticeship	16,700	18,900	28,400	33,400	36,200	45,200	59,400	67,500	84,700	95,000	12.2%	468.9%
	Higher Apprenticeship	0	0	0	0	-	-	200	1,000	1,200	1,600	33.3%	
	All apprenticeships	49,300	67,200	98,700	111,800	112,600	143,400	171,500	200,300	258,400	252,900	-2.1%	413.0%
	Percentage level 3+	33.9%	28.1%	28.8%	29.9%	32.1%	31.5%	34.6%	34.2%	33.2%	38.2%	15.1%	12.7%

Source: The Data Service

847 Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred. 848 - Indicates a base value of less than 5

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Table 10.10 shows the number of Apprenticeship Achievements by age, level and Sector Subject Area. Overall, two in five (42.5%) of all Intermediate Apprenticeship achievements are from apprentices aged 25+, while for Advanced Apprenticeships it is nearly half (48.1%). However, Higher Apprenticeships had the lowest proportion of achievements by over-25s, at just over a third (37.5%) of 1,600.

Across all engineering-related Sector Subject Areas, two in five (39.5%) intermediate Apprenticeship Achievements were from apprentices aged 25+. However, the proportion of over-25s who achieved an Advanced Apprenticeship or Higher Apprenticeship is much lower than the average for all achievements (16.5% and 14.3% respectively).

For construction, planning and the built environment, around one in 11 of those achieving either an Intermediate Apprenticeship (8.0%) or Advance Apprenticeship (9.0%) were aged 25+. The pattern for the other two engineering-related Sector Subject Areas was quite different. For engineering and manufacturing technologies, nearly half (47.7%) of intermediate Apprenticeship Achievements were from people aged over 25, which is above the average for all achievements. However, only 14.1% of Advanced Apprenticeship achievements came from over-25s. Finally, two in five (42.6%) of those achieving an Intermediate Apprenticeship in information and communication technology were aged over 25, but this falls to 28.8% for those achieving an Advanced Apprenticeship – well below average.

Table 10.10: Apprenticeship achievements by Sector Subject Area, level and age (2012/13) – England[849]

	Age	Intermediate Apprenticeship	Advanced Apprenticeship	Higher Apprenticeship	All apprenticeships
Construction, planning and the built environment	Under 19	4,260	990	-[850]	5,250
	19-24	1,730	1,340	-	3,070
	25+	520	230	-	750
	All ages	6,510	2,560	-	9,060
	Percentage of all apprentices aged 25+	8.0%	9.0%		8.3%
Engineering and manufacturing technologies	Under 19	6,880	6,150	10	13,040
	19-24	5,570	5,330	10	10,910
	25+	11,340	1,890	-	13,240
	All ages	23,790	13,370	20	37,180
	Percentage of all apprentices aged 25+	47.7%	14.1%		35.6%
Information and communication technology	Under 19	1,020	1,540	10	2,580
	19-24	930	1,400	30	2,360
	25+	1,450	1,190	10	2,650
	All ages	3,400	4,130	50	7,580
	Percentage of all apprentices aged 25+	42.6%	28.8%	20.0%	35.0%
Sub-total all engineering related Sector Subject Areas	Under 19	12,160	8,680	20	20,870
	19-24	8,230	8,070	40	16,340
	25+	13,310	3,310	10	16,640
	All ages	33,700	20,060	70	53,820
	Percentage of all apprentices aged 25+	39.5%	16.5%	14.3%	30.9%
Science and mathematics	Under 19	20	20	-	50
	19-24	10	20	-	30
	25+	20	20	-	40
	All ages	50	60	-	120
	Percentage of all apprentices aged 25+	40.0%	33.3%		33.3%
All Sector Subject Areas	Under 19	42,100	18,600	100	60,800
	19-24	47,700	30,800	800	79,300
	25+	66,500	45,700	600	112,800
	All ages	156,300	95,000	1,600	252,900
	Percentage of all apprentices aged 25+	42.5%	48.1%	37.5%	44.6%

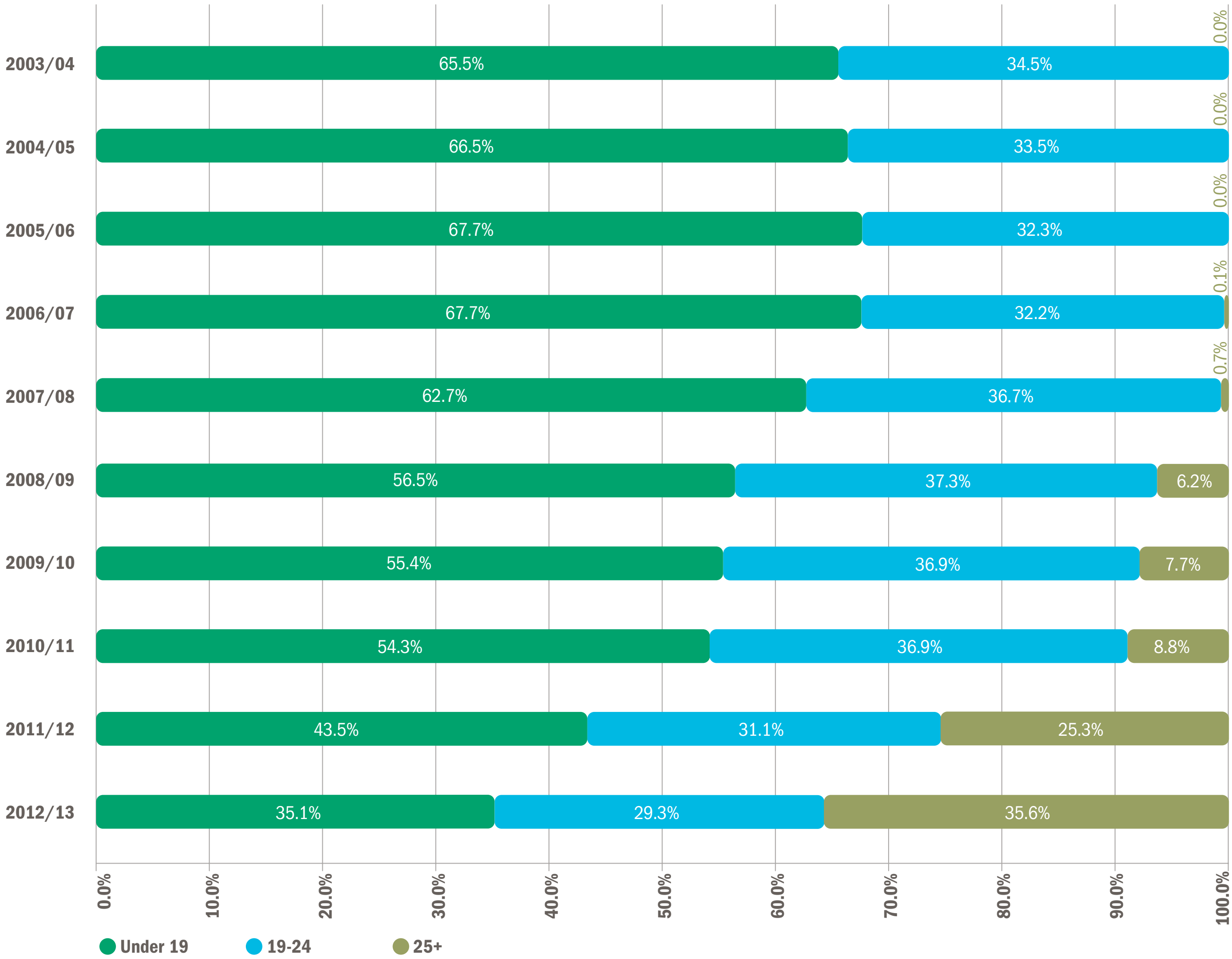
Source: The Data Service

849 Volumes are rounded to the nearest ten except for the grand totals which are rounded to the nearest hundred. 850 - Indicates a base value of less than 5

Figure 10.4 shows the 10-year trend in the proportion of Apprenticeship Achievements by the different age groups for engineering and manufacturing technologies. In 2003/04, two thirds (65.5%) of achievements were from under-19s and a third (34.5%) from 19- to 24-year-olds. By 2012/13 the pattern had changed to one where approximately a third of all achievements were from people in each of the three age groups: under 19 (35.1%), 19-24 (29.3%) and 25+ (35.6%). However, Table 10.7 shows that in 2012/13 there were 11,340 achievements by those aged over 25 for Intermediate Apprenticeships, compared with 1,890 for Advanced Apprenticeships.

Figure 10.5 shows the 10-year trend in the proportion of achievements for construction, planning and the built environment by age. In 2003/04, three quarters (76.9%) of achievements were from students aged under 19, with just under a quarter (23.1%) from those aged 19-24. By 2012/13, the proportion of those aged under 19 had declined to just over half (57.9%), while those aged 19-24 had increased to a third (33.9%) and over 25s represented just 8.3% of achievements.

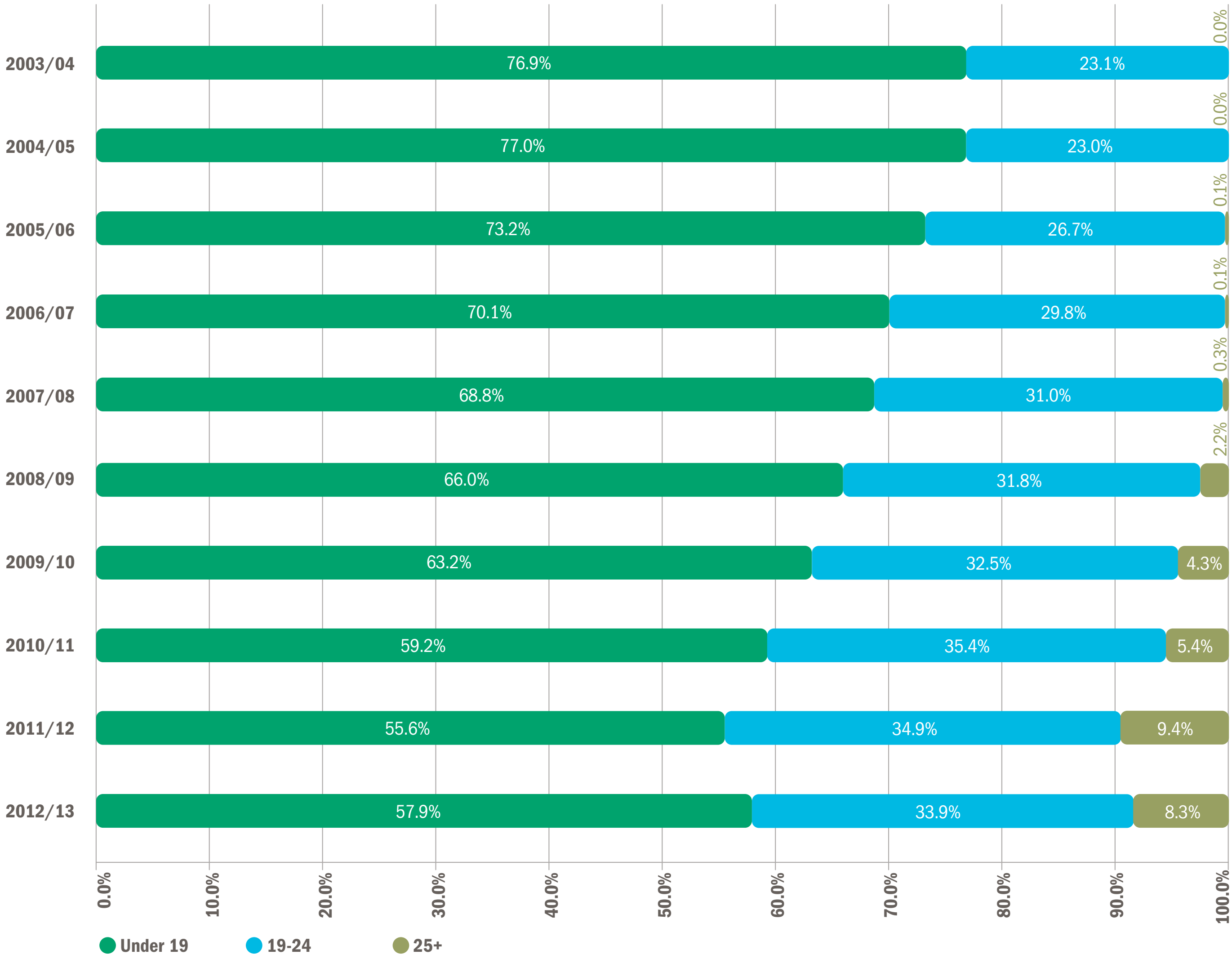
Fig. 10.4: Apprenticeship achievements in engineering and manufacturing technologies by age (2003/04-2012/13) – England[851 852]



Source: The Data Service

851 Age is calculated based on age at start of the programme rather than based on 31 August 852 Values less than 5 have been set to zero for this chart

Fig. 10.5: Apprenticeship achievements in construction, planning and the built environment by age (2003/04-2012/13) – England[853 854]



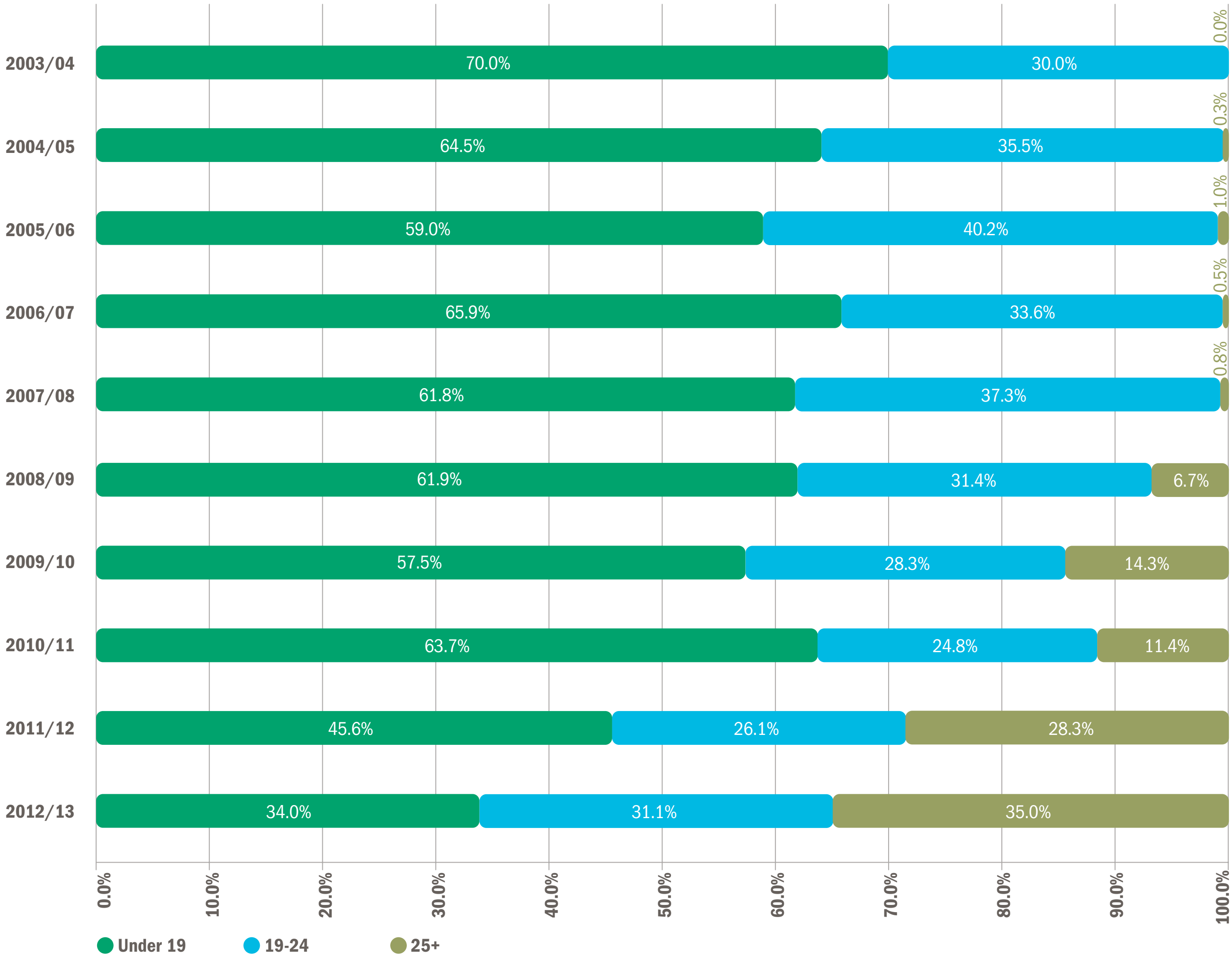
Source: The Data Service

853 Age is calculated based on age at start of the programme rather than based on 31 August 854 Values less than 5 have been set to zero for this chart

The profile of achievements in information and communication technology over 10 years by age is shown in Figure 10.6. In 2003/04, nearly three quarters (70.0%) of achievements were from under 19s, while a third (30.0%) were from 19- to 24-year-olds.

By 2012/13, the profile had completely changed, with approximately a third of achievements occurring in each of the three age categories: under 19 (34.0%), 19-24 (31.1%) and 25+ (35.0%). Table 10.7 shows that in 2012/13, two in five (42.6%) of those achieving an Intermediate Apprenticeship were over 25, compared with a quarter (28.8%) of those getting an achievement in an Advanced Apprenticeship.

Fig. 10.6: Apprenticeship achievements in information and communication technology by age (2003/04-2012/13) – England[855 856]



Source: The Data Service

855 Age is calculated based on age at start of the programme rather than based on 31 August 856 Values less than 5 have been set to zero for this chart

Table 10.11 shows Apprenticeship Achievements for all Sector Subject Areas by provider type and age in 2011/12. It shows that for all three age groups, over half of all Advanced and Higher Apprenticeships were delivered by private sector bodies that are publicly funded, with general FE Colleges (including tertiary colleges) being the second largest provider.

Research by Ofsted[857] has shown that apprenticeship training for construction was weaker in FE Colleges because employers had problems planning onsite training to accompany the training being provided by the college.

10.1.5 Success rates[865 866]

Figure 10.7 shows the apprenticeship success rates for the three engineering related Sector Subject areas and science and maths in 2012/13 by level.

It shows that for each Sector Subject Area the success rate increases as the level increases so Higher Apprenticeships have the highest success rate followed by Advanced Apprenticeships and then Intermediate Apprenticeships.

The highest overall success rate was for Higher Apprenticeships in information and communication technology (90.0%). By comparison the lowest success rate level was for Intermediate Apprenticeships in construction, planning and the built environment.

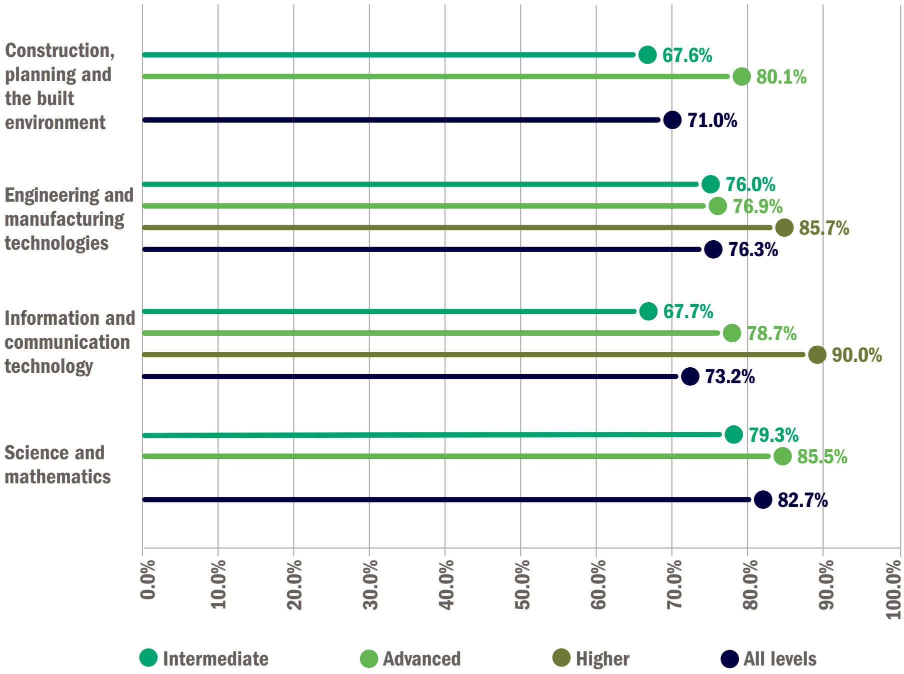
Table 10.11: Apprenticeship achievements by provider type, age and level (2011/12) – England[858 859]

		Achievements						
		General FE College including tertiary	**Sixth Form College**	**Special colleges[860]**	**Other public funded[861]**	**Schools[862]**	**Private sector public funded[863]**	**Total**
Under 19	Intermediate Apprenticeship	18,890	210	1,090	4,730	20	31,620	56,500
	Advanced Apprenticeship	6,930	70	210	1,160	-[864]	12,900	21,300
	Higher Apprenticeship	20	-	-	-	-	60	100
	All apprenticeships	25,800	300	1,300	5,900	-	44,600	77,900
19-24	Intermediate Apprenticeship	11,390	130	450	5,110	10	37,050	54,100
	Advanced Apprenticeship	7,950	90	230	2,630	-	19,720	30,600
	Higher Apprenticeship	180	10	-	-	-	650	800
	All apprenticeships	19,500	200	700	7,700	-	57,400	85,600
25+	Intermediate Apprenticeship	15,180	180	200	2,110	-	44,110	61,800
	Advanced Apprenticeship	7,840	120	120	1,550	10	23,140	32,800
	Higher Apprenticeship	100	-	-	-	-	220	300
	All apprenticeships	23,100	300	300	3,700	-	67,500	94,900
All ages	Intermediate Apprenticeship	45,450	510	1,730	11,950	30	112,770	172,400
	Advanced Apprenticeship	22,720	280	560	5,340	10	55,770	84,700
	Higher Apprenticeship	300	10	-	-	-	930	1,200
	All apprenticeships	68,500	800	2,300	17,300	-	169,500	258,400

Source: The Data Service

857 *The report of Her Majesty's Chief Inspector of Education, Children's Services and Skills*, Ofsted, 2013, p15 858 Volumes are rounded to the nearest ten except for the Grand Totals which are rounded to the nearest hundred 859 Age is calculated based on age at start of the programme rather than based on 31 August 860 Special Colleges include agriculture and horticulture Colleges; art, design and performing arts Colleges and specialist designated Colleges. 861 Other Public Funded includes Central Government Department, Central Government NDPB, Public Corporations and Trading Funds, Local Education Authority (LEA), Social Services, Other Local Authority, Police Authority, Fire Authority, Local Authority Dept, Local Authority, NHS-English Foundation Trust, NHS-English Non Foundation Trust, NHS-Other Organisations, Independent school or College, UFI Directly Funded Hub, Dance and Drama School, External Institution, Higher Education Organisation, School Sixth Form (not College), Special learning needs establishment, Other Public Organisation, Charitable, Non-Charitable, Other Voluntary Organisation, LSC Region, Special College, Academy, Academy-Converter, Academy-Free School, Academy-Sponsor Led, External Institution, Institution funded by Other Govt Dept and University Technology College. 862 Schools includes City Academy with Sixth Form, City Technology College, Pupil Referral Unit, School-Community, School-Community Special, School-Foundation, School-Foundation Special, School-Independent-SEN Approved, School-Non-Maintained Special, School-Other Independent, School-Other Independent Special, School-Voluntary aided, School-Voluntary controlled, Sixth Form Centre and School-Independent-SEN Approved. 863 Private Sector Public Funded includes Community Interest Company, Company Incorporated by Royal Charter (England/Wales), Employer Association, Independent Association, Industrial/Provident (England/Wales), Limited Liability Partnership, Limited Partnership, PRI/LBG/NSC/S.30, PRI/LTD BY GUAR/NSC, Private Limited Company, Private Unlimited Company, Public Limited Company, Sole Trader, Trade Union, Chamber of Commerce / Trade, Organisation in Business in its own right, Other Private Organisation and Business Link.
864 - Indicates a base value of less than 5

Fig. 10.7: Apprenticeship success rates by Sector Subject Area and level (2012/13) – England[867]



Source: The Data Service[868]

10.2 Engineering apprenticeships in the devolved nations

10.2.1 Engineering apprenticeships in Scotland

In Scotland, Modern Apprenticeships are a method of learning for the over-16s that combine paid employment and training to achieve industry qualifications at the level required for the job. Modern Apprenticeships can be delivered at one of a number of different levels.

All apprenticeships in Scotland must contain the same three elements:[869]

- a relevant SVQ (or alternative competency based qualifications)
- core skills
- industry specific training

And each apprentice is required to achieve the following core skills:

- communication
- working with others
- problem solving
- information and communication technology
- numeracy

Modern Apprenticeships were developed in the 1990s and offer over-16s the opportunity to learn skills while being paid, in a vocational setting.[870] There are around 70 Modern Apprenticeship frameworks, which can be studied at levels 2-5. Eighteen Sector Skills Councils are responsible for leading on the design and development of apprenticeship frameworks to meet the needs of employers in their sector.[871] It is possible to progress from a level 2 apprenticeship to a level 3, but the Organisation for Economic Co-operation and Development (OECD) has demonstrated that just over 750 individuals did this in 2012/13, compared with 11,000 apprentices who started a level 2 apprenticeship the previous year.[872]

The Scottish Government has a target of 25,000 Apprenticeship Programme Starts per year, across all frameworks. From 2011/12 to 2015/16 and in 2012/13 it achieved 25,691 starts.[873] Since 2010/11, at least half (50%) of all starts have been in the 16- to 19-year-old age group, meeting the target set by the Scottish Government.[874]

As well as increasing the number of Apprenticeship Programme Starts, Scotland has also improved the achievement rate for apprenticeships. Over a five year period, the number of apprenticeship achievements in Scotland has increased from 67% in 2008/09 to 77% in 2012/13.[875]

Public spending, in real terms, has increased by a quarter (24%) since 2008/09 to just under £75 million in 2012/13.[876] Although they only represented 50% of starts in 2012/13, the higher funding rate for the 16- to 19-year-old cohort means that nearly three quarters (70%) of apprenticeship expenditure is on this age cohort.[877]

Table 10.12 shows all the engineering-related Apprenticeship Programme Starts, broken down by gender, age and level. Out of 25,691 starts, 7,919 were in engineering-related frameworks, with engineering being the most popular framework (1,429 starts), followed by food manufacture (1,212) and construction [craft operation] (1,006).

Across all frameworks, 43.0% of starters were female. For engineering-related frameworks the comparable figure was one in ten (9.9%). However, it should be noted that food manufacture had 1,212 starts, of which 43.8% were female.

Previously we have mentioned that at least half of all apprentices starting a programme in Scotland in 2012/13 were aged 16-19. For engineering-related frameworks, the comparable figure was 53.0%. However, for the automotive framework, 84.3% of the 903 starters were aged 16-19.

Finally, it is worth noting that over half (58.0%) of all Apprenticeship Programme Starts were at level 3+. For engineering, however, this rose to nearly three quarters (71.5%), with 100% of the 1,006 apprentices starting the construction [craft operations] being level 3+.

865 The overall success rate is based on the Hybrid End Year. The Hybrid End Year is the later of the Expected End Year and the Actual End Year of a framework **866** Success rates are based on the individual apprenticeship frameworks that were completed in the relevant year (the Hybrid End Year). They are calculated as the number of framework aims achieved divided by the number started, excluding the framework aims of any learners that transferred onto another qualification within the same institution. **867** Sector Subject Area Tier 2 was set to all Tier 2 subjects **868** https://www.gov.uk/government/statistical-data-sets/sfa-national-success-rates-tables-2012-to-2013 **869** An International Comparison of Apprentice pay: Final Report, London Economics, October 2013, p11 **870** *Modern apprenticeships*, Audit Scotland, March 2014, p5 **871** *Modern apprenticeships*, Audit Scotland, March 2014, p13 **872** *OECD Reviews of Vocational Education and Training A Skills Beyond School Commentary on Scotland*, OECD, December 2013, p29 **873** *Modern apprenticeships*, Audit Scotland, March 2014, p5 **874** *Modern apprenticeships*, Audit Scotland, March 2014, p19 **875** *Modern apprenticeships*, Audit Scotland, March 2014, p22 **876** *Modern apprenticeships*, Audit Scotland, March 2014, p13 **877** *Modern apprenticeships*, Audit Scotland, March 2014, p25

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Table 10.12: Engineering related Modern Apprenticeship starts by gender, age and level (2012/13) – Scotland

	Gender			Age				Level					
	Female	Male	Percentage female	16-19	20-24	25+	Percentage 16-19	Level 2	Level 3	Level 4	Level 5	Percentage level 3+	All starts
Automotive	17	886	1.9%	761	97	45	84.3%	111	792	0	0	87.7%	903
Bus and coach engineering and maintenance	0	17	0.0%	13	4	0	76.5%	0	17	0	0	100.0%	17
Construction	0	113	0.0%	33	34	46	29.2%	50	61	2	0	55.8%	113
Construction – building	0	9	0.0%	3	1	5	33.3%	9	0	0	0	0.0%	9
Construction – civil engineering	0	59	0.0%	7	13	39	11.9%	59	0	0	0	0.0%	59
Construction (civil engineering and specialist sector)	4	585	0.7%	260	99	230	44.1%	589	0	0	0	0.0%	589
Construction (craft operations)	16	990	1.6%	812	142	52	80.7%	0	1,006	0	0	100.0%	1,006
Construction – specialist	2	50	3.8%	17	19	16	32.7%	52	0	0	0	0.0%	52
Construction (technical operations)	40	625	6.0%	33	32	600	5.0%	0	339	265	61	100.0%	665
Electrical installation	9	559	1.6%	362	79	127	63.7%	0	568	0	0	100.0%	568
Electrotechnical services	0	1	0.0%	0	1	0	0.0%	0	1	0	0	100.0%	1
Engineering	47	1,382	3.3%	1,112	215	102	77.8%	0	1,429	0	0	100.0%	1,429
Engineering construction	11	52	17.5%	23	37	3	36.5%	0	63	0	0	100.0%	63
Extractive and mineral processes	3	175	1.7%	6	10	162	3.4%	120	58	0	0	32.6%	178
Food manufacture	531	681	43.8%	158	240	814	13.0%	1,077	135	0	0	11.1%	1,212
Gas industry	1	37	2.6%	26	10	2	68.4%	0	38	0	0	100.0%	38
Glass industry operations	2	133	1.5%	23	27	85	17.0%	95	40	0	0	29.6%	135
Heating, ventilation, air conditioning and refrigeration	0	83	0.0%	57	12	14	68.7%	0	83	0	0	100.0%	83
Information and communication technologies professional	77	391	16.5%	263	79	126	56.2%	0	468	0	0	100.0%	468
Land-based engineering	1	64	1.5%	59	6	0	90.8%	55	10	0	0	15.4%	65
Oil and gas extraction	9	124	6.8%	89	40	4	66.9%	0	133	0	0	100.0%	133
Power distribution	0	28	0.0%	13	11	4	46.4%	28	0	0	0	0.0%	28
Printing	1	8	11.1%	7	2	0	77.8%	8	1	0	0	11.1%	9
Process manufacturing	4	33	10.8%	36	0	1	97.3%	0	37	0	0	100.0%	37
Vehicle body and paint operations	1	1	50.0%	1	1	0	50.0%	0	2	0	0	100.0%	2
Vehicle maintenance and repair	1	5	16.7%	2	4	0	33.3%	0	6	0	0	100.0%	6
Water industry	2	32	5.9%	8	4	22	23.5%	2	32	0	0	94.1%	34
Wind turbine operations and maintenance	2	15	11.8%	12	3	2	70.6%	0	17	0	0	100.0%	17
Sub-total all engineering related frameworks	781	7,138	9.9%	4,196	1,222	2,501	53.0%	2,255	5,336	267	61	71.5%	7,919
All frameworks	11,040	14,651	43.0%	12,719	6,962	6,010	49.5%	10,781	14,339	496	75	58.0%	25,691

Source: Skills Development Scotland

The number of achievements in each apprenticeship framework by gender, age and level is shown in Table 10.13. Overall, there were 19,921 Framework Achievements in 2012/13, of which 6,334 were for engineering-related frameworks. Of these, 1,920 were in construction.

Looking at the data by gender shows that 42.9% of all achievements were from women. However, this dropped to one in 11 (9.1%) for the engineering-related frameworks. Food manufacture was particularly noteworthy, as nearly half (45.7%) of those achieving the framework were female compared with just 1.6% of those achieving an apprenticeship in construction.

Half (51.1%) of all those achieving an apprenticeship were aged 16-19 and, for the engineering-related frameworks, it was slightly higher at 54.9%. Out of the 924 achievements in engineering, 751 (81.3%) were from students aged 16-19.

Nearly two thirds (59.9%) of all achievements were at level 3+, but for engineering-related frameworks it was three quarters (76.0%). For construction, 79.7% of the 1,920 achievements were at level 3+, but for food manufacture only 92 out of 976 achievements were at level 3+.

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Table 10.13: Engineering related Modern Apprenticeship achievements by gender, age and level (2012/13) – Scotland

	Gender			Age				Level					
	Female	**Male**	**Percentage female**	**16-19**	**20-24**	**25+**	**Percentage 16-19**	**Level 2**	**Level 3**	**Level 4**	**Level 5**	**Percentage level 3+**	**All achievements**
Automotive	0	9	0.0%	3	3	3	33.3%	1	8	0	0	88.9%	9
Biotechnology	2	6	25.0%	4	2	2	50.0%	0	8	0	0	100.0%	8
Chemicals manufacturing and petroleum industries	0	6	0.0%	2	3	1	33.3%	0	6	0	0	100.0%	6
Construction	31	1,889	1.6%	1,158	257	505	60.3%	390	1,327	166	37	79.7%	1,920
Construction (civil engineering and specialist sector)	0	100	0.0%	7	12	81	7.0%	100	0	0	0	0.0%	100
Construction (craft operations)	0	7	0.0%	0	6	1	0.0%	0	7	0	0	100.0%	7
Construction (technical operations)	15	366	3.9%	0	14	367	0.0%	0	197	135	49	100.0%	381
Electrical installation	0	23	0.0%	3	5	15	13.0%	0	23	0	0	100.0%	23
Electricity industry	0	26	0.0%	19	3	4	73.1%	0	26	0	0	100.0%	26
Electrorechnical services	8	622	1.3%	477	73	80	75.7%	0	622	0	0	98.7%	630
Engineering	23	901	2.5%	751	122	51	81.3%	0	914	0	0	98.9%	924
Engineering construction	4	62	6.1%	43	18	5	65.2%	0	66	0	0	100.0%	66
Extractive and mineral processing	2	57	3.4%	0	3	56	0.0%	35	20	4	0	40.7%	59
Food manufacture	446	530	45.7%	148	168	660	15.2%	884	92	0	0	9.4%	976
Gas industry	2	78	2.5%	66	6	8	82.5%	0	80	0	0	100.0%	80
Glass industry operations	1	69	1.4%	14	8	48	20.0%	48	22	0	0	31.4%	70
Heating, ventilations, air conditioning and refrigeration	0	112	0.0%	65	29	18	58.0%	0	112	0	0	100.0%	112
Information and communication technologies professionals	29	165	14.9%	87	22	85	44.8%	0	194	0	0	100.0%	194
Laboratory technicians in education	1	2	33.3%	3	0	0	100.0%	0	3	0	0	100.0%	3
Land-based engineering	0	61	0.0%	54	5	2	88.5%	19	42	0	0	68.9%	61
Meat and poultry processing	1	5	16.7%	3	2	1	50.0%	0	6	0	0	100.0%	6
Oil and gas extraction	3	76	3.8%	57	19	3	72.2%	0	79	0	0	100.0%	79
Printing	1	8	11.1%	6	2	1	66.7%	1	8	0	0	88.9%	9
Process manufacturing	0	3	0.0%	3	0	0	100.0%	0	3	0	0	100.0%	3
Rail transport engineering	0	3	0.0%	3	0	0	100.0%	0	3	0	0	100.0%	3
Vehicle body and paint operations	0	54	0.0%	53	0	1	98.1%	0	54	0	0	100.0%	54
Vehicle maintenance and repair	8	462	1.7%	403	43	24	85.7%	24	446	0	0	94.9%	470
Vehicle parts operations	0	54	0.0%	48	4	2	88.9%	0	54	0	0	100.0%	54
Water industry	0	1	0.0%	0	1	0	0.0%	0	1	0	0	100.0%	1
Sub-total all engineering related frameworks	577	5,757	9.1%	3,480	830	2,024	54.9%	1,502	4,423	305	86	76.0%	6,334
All frameworks	8,538	11,383	42.9%	10,181	3,069	6,671	51.1%	7,994	11,184	614	129	59.9%	19,921

Source: Skills Development Scotland

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10.2.2 Engineering apprenticeships in Wales

In 2009, the Welsh Government, in partnership with Sector Skills Councils and Further Education Colleges, introduced the Pathways to Apprenticeships programme. This is one of a number of programmes aimed at encouraging take up of apprenticeships. The Pathways to Apprenticeships programme is a one-year intensive programme for 16- to 24-year olds, designed to provide them with skills and experience to progress onto an apprenticeship.[878]

Table 10.14 shows the number of students completing a Pathway to Apprenticeship programme, by pathway and subsequent learning programme for 2011/12. In total, 1,010 students completed the programme. Progression onto an apprenticeship was highest for those on the science, engineering and manufacturing technologies pathway (40%).

Of those students not on a subsequent programme, 29% were in employment.[882]

In Wales, apprenticeships are offered at three levels:[883]

- Foundation Apprenticeship – level 2
- Apprenticeship – level 3
- Higher Apprenticeship – level 4+

Through the Young Recruits programme, employers in Wales are incentivised to take on additional young people (aged 16-24) as apprentices, with the Welsh Government paying a wage subsidy of £2,600 over 52 weeks.[884]

Table 10.15 shows the number of learners attaining a full framework by apprenticeship type and Sector Subject Area in 2012/13. Overall, 1,495 apprentices attained an engineering-related apprenticeship at level 3 and 2,085 attained a Foundation Apprenticeship at level 2. At both apprenticeship levels, over half of those attaining a full framework had studied engineering and manufacturing technologies.

The table also shows that at both Foundation Apprenticeship and apprenticeship level construction, planning and the built environment had a below-average percentage of students attaining the full framework.

Table 10.14: Number of learners completing Pathways to Apprenticeships programmes by pathway and subsequent learning programme (2011/12) – Wales[879]

	Apprenticeships		Foundation apprenticeship		Further Education (level 3)		Other learning programme		No subsequent programme identified		Total
Pathway	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number
Agriculture, horticulture and land-based engineering	5	22%	*[880]	**[881]	10	44%	*	**	5	22%	25
Automotive skills	5	7%	30	30%	20	18%	*	**	35	35%	100
Construction	*	**	125	39%	10	3%	15	5%	35	10%	320
Hospitality, leisure, travel and tourism	5	6%	0	0%	40	40%	10	9%	40	40%	105
IT and telecommunications	0	0%	0	0%	55	62%	5	8%	20	23%	85
Plumbing	20	25%	10	17%	*	**	*	**	25	33%	70
Science, engineering and manufacturing technologies	95	40%	15	7%	40	17%	5	3%	70	29%	240
Sport and active leisure	*	**	*	**	15	48%	*	**	10	26%	30
Total	140	14%	195	19%	205	20%	45	4%	250	25%	1,010

Source: Welsh Government

Table 10.15: Leavers attaining full framework by apprenticeship type and Sector Subject Area (2012/13) – Wales[885]

	Foundation Apprenticeships		Apprenticeships		All apprenticeships	
	Leavers attaining full framework	Percentage	Leavers attaining full framework	Percentage	Leavers attaining full framework	Percentage
Engineering and manufacturing technologies	1,145	88%	810	92%	1,955	89%
Construction, planning and the built environment	665	80%	565	81%	1,230	81%
Information and communication technology	275	86%	120	90%	395	87%
Sub-total all engineering related Sector Subject Areas	2,085		1,495		3,580	
All Sector Subject Areas	7,620	85%	5,750	87%	13,370	86%

Source: Welsh Government

878 *Progressions from Pathways to Apprenticeship Programmes*, Welsh Government, 27 August 2013, p1 879 Data is rounded to the nearest five students 880 Data suppressed as data is potentially disclosive, as it represents less than 5 students 881 Percentage supressed as the base is less than 50 students 882 *Progressions from Pathways to Apprenticeship Programmes*, Welsh Government, 27 August 2013, p3 883 Website accessed on the 19 August 2014 (http://wales.gov.uk/docs/dcells/publications/140213-apprenticeships-brochure-individuals-en.pdf) 884 Website accessed on the 19 August 2014 (http://wales.gov.uk/topics/educationandskills/skillsandtraining/apprenticeships/youngrecruitsprogramme/;jsessionid=7D4A6E26387ABED63E9281C52F409D93?lang=en) 885 Data is rounded to the nearest five students

10.2.3 Engineering apprenticeships in Northern Ireland

Apprenticeships Northern Ireland is a programme that offers training to those aged 16 and above at levels 2 and 3[886] – although only certain apprenticeships are supported for those aged 25+.[887] To undertake an apprenticeship, the candidate must be in, or about to start, work of at least 21 hours per week.[888]

For apprentices under the age of 25, for the duration of the apprenticeship, the full costs of off-the-job training will be met by the Government, but for those aged 25+ only 50% will be paid in the following areas:[889]

- creative industries
- life and health sciences
- advanced engineering
- advanced manufacturing
- food and drink manufacturing
- financial services
- business services (specifically ICT)

In total, the Northern Ireland Government spends £18.8 million of the ApprenticeshipsNI programme.[890] In addition, the Government has used funding from the European Social Fund and other sources to invest €205 million in education, skills and life-long learning for 2014-2020.[891]

However, in its review of apprenticeships, the Northern Ireland Government identified that the majority of existing apprenticeship frameworks have been developed at a national level and in many cases are inflexible and out of date.[892] The OECD has also identified that Northern Ireland has insufficient information on the labour market outcomes achieved for vocational programmes.[893]

Table 10.16 shows the changing profile of Apprenticeship Programme Starts in Northern Ireland by gender over a six-year period. It shows that the number of starts does tend to fluctuate year on year, but that it 2012/13 it was 6,345: below the 7,884 starts for the year before.

It also shows that in 2007/08, two thirds (65%) of starts were males. From 2008/09 onwards, however, the gender profile of starts has been broadly balanced.

Table 10.16: Apprenticeship starts by gender (2007/08-2012/13) – Northern Ireland

		Male		Female	
	Total	Number	Percentage	Number	Percentage
2007/08[894]	4,282	2,769	65%	1,513	35%
2008/09	8,082	3,656	45%	4,426	55%
2009/10	7,835	3,666	47%	4,169	53%
2010/11	8,948	4,118	46%	4,830	54%
2011/12	7,884	3,706	47%	4,178	53%
2012/13	6,345	3,247	51%	3,098	49%

Source: Northern Ireland Government

886 Website accessed on the 19 August 2014 (http://www.nidirect.gov.uk/index/information-and-services/education-and-learning/14-19/starter-skills-16-18/apprenticeships/apprenticeship-qualifications.htm)
887 Website accessed on the 19 August 2014 (http://www.nidirect.gov.uk/index/information-and-services/education-and-learning/14-19/starter-skills-16-18/apprenticeships/apprenticeship-qualifications.htm)
888 Website accessed on the 19 August 2014 (http://www.nidirect.gov.uk/index/information-and-services/education-and-learning/14-19/starter-skills-16-18/apprenticeships/apprenticeships-explained.htm)
889 Website accessed on the 20 August 2014 (http://www.nibusinessinfo.co.uk/node/14880) 890 *Securing our Success: The Northern Ireland Strategy on Apprenticeships*, Department for Employment and Learning, June 2014, p50 891 *Securing our Success: The Northern Ireland Strategy on Apprenticeships*, Department for Employment and Learning, June 2014, p50 892 *Review of Apprenticeships Interim Report and Consultation Document*, Department for Employment and Learning, January 2014, p22 893 *OECD Reviews of Vocational Education and Training A Skills Beyond School Commentary on Scotland*, OECD, December 2013, p38 894 From September 2007 ApprenticeshipsNI was aimed at individuals aged 16-24; however in September 2008 they became all-age apprenticeships.

Table 10.17 shows the total number of participants on different ApprenticeshipsNI frameworks for July 2013. In total, there were 2,506 apprentices on a level 3 framework of whom 916 were on an engineering-related framework. The main engineering-related frameworks are vehicle maintenance and repair (270), engineering (223) and construction crafts (204).

Table 10.17: All participants on ApprenticeshipsNI by framework (July 2013) – Northern Ireland[895 896 897]

	Total	Combined level 2[898]	Level 3
Construction	92	92	0
Construction crafts	205	1	204
Electrical distribution and trans. engineering	49	49	0
Electrotechnical services	331	282	49
Engineering	692	469	223
Engineering construction	1	0	1
Food and drink manufacturing	4	2	2
Food and drink manufacturing operations	103	103	0
Food manufacture	119	98	21
Furniture production	2	1	1
Gas utilisation, installation and maintenance	23	22	1
Glass industry occupations	8	3	5
Heating, ventilation, air conditioning and refrigeration	40	19	21
IT services and development	49	33	16
Land based service engineering	40	6	34
Light vehicle body and paint operations	4	0	4
Mechanical engineering services (plumbing)	105	64	41
Motor vehicle industry	142	142	0
Polymer processing	4	1	3
Print production	20	0	20
Printing industry	19	19	0
Vehicle maintenance and repair	273	3	270
Water utility operations	39	39	0
Sub-total all engineering related frameworks	2,364	1,448	916
All frameworks	7,558	5,042	2,506

Source: Northern Ireland Government

10.3 Balancing skills needs: recognising and rewarding Engineering Technicians

The demand for science, technology, engineering and maths (STEM) qualified technicians is now well recognised by employers, the engineering profession and Government,[899] with evidence showing 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[900] 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.[901]

For individuals, professional recognition of their achievement is a key driver for seeking to achieve registration. This is also true of apprentices in the sector. A recent Industry Apprentice Council survey demonstrated that 96.5% of apprentices wished their apprenticeship would lead to professional registration as standard.[902]

Recently, there have been major changes in Government policy, whereby vocational qualifications and apprenticeships are required to meet professional standards. Thanks to this, the profession can now promote professional registration as a means of improving the recognition and status of technicians and to encouraging more people into technician careers.

Developing pathways to technician registration

Engineering employers, with support from the professional engineering institutions, are now beginning to balance the skills they need by developing 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. The requirement to align Tech level qualifications[903] and Trailblazer Apprenticeships[904] with UK-SPEC[905] and the ICT*Tech* Standard[906] will enable the approval of more pathways leading to Engineering Technician (EngTech), ICT Technician (ICT*Tech*) and Incorporated Engineer (IEng) registration.

895 These figures are for apprentices on ApprenticeshipsNI, they do not include those apprentices who remain on the Jobskills Modern Apprenticeships programme. **896** A participant is defined for statistical purposes as an individual on ApprenticeshipsNI. An individual can participate on ApprenticeshipsNI more than once. **897** The number of participants on the programme/provision at a particular point in time. Occupancy figures relate to those participants on provision on the last Friday of the quarter. **898** Includes apprentices on level 2 programmes and those apprentices within specific Personal Training Plan, who are pursuing an NVQ level 2 en route to a targeted outcome of which is NVQ level 3 or equivalent. **899** UK Commission for Employment and Skills Working Futures 2010-2020 **900** CBI/Pearson Education and Skills Survey 2014, Gateway to Growth **901** Project TRaM, 2013 **902** http://www.eal.org.uk/latest-resources/doc_download/219-iac-apprentice-survey-infographic **903** https://www.gov.uk/government/publications/vocational-qualifications-for-14-to-19-year-olds **904** https://www.gov.uk/government/publications/future-of-apprenticeships-in-england-guidance-for-trailblazers **905** http://www.engc.org.uk/professional-registration/standards/uk-spec **906** http://www.engc.org.uk/professional-registration/standards/icttech-standard

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UK-SPEC and the ICT*Tech* 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 now be readily recognised through the Engineering Council Approved Qualification and Apprenticeship logos, and are listed on the Engineering Council's website.[907]

Engineering Council approved qualification | Engineering Council cymhwyster cymeradwy

Engineering Council approved apprenticeship | Engineering Council prentishiaesh gymeradwy

The ability for individuals to identify these approved pathways, and to more readily achieve professional registration upon completion, will provide an 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).[908] From the low number of these individuals on the register, it is evident that employers generally have a low awareness of where technicians are located in their business, and are not aware of the value that professional registration can bring for their technical staff.

However, those employers who actively support professional registration for their staff are found to extol its virtues to their employees and to their organisation. The benefits of registration include that it:

- 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 the 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 ambitious employees, who can use EngTech registration as an interim step towards progression to IEng and CEng

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.

Registered technicians 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 and skills, enabled them to stay up to date with the latest industry trends and issues and, ultimately improved their own careers 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:[909] it brings together employers, professional engineering institutions and colleges, to ensure that business needs through the recruitment and training of technician apprentices are met. 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 who then commit to providing technician apprenticeship places
- broaden availability across a range of engineering disciplines through using the common base of the Engineering Council UK Standard for Professional Engineering Competence (UK-SPEC) to compile a suite of linked qualifications working with Sector Skills Councils, professional institutions and awarding bodies

A partnership between the Institution of Civil Engineers (ICE), Institution of Mechanical Engineers (IMechE) and the Institution of Engineering and Technology (IET) has also been formed to significantly increase the EngTech population within their disciplines. The EngTechNow[910] campaign will promote technician membership and professional registration to those both entering the skills pipeline as well as those already employed. The key aims are to achieve 100,000 registered EngTechs by 2018, and to establish a valued membership product so that technician registration and membership becomes the norm for those entering the profession.

907 www.engc.org.uk/techdb **908** See Section 15.4 for more details **909** http://www.tacnet.org.uk/home/511 **910** http://www.engtechnow.com/

Part 2 – Engineering in Education and Training
11.0 Higher Education

Overall, in the UK, the pool of level 4+ individuals with qualifications that allowed them to go into engineering occupations was 82,000[911] in 2012/13, which is 25,000 below the demand of 107,000 per year.

In 2012/13, applicants to engineering increased by 5.5% on the previous year, to 32,026. Overall, 87.1% of the applicants were male and 12.9% were female. However, production and manufacturing engineering (23.4%) and chemical, process and energy engineering (25.7%) attract around double the proportion of female applicants than the average for all engineering sub-disciplines.

Non-continuation rates[912] are a major factor as they further restrict a small supply. Analysis shows that overall the non-continuation rate for engineering and technology is 15.6%, which is above the average for all subjects of 14.2%. However, examining the data by engineering sub-discipline shows that the non-continuation rate for general engineering is 27.1%, and that this is skewing the results for the whole engineering and technology subject area.

Finally, the chapter shows that 24,755 First Degrees were obtained in engineering and technology in 2012/13, which is an increase of 4.9% on the previous year.

The Higher Education (HE) sector is going through a period of considerable change. In academic year 2012/13, students entering HE in England were charged course fees of up to £9,000 per year for full-time students and £6,750 per year for part-time students.[913 914] To fund these course fees, students are able to take out student loans, with the maximum loan available equal to the annual course fee.[915] As the burden of funding courses has moved to fees paid by student loans, the Higher Education Funding Council for England (HEFCE) funding largely focuses on:

- high cost subjects
- widening participation
- improving retention
- some forms of flexible learning[916]

This has resulted in a change in the balance between the HEFCE teaching grant and the funding generated by tuition fees (Figure 11.0). However, it should also be noted that the overall level of funding has increased as the amount of money estimated to be generated by tuition fees rises faster than the reduction in the HEFCE teaching grant.

All courses are grouped into four price groups which then receive different rates of funding:

- Price group A – the clinical years of study for the subjects of medicine, dentistry and veterinary science. This price group has applied only to Higher Education providers that provide training for students seeking a first registrable qualification as a doctor, dentist or veterinary surgeon or who are already qualified in those professions.
- Price group B – laboratory-based subjects in science, engineering and technology.
- Price group C – intermediate-cost subjects with a laboratory, studio or fieldwork element, such as geography, art and design, languages or computing. This price group also includes all students on a sandwich year-out placement.
- Price group D – classroom-based subjects such as humanities, business or social sciences.[917]

HEFCE proposes to fund only those subjects that, on average, cost providers more than £7,500 per student to deliver.[918] These are courses in price groups A and B.[919] In addition, from 2013/14 HEFCE will provide higher rates of

911 See Section 15.3 for more details **912** The non-continuation rate has been defined, in this report, as students whose non-continuation marker is either dormant or left with no award. For further details on non-continuation markers please see https://www.hesa.ac.uk/content/view/2880/#ContStat **913** Website accessed on the 18 June 2014 (https://www.gov.uk/student-finance-calculator/y/2014-2015/uk-full-time) **914** For details of tuition fee arrangements across the different nations of the UK look at Engineering UK 2014 The state of engineering p129 **915** Website accessed on the 18 June 2014 (http://www.nus.org.uk/en/advice/money-and-funding/average-costs-of-living-and-study/) **916** *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p17 **917** *Student number controls and teaching funding Consultation on arrangements for 2013-14 and beyond*, Higher Education Funding Council for England, February 2012, p38 **918** *Student number controls and teaching funding Consultation on arrangements for 2013-14 and beyond*, Higher Education Funding Council for England, February 2012, p5 **919** *Student number controls and teaching funding Consultation on arrangements for 2013-14 and beyond*, Higher Education Funding Council for England, February 2012, p39 grants for taught postgraduate courses than for undergraduate courses. This reflects the fact that there is no loan facility at present for postgraduate courses.[920]

HEFCE will also provide additional funding for four subjects which are particularly expensive to deliver, and hence where costs are not fully represented in the four price groups. These four subjects are:

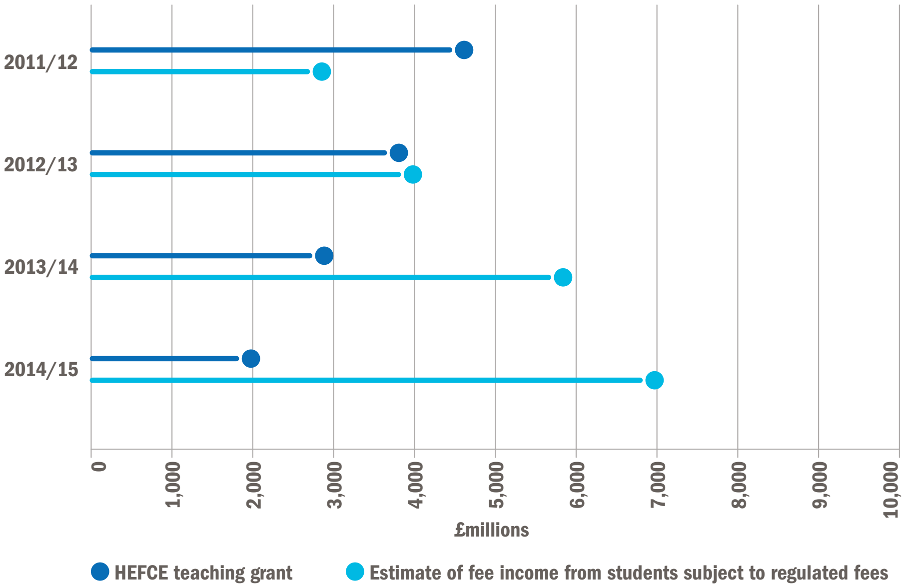
- chemistry
- physics
- chemical engineering
- mineral, metallurgy and materials engineering[921]

One result of the increase in tuition fees is that it has been estimated that students will graduate with debts averaging more than £44,000.[922] What impact this will have on progression from undergraduate study to postgraduate study can't currently be determined but is a potential risk factor. The House of Commons Committee of Public Accounts has identified that there is also a loan risk for the Government. Currently, there are £46 billion of student loans on the Government books. By 2042, this will rise to £200 billion (in 2013 prices) and there will be 6.5 million people with a student loan.[923] Disturbingly, the Department for Business, Innovation and Skills (BIS) is unable to accurately forecast student loan repayments and is unable to identify the likely cost of future non-repayment of loans.[924]

Using the different tuition fee rates across the different nations of the UK, the Higher Education Academy and the Higher Education Policy Institute have been able to determine that the biggest influence on perceptions of value for money are generated by the difference between no tuition fees and moderate tuition fees and not between moderate tuition fees and high tuition fees.[925]

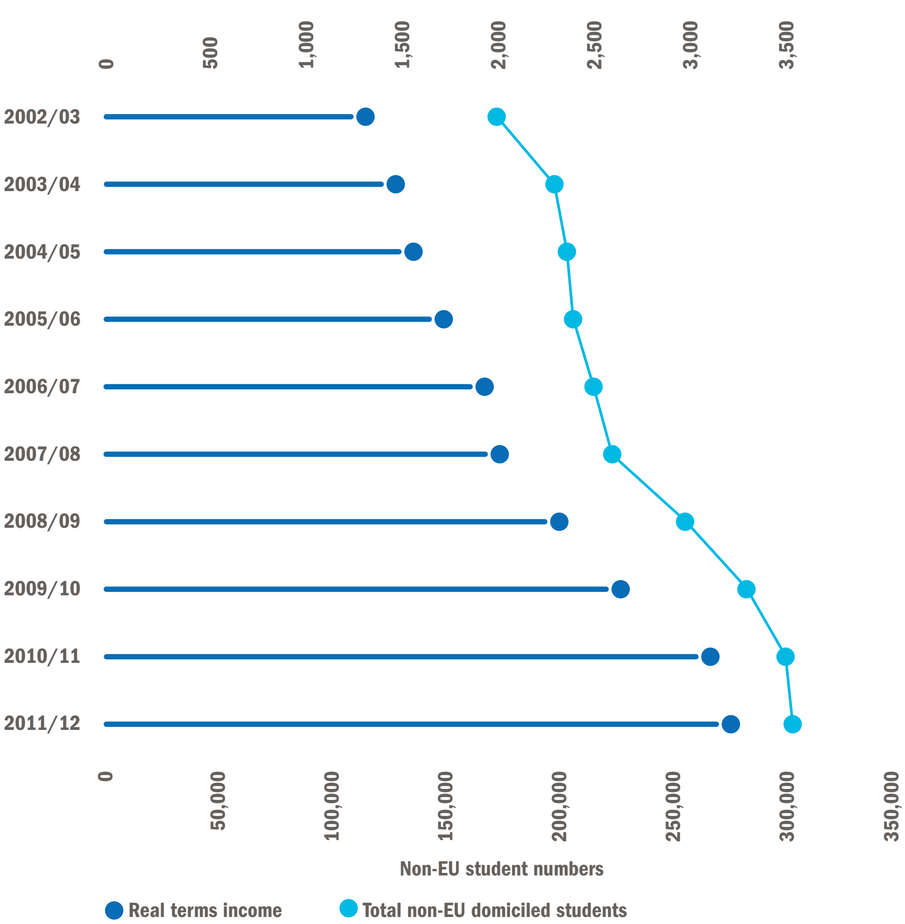
In addition to charging tuition fees for UK students, HE institutions also charge tuition fees for overseas students. Figure 11.1 shows the growth in the number of non-EU students and income over the 10-year trend period. The House of Lords Science and Technology Select Committee estimates that the overseas student pays on average £10,000 in tuition fees, in addition to the money they spend while living here.[926] A Government estimate has calculated living expenses for overseas students in 2011/12 at £6.3 billion.[927]

Fig. 11.0 Balance between HEFCE teaching grant and tuition fee outlay (2011/12–2014/15)



Source: Office of Fair Trading[928]

Fig. 11.1: HE income and student numbers (2002/03-2011/12) – all non-EU students



Source: UniversitiesUK[929]

920 *Student number controls and teaching funding Consultation on arrangements for 2013-14 and beyond*, Higher Education Funding Council for England, February 2012, p5 921 *Student number controls and teaching funding Consultation on arrangements for 2013-14 and beyond*, Higher Education Funding Council for England, February 2012, p6 922 *Payback Time? Student debt and loan repayments: what will the 2012 reforms mean for graduates?*, Institute of Fiscal Studies, April 2014, p7 923 *Student Loan repayments*, House of Commons Committee of Public Accounts, 10th February 2014, p3 924 *Estimating the public cost of student loans*, Institute of Fiscal Studies, April 2014, p7 925 *The HEPI–HEA Student Academic Experience Survey 2014*, Higher Education Policy Institute and the Higher Education Academy, 2014, p9 926 *International Science, Technology, Engineering and Mathematics (STEM) students*, House of Lords Science and Technology Select Committee, 11 April 2014, p7 927 *Industrial Strategy: government and industry in partnership*, HM Government, July 2013, p6 928 *Higher Education in England An OFT Call for Information*, Office of Fair Trading, March 2014, p18 929 *Higher Education in Facts and Figures*, UniversitiesUK, September 2013, p15

Research by BIS[930] has shown that UK education exports were worth £17.5 billion in 2011, of which over £10 billion was generated by the Higher Education sector.[931] In addition, the Institute of Public Policy Research (IPPR) estimates that half of UK publically-funded HE institutions generate at least 10% of their income from non-EU students.[932] IPPR also estimates that nearly 70,000 jobs are created in the UK economy by non-EU HE students, of which 25,000 are in the HE sector.[933]

The Government has recognised the value of educational exports and has published a strategy to increase these exports by £3 billion by 2020.[934] BIS is promoting growth in the international education sector and estimates that numbers of international students in HE can grow by 15-20% in the next five years.[935] Education UK will support the education sector by focusing on high value overseas opportunities. The unit aims to generate contracts worth £1 billion by 2015 and £3 billion by 2020.[936]

However, there are significant risks in the education exports sector. About a quarter of international undergraduate full-time entrants in 2012/13 entered into year two or three of their course.[937] In addition, international students are also prevalent in postgraduate-level courses.[938] Non-UK students account for 46% of all taught postgraduates and 41% of all research postgraduates. They also provide a high proportion of students in certain subjects. For example, 84% of new entrants to postgraduate electronic and electrical engineering courses in 2011/12 were international students.[939] Further research has identified that the total number of HE entrants from outside the UK in 2012/13 represented 53% of all non UK students, meaning that HE institutions have to recruit more than half their non UK student body each year.[940] It should also be noted that in 2012/13, 23% of international taught masters entrants came from China compared with 26% from the UK.[941] However, in 2012/13 international entrance to HE was broadly flat, which is a sharp decrease from the annual growth rates of 6.3% experienced in 2007/08 to 2001/12.[942] The House of Lords Science and Technology Select Committee identified that there has been a particularly sharp decline in the number of Indian STEM students – down 28% in 2012/13[943], while Universities UK has shown STEM postgraduate taught courses have been particularly affected.[944] The House of Lords Science and Technology Select Committee also identified that a decline in international students studying taught STEM courses could affect the attractiveness of the sector and potentially create a cycle of decline, which in turn would have a knock-on effect of reducing the range of courses on offer for UK students.[945]

In addition to growing UK education exports, the Government is also looking to boost the number of UK students who study overseas. Under the Erasmus+ scheme, there is a fund of £793 million to encourage overseas study, teaching and volunteering.[946] The Government is also looking to double the number of UK exchange students who visit China, in order to boost trade links.[947]

The UK Government has also recognised the non-export importance of the HE Sector.[948] Research by UniversitiesUK has identified that the HE sector generated over £73 billion in output and over three quarters of a million full-time equivalent jobs in the economy.[949] Furthermore, it identified that for every 100 full-time jobs in universities, a further 117 full-time jobs were created elsewhere in the economy,[950] and that for every £1 million of university output there was a further £1.35 million of output elsewhere in the economy.[951] The Government has also announced a pilot of University Enterprise Zones to help drive the growth of new high-tech companies.[952] However, the Confederation of British Industry (CBI) has identified the potential for the HE sector to expand into business workforce training. Currently, HE institutions supply only 1.2% of this £49 billion market.[953]

Higher Education also provides financial benefits for the individual. Research quoted by BIS has identified that the lifetime earning premium for a graduate is £168,000 for men and £252,000 for women,[954] although the OECD has shown that the UK has a particularly pronounced gender gap for private NET returns.[955] The BIS research also identified that those from lower socio-economic backgrounds received higher returns. An undergraduate qualification also increases the probability of being in employment by 4.2 percentage points for women and 2.1 percentage points for men.[956]

In addition to the financial benefits of HE, there are also substantial non-financial benefits. The Organisation for Economic Co-operation and Development (OECD) has identified that more years in education has a positive relationship with better health and well-being.[957] Soft power is the global reach and perception of a country. Research has placed the UK second in the world for soft power acquired via its HE sector.[958]

The HE sector is also experiencing an increase in competition for student places. For 2014/15, students who obtain ABB or higher in A levels or certain equivalent qualifications will be exempt from HE institutions number controls.[959] In the Autumn Statement, the Government announced that for 2014/15 the number of students funded by HEFCE will be increased by 30,000.[960] In 2015/16, the student cap will be removed,[961] which the Government estimates will lead to an estimated 60,000 young people entering HE per year.[962] In 2015/16, the Government will also provide an additional £50 million per year of additional funding for STEM students.[963]

The Government believes that freeing institutions from number controls will help improve quality,[964] however HEFCE has highlighted that it will create opportunities and risks for institutions and HE providers will face increased uncertainty over student recruitment.[965]

HEFCE[966] has shown that the HE sector is planning to significantly increase capital infrastructure expenditure from £2.6 billion in 2012/13 to £3.9 billion (Figure 11.2).[967]

930 *Industrial Strategy: government and industry in partnership*, HM Government, July 2013, p21 **931** *Industrial Strategy: government and industry in partnership*, HM Government, July 2013, p22 **932** *Britain wants you – why the UK should commit to increasing International Students Numbers*, IPPR, November 2013, p20 **933** *Britain wants you – why the UK should commit to increasing International Students Numbers*, IPPR, November 2013, p19 **934** The strategy can be accessed at https://www.gov.uk/government/news/new-push-to-grow-uks-175-billion-education-exports-industry **935** *Britain wants you – why the UK should commit to increasing International Students Numbers*, IPPR, November 2013, p2 **936** *Industrial Strategy: government and industry in partnership*, HM Government, July 2013, p11 **937** *Global demand for English Higher Education An analysis of international student entry to English Higher Education courses*, Higher Education Funding Council for England, April 2014, p9 **938** *Students in Higher Education Institutions 2011/12*, Higher Education Statistics Agency, 2013 https://www.hesa.ac.uk/component/option,com_pubs/task,show_pub_detail/pubid,1/Itemid,286/ **939** *Students in Higher Education Institutions 2011/12*, Higher Education Statistics Agency, 2013 https://www.hesa.ac.uk/component/option,com_pubs/task,show_pub_detail/pubid,1/Itemid,286/ **940** *Global demand for English Higher Education An analysis of international student entry to English Higher Education courses,* Higher Education Funding Council for England, April 2014, p3 **941** *Global demand for English Higher Education An analysis of international student entry to English Higher Education courses*, Higher Education Funding Council for England, April 2014, p4 **942** *Britain wants you – why the UK should commit to increasing International Students Numbers*, IPPR, November 2013, p3 **943** *International Science, Technology, Engineering and Mathematics (STEM) students*, House of Lords Science and Technology Select Committee, 11 April 2014, p5 **944** *Worrying Trends in International Student Recruitment*, Universities UK, 2014, p1 **945** *International Science, Technology, Engineering and Mathematics (STEM) students*, House of Lords Science and Technology Select Committee, 11 April 2014, p42 **946** Website accessed on the 18 June (https://www.gov.uk/government/news/800-million-to-help-uk-students-study-overseas) **947** Website accessed on the 18 June 2014 (https://www.gov.uk/government/news/80000-uk-students-to-visit-china-to-boost-trade-links) **948** Website accessed on the 18 June 2014 (https://www.gov.uk/government/speeches/contribution-of-uk-universities-to-national-and-local-economic-growth) **949** *The Impact of Universities on the UK Economy*, UniversitiesUK, April 2014, p4 **950** *The Impact of Universities on the UK Economy*, UniversitiesUK, April 2014, p4 **951** *The Impact of Universities on the UK Economy*, UniversitiesUK, April 2014, p4 **952** Website accessed on the 18 June 2014 (https://www.gov.uk/government/news/15-million-boost-for-local-business-growth-at-universities) **953** *Tomorrow's growth: New routes to higher skills, Confederation of British Industry*, July 2013, p24 **954** *The Benefits of Higher Education Participation for Individuals and Society: key findings and reports "The Quadrants"*, Department for Business, Innovation and Skills, October 2013, p45 **955** Education at a glance 2014, OECD, September 2014, p154 **956** *The Benefits of Higher Education Participation for Individuals and Society: key findings and reports "The Quadrants"*, Department for Business, Innovation and Skills, October 2013, p48 **957** *Things we know and don't know about the Wider Benefits of Higher Education*, Department for Business, Innovation and Skills, October 2013, p12 **958** *Richer for it The social, cultural and educational impact international*, Universities Scotland, September 2013, p14 **959** *Student number controls Outcomes of consultation on arrangements for 2014-15 onwards*, HEFCE, September 2013, p1 **960** *Autumn Statement 2013*, HM Treasury, December 2013, p54 **961** *Financial health of the Higher Education sector 2012-13 financial results and 2013-14 forecasts*, Higher Education Funding Council for England, March 2014, p2 **962** *Autumn Statement 2013*, HM Treasury, December 2013, p54 **963** *Autumn Statement 2013*, HM Treasury, December 2013, p54 **964** *Autumn Statement 2013*, HM Treasury, December 2013, p54 **965** *Financial health of the Higher Education sector 2012-13 financial results and 2013-14 forecasts*, Higher Education Funding Council for England, March 2014, p2 **966** *Financial health of the Higher Education sector 2012-13 financial results and 2013-14 forecasts*, Higher Education Funding Council for England, March 2014, p2 **967** *Financial health of the Higher Education sector 2012-13 financial results and 2013-14 forecasts*, Higher Education Funding Council for England, March 2014, p2

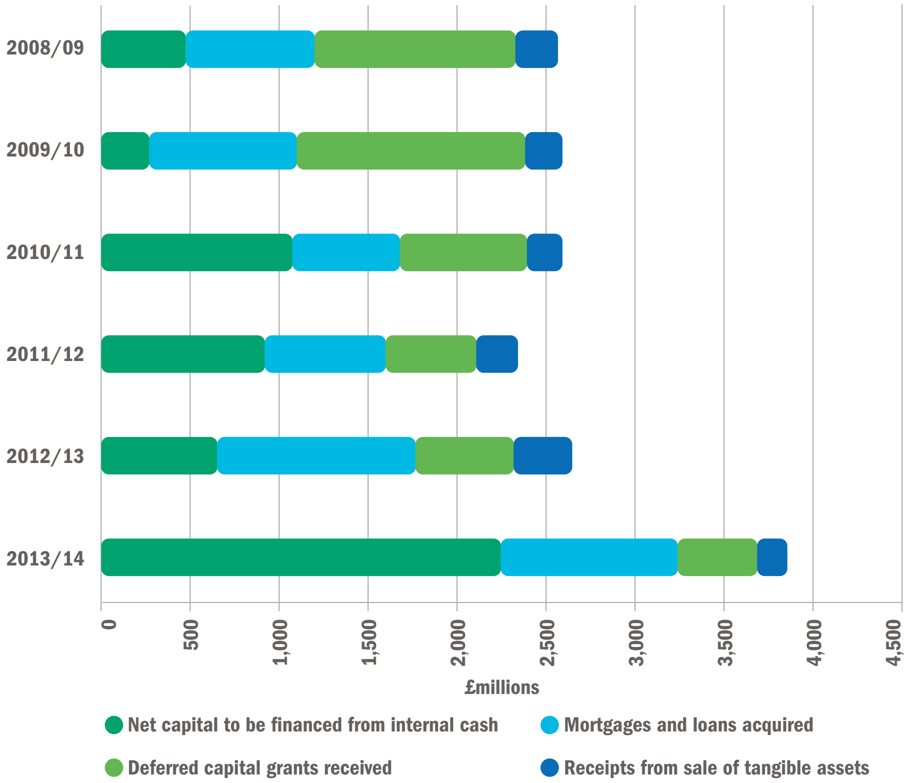
However, as John Perkins highlighted in his review of engineering skills,[968] the UK's capital investment into HE lags behind that of our competitor countries and that quality of learning spaces is the one area where the UK underperforms.

Finally, Table 11.0 shows the main sources of income and expenditure for the Higher Education sector. Over the three-year period, expenditure has risen by 6.5%, which is more than the rise in income (5.9%). This picture was also replicated in the last year with expenditure rising 4.6% compared with income, which rose by 4.4%.

The table also shows the change in income source as a result of the introduction of variable fees and the corresponding reduction in grants. Over three years, funding body grants have declined by a fifth (20.7%) to £7.0 billion, while tuition fees and education contracts have increased by over a quarter (29.8%) to £11.7 billion.

The largest source of expenditure was staff costs, which amounted to £15.4 billion in 2012/13, out of a total expenditure of £27.9 billion (55.2% of total expenditure).

Fig. 11.2: Funding breakdown of capital expenditure (2008/09-2013/14)



Source: HEFCE[969]

Table 11.0: Total income and expenditure by source of income and category of expenditure (2010/11-2012/13) – UK

	Total in thousand £ 2010/11	Total in thousand £ 2011/12	Total in thousand £ 2012/13	Change over one year	Change over three years
Income					
Funding body grants	8,865,958	8,270,989	7,031,856	-15.0%	-20.7%
Tuition fees and education contracts	8,979,964	9,676,459	11,655,756	20.5%	29.8%
Research grants and contracts	4,435,783	4,509,715	4,768,549	5.7%	7.5%
Other income	5,000,775	5,180,126	5,398,125	4.2%	7.9%
Endowment and investment income	240,926	285,027	289,583	1.6%	20.2%
Total income	27,523,406	27,922,316	29,143,869	4.4%	5.9%
Expenditure					
Staff costs	14,728,278	14,808,923	15,407,795	4.0%	4.6%
Other operating expenses	9,626,469	9,950,643	10,489,655	5.4%	9.0%
Depreciation	1,478,023	1,543,750	1,618,103	4.8%	9.5%
Interest and other finance costs	372,657	381,413	402,378	5.5%	8.0%
Total expenditure	26,205,427	26,684,729	27,917,931	4.6%	6.5%

Source: HESA finance spreadsheets and HESA website[970]

968 *Professor John Perkins' Review of Engineering Skills*, Department for Business, Innovation and Skills, November 2013, p39 969 *Financial health of the Higher Education sector 2012-13 financial results and 2013-14 forecasts*, Higher Education Funding Council for England, March 2014, p20 970 Website accessed on the 19 June 2014 (https://www.hesa.ac.uk/index.php?option=com_content&view=article&id=1900&Itemid=634

Engineering Gateways: a work-based learning route 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 progression routes, 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[971] 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 (Masters or Bachelors degree) and demonstration (completed fully or partially alongside the degree) of the required competences 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 160 individuals have achieved or are working towards professional registration as Incorporated or Chartered Engineers.

An original aspiration of the programme to "offer an attractive progression route for those on Advanced Apprenticeships who need help progressing to professional registration" remains true. With heightened interest in apprenticeships, this model could be utilised to enable those who have achieved EngTech registration or completed an Advanced Apprenticeship to progress further in a work-based setting.

11.1 The HE sector

Table 11.1 provides an overview of the HE sector in the UK. It shows that overall there are 162 HE institutions in the UK with the majority (130) in England.

As Figure 11.3 highlights, not all institutions offer a full range of STEM courses. There are 108 universities or colleges that offer courses in engineering and technology. The picture for computer sciences is slightly better, with 126.

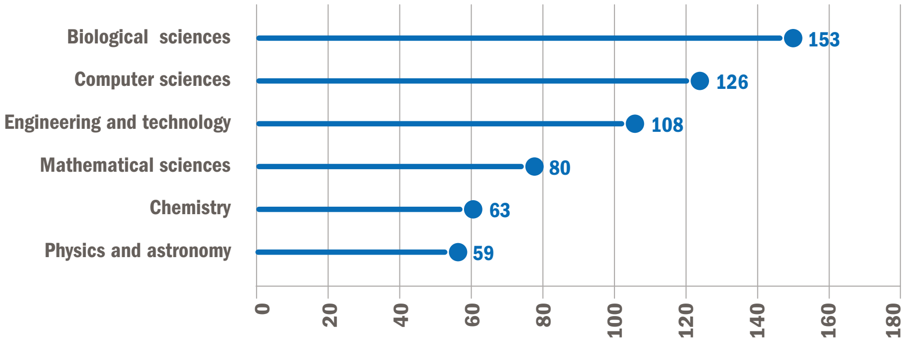
However, for mathematical sciences it is just 80 and for physics and astronomy it is just 59.

Table 11.1: Overview of the HE sector (September 2013)

	HE institutions
England	130
Scotland	18
Wales	10
Northern Ireland	4
UK total	162

Source: UniversitiesUK[972]

Fig. 11.3: Number of universities or colleges with STEM undergraduate degree courses



Source: Campaign for Science and Engineering[973]

971 www.engc.org.uk/engineering-gateways 972 *Higher Education in Facts and Figures*, UniversitiesUK, September 2013, p11 973 *Improving Diversity in STEM*, Campaign for Science and Engineering, May 2014, p37

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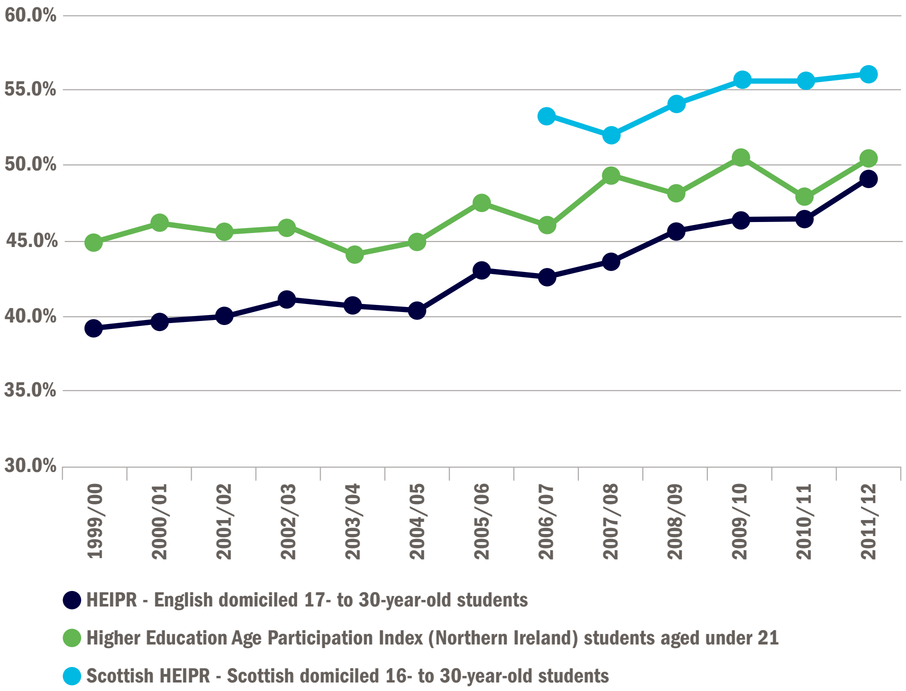
11.2 Participation rates

UniversitiesUK has produced an analysis of participation rates for students in England, Scotland and Northern Ireland (Figure 11.4). It shows the Higher Education Initial Participation Rate (HEIPR) for Scotland has been above 50% for every year since 2006/07. This participation rate is higher each year than the HEIPR figure for English domiciled students, although the age range of students covered in the two HEIPR calculations is slightly different. One reason why the young participation rate in Scotland is higher than in other nations of the UK is the high proportion of young people studying for a HE qualification in Scottish Further Education Colleges.[974]

The HEIPR rate for England has increased from 1999/2000 to 2011/12, but there has been a degree of fluctuation between individual years, from around 40% in 1999/2000 to nearly 50% in 2011/12. Separate research by HEFCE suggests that the participation rate has increased among 18- to 19-year-olds from around 30% in the mid 1990s to 36% at the end of the 2000s.[975] The overall number of 18- and 19-year-olds is declining in England, while the number entering HE remains steady – resulting in a greater proportion of 18- and 19-year-olds entering HE.[976]

The Government in Northern Ireland doesn't use the HEIPR methodology but instead uses the Higher Education Age Participation Index for students aged under 21. In 1999/2000, the percentage rate was around 45%, increasing to around 50% by 2011/12.

Fig. 11.4: Higher Education participation rates (1999/2000-2011/12) – England, Scotland and Northern Ireland



Source: UniversitiesUK

974 *Trends in young participation in Higher Education*, HEFCE, October 2013, p7 **975** *School and College-level Strategies to Raise Aspirations of High-achieving Disadvantaged Pupils to Pursue Higher Education Investigation*, Department for Education, January 2014, p7 **976** *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p9 **977** *Higher Education in Facts and Figures*, UniversitiesUK, September 2013, p7

11.3 Widening participation

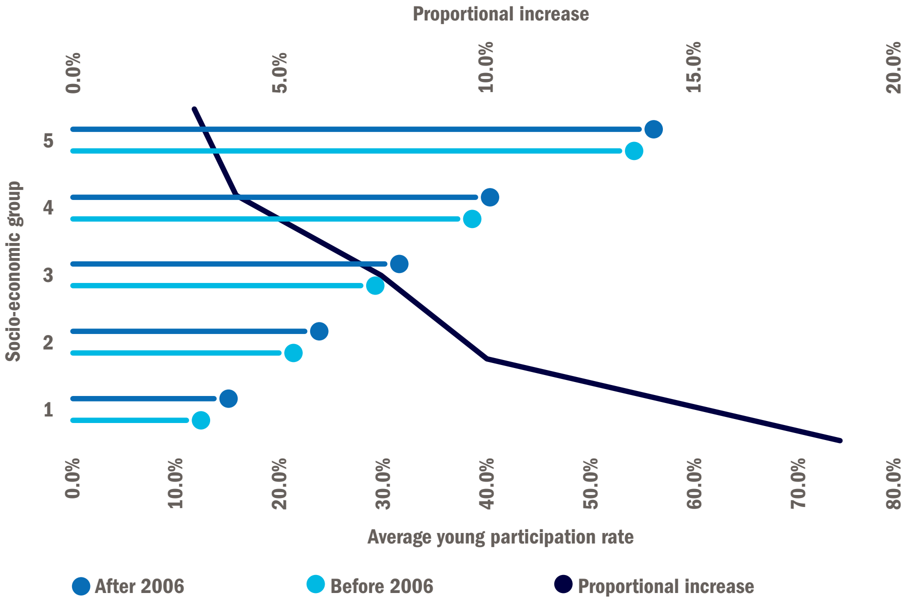
Participation of local areas (POLAR) data is the main method used for measuring widening participation in HE. The POLAR data is broken down into five quintiles. Figure 11.5 shows that fewer than one in five young people in quintile 1 progress to HE, while more than half in quintile 5 do. However, the proportional increase in HE participation has been higher for those in quintile 1 than it has been for those in quintile 5.

Figure 11.6 shows the progression of students who are and are not eligible for Free School Meals and the percentage point gap between the two. In 2005/06, nearly a third (32.8%) of students not eligible for Free School Meals progressed to HE, compared with 13.5% who were eligible. By 2010/11, the corresponding figures were 37.7% and 19.9%. This means the gap between those who are and are not eligible for Free School Meals has declined from 19.3 percentage points in 2005/06 to 17.8 in 2010/11.

Research by HEFCE[979] has shown that around 21% of pupils in an area classed as quintile 1 under the POLAR system are in receipt of Free School Meals, compared with around 7% of those in quintile 5. This means that in those areas with the lowest progression to HE, pupils are three times more likely to be in receipt of Free School Meals than those living in areas with the highest progression. Further analysis by HEFCE has shown that in the 2011/12 cohort, as a result of increased participation, there are an additional 9,000 young people from the most disadvantaged areas in HE when compared with 1998/99, even after accounting for differences in the cohort size.[980] Finally, it is worth considering some research from UCAS which shows that within the pool of students who receive Free School Meals, young women have a 44% higher HE entry rate than young men.[981]

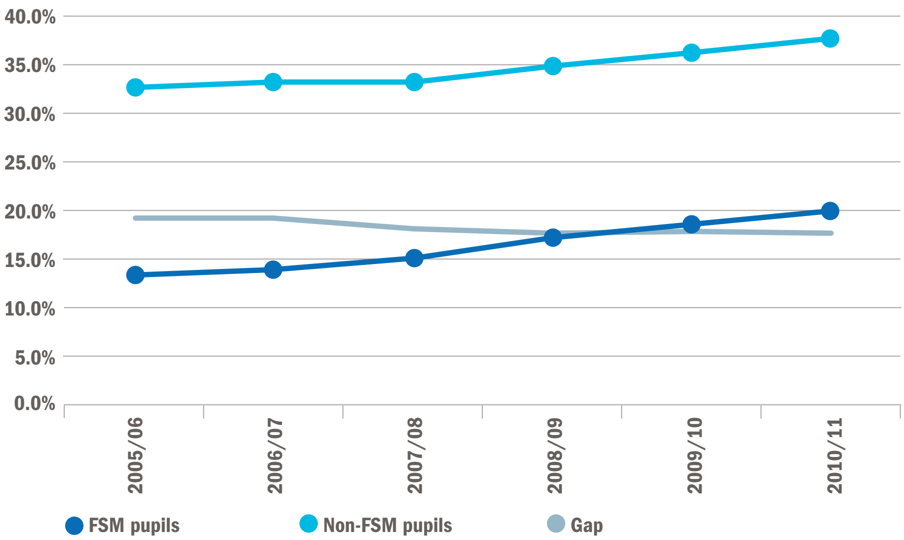
Table 11.2 shows the distribution of POLAR3 quintiles for different subject areas for young entrants. For engineering and technology, a third (33.1%) of entrants were from quintile 5 areas which is above the average for all subjects (31.4%). Conversely, engineering and technology had a below average number of entrants from quintiles 1, 2 and 3. Physical sciences and mathematical sciences follow a similar partern to engineering and technology in that the proportion of entrants from quintile 5 is above average while the proportion of entrants from quintiles 1, 2 and 3 are below average.

Fig. 11.5: Increase in participation rates by POLAR classification (before and after 2006)



Source: UniversitiesUK[978]

Fig. 11.6: Progression of pupils aged 15 to HE at 19 by whether they are eligible for Free School Meals and by the percentage point gap



Source: Social Mobility and Child Poverty Commission[982]

However, computer science has a very different pattern: it has an above average proportion of entrants from quintiles 1, 2 and 3 and a below average proportion of entrants from quintiles 4 and 5. A quarter (24.3%) of entrants to computer science are from quintile 5, compared with the average for all subjects of 31.4%.

978 *Where student fees go*, Universities UK, September 2013, p11 **979** *Further information on POLAR3 An analysis of geography, disadvantage and entrants to Higher Education*, HEFCE, February 2014, p38 **980** *Trends in young participation in Higher Education*, HEFCE, October 2013, p15 **981** *2013 Application Cycle: End of Cycle Report*, UCAS, December 2013, p73 **982** *State of the nation 2013: social mobility and child poverty in Great Britain*, Social Mobility and Child Poverty Commission, October 2013

Table 11.2: Distribution of young HE entrants by POLAR3 quintile and subject area (2011)

	POLAR3 quintile				
	1	2	3	4	5
Creative arts and design	12.7%	16.3%	19.9%	23.5%	27.7%
Business and administrative studies	10.5%	15.4%	19.9%	23.4%	30.8%
Biological sciences	11.2%	16.0%	19.8%	23.9%	29.0%
Social studies	10.1%	14.5%	18.9%	22.8%	33.7%
Subjects allied to medicine	11.3%	16.3%	20.0%	24.0%	28.3%
Engineering and technology	9.9%	14.7%	18.8%	23.5%	33.1%
Languages	8.5%	12.1%	17.3%	24.0%	38.0%
Physical sciences	8.5%	13.6%	18.1%	24.1%	35.7%
Computer sciences	14.1%	17.9%	21.2%	22.6%	24.3%
Education	13.7%	18.6%	21.0%	23.1%	23.7%
Historical and philosophical studies	7.4%	12.2%	17.1%	24.3%	39.1%
Law	12.3%	16.2%	21.0%	22.8%	27.7%
Mass communication and documentation	12.0%	17.0%	21.3%	23.0%	26.7%
Architecture, building and planning	8.7%	13.2%	19.0%	23.9%	35.3%
Mathematical sciences	9.0%	13.6%	18.3%	22.8%	36.3%
Medicine and dentistry	4.1%	8.5%	13.7%	23.9%	49.9%
Agriculture and related subjects	9.8%	15.0%	20.1%	25.5%	29.6%
Veterinary science	2.2%	6.7%	17.1%	27.1%	46.8%
Combined subjects	10.2%	15.4%	18.1%	23.4%	33.0%
All subjects	10.7%	15.2%	19.3%	23.5%	31.4%

Source: HEFCE[983]

HEFCE has shown that pupils at maintained schools in areas with higher rates of HE participation achieve more highly in their GCSE subjects.[984] Those pupils in the most disadvantaged areas have on average 242 points compared with 393 from pupils in the least disadvantaged areas. However, when GCSE equivalent qualifications are added, the relationship between pupil's attainment scores and young participation rates becomes less clear.[985] This finding is supported by other research which demonstrates that prior low attainment is the main obstacle to progression to HE.[986] Pupils from the most disadvantaged areas are also hampered in their access to high tariff universities as they often lack the necessary grades in the requisite subjects to meet the entry requirements of selective universities.[987] However, the Sutton Trust has also argued that prior attainment doesn't entirely explain the gap in entry to the most selective institutions and that more than 3,000 suitably qualified young people from disadvantaged backgrounds don't enter the most selective institutions each year.[988] The Department for Education has identified the impact of geography on high achieving disadvantaged pupils progressing to the most selective institutions.[989] In particular, it identified concerns about living away from home or moving somewhere new as a particular challenge.

983 *Further information on POLAR3 An analysis of geography, disadvantage and entrants to Higher Education*, HEFCE, February 2014, p65 984 *Further information on POLAR3 An analysis of geography, disadvantage and entrants to Higher Education*, HEFCE, February 2014, p33 985 *Further information on POLAR3 An analysis of geography, disadvantage and entrants to Higher Education*, HEFCE, February 2014, p35 986 *(How) did New Labour narrow the achievement and participation gap?*, Centre for Learning and Life Chances in Knowledge Economies and Societies, 5 December 2013, p5 987 *National strategy for access and student success in Higher Education*, Department for Business, Innovation and Skills, April 2014, p25 988 *National strategy for access and student success in Higher Education*, Department for Business, Innovation and Skills, April 2014, p25 989 *School and College-level Strategies to Raise Aspirations of High-achieving Disadvantaged Pupils to Pursue Higher Education Investigation*, Department for Education, January 2014, p120

11.4 Applicants to STEM HE courses

11.4.1 Applicants to undergraduate STEM HE courses[990]

Figure 11.7 shows that a quarter (24%) of students in 2012 said they went to university as it was essential for their career. Other key reasons for choosing to go to university in 2012 were improving job opportunities and improving knowledge in an area of interest. In addition, comparing the responses in 2012 with those in 2010 shows an overall increase in students choosing practical reasons, at the expense of other options.

The number of applicants to STEM HE subjects and all subjects is shown in Table 11.3. Across all subjects there was a 3.1% increase in the total number of applicants overall to HE courses in 2012/13. Slightly more applicants came from the UK (an increase of 3.2%) and outside the EU (an increase of 3.4%) but EU applicants only rose by 1.2%. The 10-year trend shows applicant numbers have increased by over a third (38.7%) since 2003/04. UK applicants were slightly below this 10-year average (36.1%), while applicants from the EU (73.1%) and from outside the EU (43.2%) were both above average.

For engineering, the one-year increase in the number of applications was 5.5% – almost double the 3.1% increase for all subjects – bringing the 2012/13 total to 32,026 applicants. Of these, there was a 6.7% increase in applicants from the UK, a 4.1% increase in non-EU applicants, and just a 0.4% increase in EU applicants. In addition, the increase in female applicants (5.6%) was slightly higher than the increase in all applicants (5.5%). Over the 10-year period, the total number of applicants increased by 43.8%. Growth was driven by applicants from the UK, who rose 48.1%, compared with a 43.7% increase in EU applicants and 32.9% for non-EU.

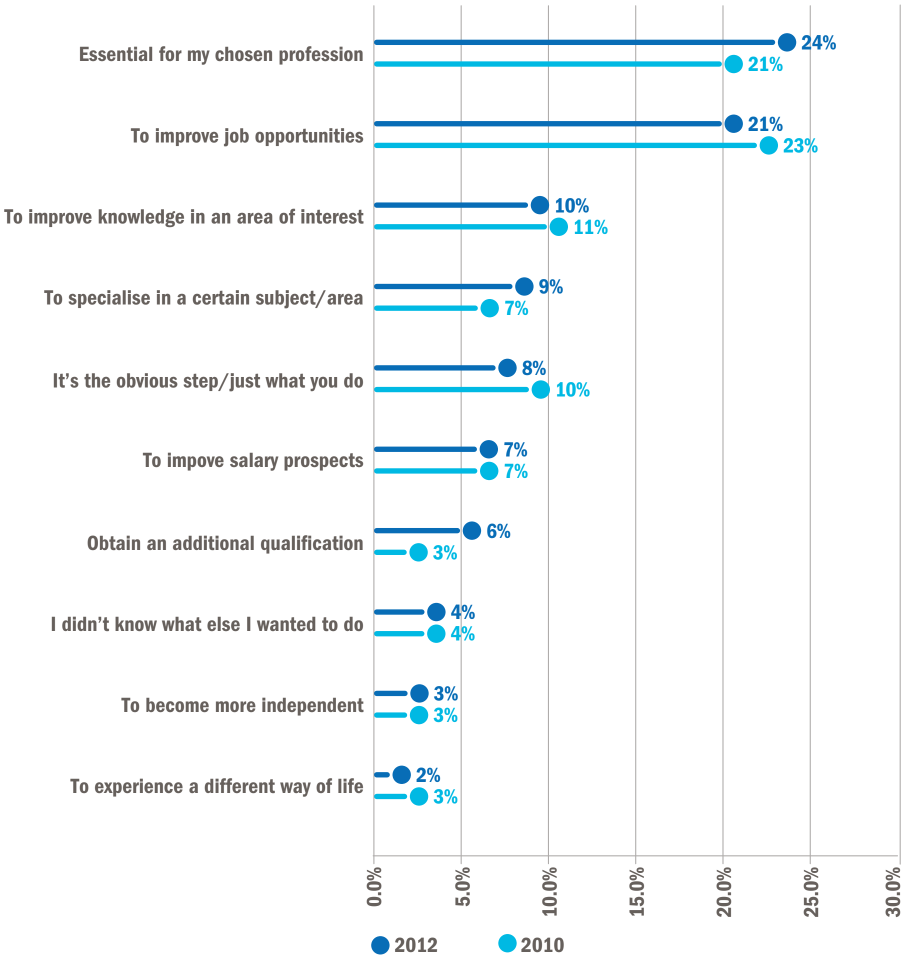
The largest STEM subject by number of applicants was biological sciences, which in 2012/13 had 50,241 applicants. It was also the only STEM subject where over half (57.2%) of the applicants were female. In 2012/13, biological sciences had a 9.2% increase in the number of applicants compared with the previous year. This large increase was particularly influenced by the number of applicants from outside the EU, which grew 13.5% compared with 9.9% for the EU and 8.9% for the UK. Over 10 years, the number of applicants has increased by 50%, from 33,501 in 2003/04 to 50,241 in 2012/13. The 10-year increase in applicant numbers has been driven by students from outside the UK. EU applicants have increased by 135.8%, compared with 92.1% for non-EU applicants and 44.1% for UK applicants.

The second largest STEM subject is mathematical and computer sciences which in 2012/13 had 33,248 applicants. Compared with the previous year, mathematical and computer sciences grew by 8.0%, with the number of EU applicants growing by 8.8%, compared with 6.4% for EU applicants and 2.8% for non-EU applicants. Over 10 years, there has been growth of 26.6% in applicant numbers. The increase in UK applicants is very close to this overall increase (27.1%). EU applicant numbers increased by 121.5% compared with a 6.8% decline from non-EU applicants.

Technology was the smallest STEM subject in each of the 10 years considered. In 2012/13, it attracted 1,687 applicants, which was a decrease of 10.8% on the previous year. However, the 10-year trend was positive, with an increase of 12.2%. Over 10 years, there has been growth in applicants from the UK (15.9%) and the EU (23.7%) but non-EU applicant numbers declined by 13.3%.

Physical sciences had growth of 5.9% in 2012/13 when compared with the previous year. There was higher growth from UK-based applicants (6.3%) than there was from the EU (2.5%) or from outside the EU (3.5%). Over 10 years, there has been significant growth in applicants from outside of the UK: EU applicant numbers rose by 170.1% and non-EU applicants increasing by 112.8%, compared with a 56.7% increase from those in the UK. It is also interesting to note that 37.6% of all applicants were female – the second highest proportion for all STEM subjects.

Fig. 11.7: Top ten reasons for going to university (2010 and 2012)



Source: YouthSight[991]

990 UCAS applicants are those who apply to full-time, undergraduate Higher Education courses (First Degrees, HNC/HNDs etc) offered by universities or colleges who are members of the UCAS scheme. Some applicants, predominantly international, apply directly without going through UCAS **991** *YouthSight Fact File 2013/14*, YouthSight, p18

Table 11.3: Applicants to STEM HE courses by domicile (2003/04-2012/13)[992 993]

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
Biological sciences	UK	30,654	32,537	31,172	32,923	34,903	37,037	41,895	43,016	40,581	44,180	8.9%	44.1%
	EU	1,355	1,510	1,727	1,784	1,752	2,086	2,658	2,939	2,906	3,195	9.9%	135.8%
	Non-EU	1,492	1,567	1,383	1,421	1,454	1,682	1,920	2,210	2,525	2,866	13.5%	92.1%
	Total	**33,501**	**35,614**	**34,282**	**36,128**	**38,109**	**40,805**	**46,473**	**48,165**	**46,012**	**50,241**	**9.2%**	**50.0%**
	All female applicants	20,425	21,339	20,484	21,663	22,615	23,803	26,343	27,291	26,220	28,717	9.5%	40.6%
	Percentage female applicants	61.0%	59.9%	59.8%	60.0%	59.3%	58.3%	56.7%	56.7%	57.0%	57.2%	0.4%	-6.2%
	Percentage non-UK	8.5%	8.6%	9.1%	8.9%	8.4%	9.2%	9.9%	10.7%	11.8%	12.1%	2.5%	42.4%
	Percentage non-EU	4.5%	4.4%	4.0%	3.9%	3.8%	4.1%	4.1%	4.6%	5.5%	5.7%	3.6%	26.7%
Physical sciences	UK	12,200	13,159	13,246	14,168	14,826	15,637	17,178	18,336	17,993	19,121	6.3%	56.7%
	EU	432	479	561	692	708	860	1,070	1,191	1,138	1,167	2.5%	170.1%
	Non-EU	649	746	692	707	880	961	1,113	1,145	1,334	1,381	3.5%	112.8%
	Total	**13,281**	**14,384**	**14,499**	**15,567**	**16,414**	**17,458**	**19,361**	**20,672**	**20,465**	**21,669**	**5.9%**	**63.2%**
	All female applicants	5,091	5,602	5,657	6,068	6,519	6,886	7,515	7,773	7,579	8,146	7.5%	60.0%
	Percentage female applicants	38.3%	38.9%	39.0%	39.0%	39.7%	39.4%	38.8%	37.6%	37.0%	37.6%	1.6%	-1.8%
	Percentage non-UK	8.1%	8.5%	8.6%	9.0%	9.7%	10.4%	11.3%	11.3%	12.1%	11.8%	-2.5%	45.7%
	Percentage non-EU	4.9%	5.2%	4.8%	4.5%	5.4%	5.5%	5.7%	5.5%	6.5%	6.4%	-1.5%	30.6%
Mathematical and computer sciences	UK	22,107	21,929	21,086	20,967	22,373	24,988	27,274	28,152	25,843	28,105	8.8%	27.1%
	EU	996	1,093	1,143	1,441	1,444	1,674	1,982	2,448	2,074	2,206	6.4%	121.5%
	Non-EU	3,152	3,228	2,493	2,694	2,683	2,700	2,978	2,807	2,858	2,937	2.8%	-6.8%
	Total	**26,255**	**26,250**	**24,722**	**25,102**	**26,500**	**29,362**	**32,234**	**33,407**	**30,775**	**33,248**	**8.0%**	**26.6%**
	All female applicants	5,279	5,249	5,243	5,508	5,917	6,558	6,794	6,978	6,218	6,359	2.3%	20.5%
	Percentage female applicants	20.1%	20.0%	21.2%	21.9%	22.3%	22.3%	21.1%	20.9%	20.2%	19.1%	-5.4%	-5.0%
	Percentage non-UK	15.8%	16.5%	14.7%	16.5%	15.6%	14.9%	15.4%	15.7%	16.0%	15.5%	-3.1%	-1.9%
	Percentage non-EU	12.0%	12.3%	10.1%	10.7%	10.1%	9.2%	9.2%	8.4%	9.3%	8.8%	-5.4%	-26.7%
Engineering	UK	14,619	14,913	13,856	14,679	16,313	18,910	20,464	21,206	20,300	21,656	6.7%	48.1%
	EU	1,853	1,918	2,084	2,406	2,302	2,749	2,976	3,086	2,653	2,663	0.4%	43.7%
	Non-EU	5,798	6,027	5,198	5,514	6,121	6,610	7,141	6,910	7,404	7,707	4.1%	32.9%
	Total	**22,270**	**22,858**	**21,138**	**22,599**	**24,736**	**28,269**	**30,581**	**31,202**	**30,357**	**32,026**	**5.5%**	**43.8%**
	All female applicants	2,491	2,542	2,314	2,665	3,030	3,436	3,661	3,794	3,942	4,164	5.6%	67.2%
	Percentage female applicants	11.2%	11.1%	10.9%	11.8%	12.2%	12.2%	12.0%	12.2%	13.0%	13.0%	0.0%	16.1%
	Percentage non-UK	34.4%	34.8%	34.4%	35.0%	34.1%	33.1%	33.1%	32.0%	33.1%	32.4%	-2.1%	-5.8%
	Percentage non-EU	26.0%	26.4%	24.6%	24.4%	24.7%	23.4%	23.4%	22.1%	24.4%	24.1%	-1.2%	-7.3%
Technology	UK	1,193	1,219	1,362	1,571	1,731	2,006	2,092	2,062	1,532	1,383	-9.7%	15.9%
	EU	93	83	96	108	132	140	164	162	161	115	-28.6%	23.7%
	Non-EU	218	210	172	158	211	227	219	198	198	189	-4.5%	-13.3%
	Total	**1,504**	**1,512**	**1,630**	**1,837**	**2,074**	**2,373**	**2,475**	**2,422**	**1,891**	**1,687**	**-10.8%**	**12.2%**
	All female applicants	349	334	357	316	318	348	335	335	286	252	-11.9%	-27.8%
	Percentage female applicants	23.2%	22.1%	21.9%	17.2%	15.3%	14.7%	13.5%	13.8%	15.1%	14.9%	-1.3%	-35.7%
	Percentage non-UK	20.7%	19.4%	16.4%	14.5%	16.5%	15.5%	15.5%	14.9%	19.0%	18.0%	-5.3%	-13.0%
	Percentage non-EU	14.5%	13.9%	10.6%	8.6%	10.2%	9.6%	8.8%	8.2%	10.5%	11.2%	6.7%	-22.8%

992 Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of applicants in 2012/13 have been excluded from this analysis 993 The JACS coding system has been updated from JACS 2.0 to JACS 3.0 for the 2012/13 entry cycle, further details can be found at https://www.hesa.ac.uk/jacs3

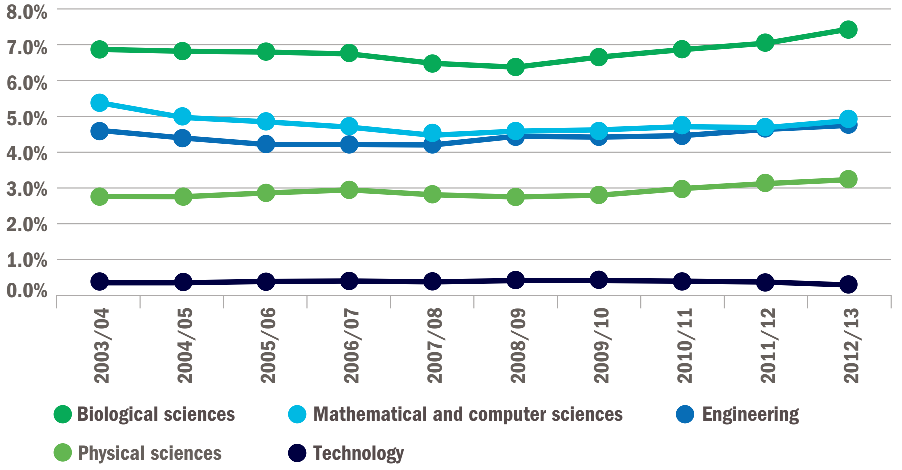
Table 11.3: Applicants to STEM HE courses by domicile (2003/04-2012/13) – continued

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
All subject areas	UK	413,334	444,630	432,196	454,148	502,461	544,285	586,821	589,350	544,752	562,349	3.2%	36.1%
	EU	25,217	28,708	29,932	33,621	34,530	39,504	47,318	49,275	43,149	43,662	1.2%	73.1%
	Non-EU	47,477	48,817	44,176	46,726	51,698	56,071	63,212	61,536	65,736	67,985	3.4%	43.2%
	Total	**486,028**	**522,155**	**506,304**	**534,495**	**588,689**	**639,860**	**697,351**	**700,161**	**653,637**	**673,996**	**3.1%**	**38.7%**
	All female applicants	262,236	283,491	277,183	293,591	328,811	355,103	390,444	393,096	368,569	380,284	3.2%	45.0%
	Percentage female applicants	54.0%	54.3%	54.7%	54.9%	55.9%	55.5%	56.0%	56.1%	56.4%	56.4%	0.0%	4.4%
	Percentage non-UK	15.0%	14.8%	14.6%	15.0%	14.6%	14.9%	15.8%	15.8%	16.7%	16.6%	-0.6%	10.7%
	Percentage non-EU	9.8%	9.3%	8.7%	8.7%	8.8%	8.8%	9.1%	8.8%	10.1%	10.1%	0.0%	3.1%

Source: UCAS

Figure 11.8 shows the 10-year trend in the proportion of applicants to STEM HE courses as a percentage of all applicants. It shows that consistently between 6-8% of all applicants choose to study biological sciences. The proportion who select mathematical and computer sciences has declined from 5.4% in 2003/04 to 4.9% in 2012/13. Meanwhile, the proportion of all applicants who choose engineering and physical sciences has increased slightly over the 10 years.

Fig. 11.8: Trends in applicants to STEM HE courses as a percentage of all applicants (2003/04-2012/13) – all domiciles[994]



Source: UCAS

994 Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of applicants in 2012/13 have been excluded from this analysis

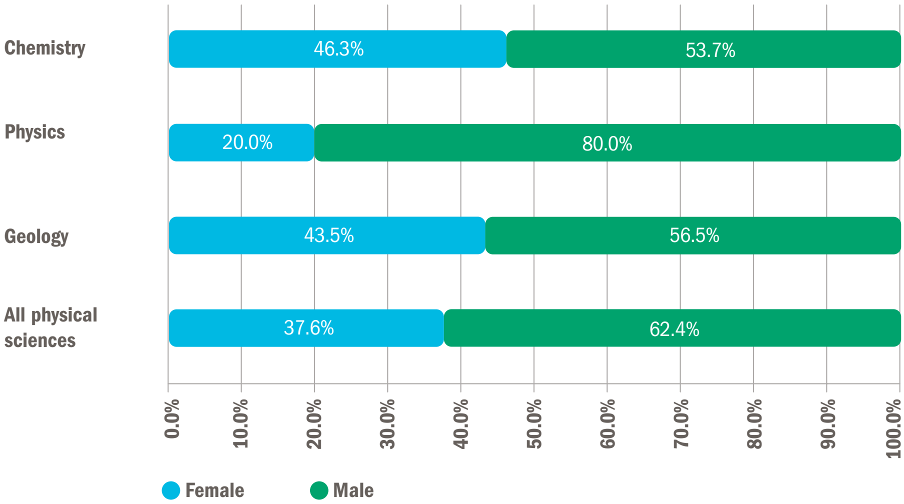
11.4.2 Applicants to STEM by gender[995]

Figure 11.9 shows that although 37.6% of all applicants to physical sciences are female, some sharp differences appear when you look at different sub-categories within physical sciences. Both chemistry and geology are close to gender parity.[996] By comparison, only one in five (20.0%) physics applicants are female.

For mathematical and computer sciences (Figure 11.10), over a third (36.7%) of applicants to mathematics are female compared with just over one in nine (12.1%) applicants to computer science, which means that an applicant to mathematics is three times more likely to be female than an applicant to computer science.

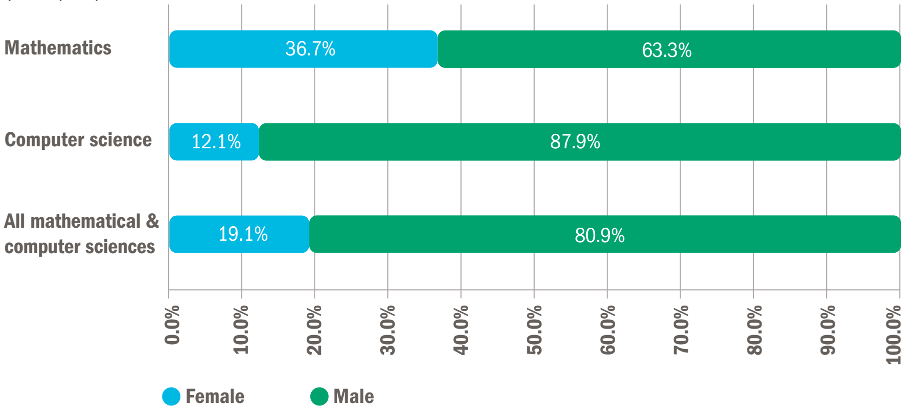
The overall proportion of female applicants to engineering and technology (Figure 11.11) was 13.1%, with technology (14.8%) performing slightly better than engineering (12.9%).

Fig. 11.9: Applicant numbers in physical sciences by gender and subject type (2012/13) – all domiciles[997 998 999 1000]



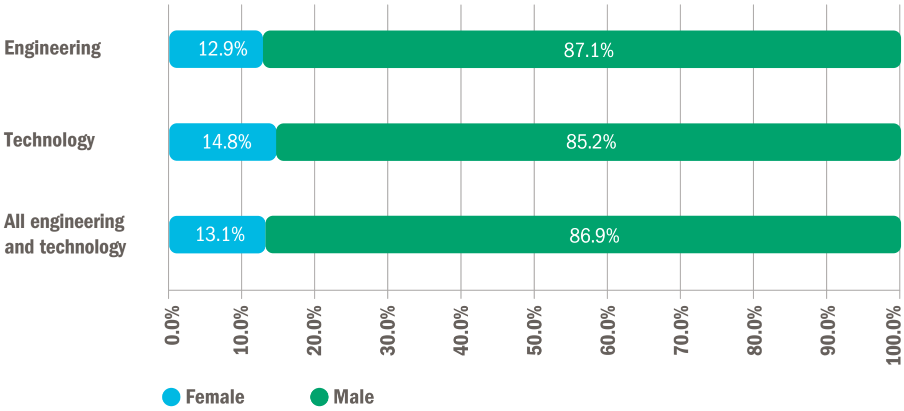
Source: UCAS

Fig. 11.10: Proportion of female applicants in mathematical and computer sciences subjects (2012/13) – all domiciles



Source: UCAS

Fig. 11.11: Applicant numbers in engineering and technology by gender (2003/04-2012/13) – all domiciles[1001]



Source: UCAS

995 Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of applicants in 2012/13 have been excluded from this analysis **996** Close to gender parity is defined as neither gender is below 40% **997** Chemistry comprises chemistry and forensic and archaeology sciences **998** Physics comprises physics and astronomy **999** Geology comprises geology, science of aquatic and terrestrial environments and physical geographical sciences **1000** Applicants choosing materials science, others in physical science, combinations within physical science and no preferred subject line have been excluded from this chart **1001** Applicants with no preferred subject line have been excluded from the calculation for mathematics and computer science

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11.4.3 Applicants to engineering by sub-discipline[1002]

Tables 11.4-11.10 provide a breakdown of applicants to selected engineering sub-disciplines by domicile status and whether they are female or not. Overall, they show that mechanical engineering is the largest engineering sub-discipline but that chemical, process and energy engineering has had the largest growth over 10 years (237.1%).

Table 11.4: Applicants to general engineering (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	754	853	855	824	1,070	1,299	1,470	1,381	1,262	1,334	5.7%	76.9%
EU (excluding UK)	84	118	183	176	151	200	192	181	159	198	24.5%	135.7%
Non-EU	147	185	229	215	246	283	355	277	381	430	12.9%	192.5%
Total non-UK	231	303	412	391	397	483	547	458	540	628	16.3%	171.9%
Female	141	164	172	168	208	273	276	278	335	322	-3.9%	128.4%
Total	**985**	**1,156**	**1,267**	**1,215**	**1,467**	**1,782**	**2,017**	**1,839**	**1,802**	**1,962**	**8.9%**	**99.2%**
Percentage of non-EU	14.9%	16.0%	18.1%	17.7%	16.8%	15.9%	17.6%	15.1%	21.1%	21.9%	0.5%	47.0%
Percentage of female applicants	14.3%	14.2%	13.6%	13.8%	14.2%	15.3%	13.7%	15.1%	18.6%	16.4%	-11.2%	14.7%

Source: UCAS

Table 11.5: Applicants to civil engineering (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	2,205	2,557	2,453	2,924	3,479	3,868	3,810	3,803	3,262	3,104	-4.8%	40.8%
EU (excluding UK)	607	626	698	831	879	960	939	880	521	425	-18.4%	-30.0%
Non-EU	739	714	616	760	863	970	1,160	1,181	1,286	1,253	-2.6%	69.6%
Total non-UK	1346	1340	1314	1591	1742	1930	2,099	2,061	1,807	1,678	-7.1%	24.7%
Female	488	561	514	627	838	865	923	907	835	787	-5.7%	61.3%
Total	**3,551**	**3,897**	**3,767**	**4,515**	**5,221**	**5,798**	**5,909**	**5,864**	**5,069**	**4,782**	**-5.7%**	**34.7%**
Percentage of non-EU	20.8%	18.3%	16.4%	16.8%	16.5%	16.7%	19.6%	20.1%	25.4%	26.2%	3.1%	26.0%
Percentage of female applicants	13.7%	14.4%	13.6%	13.9%	16.1%	14.9%	15.6%	15.5%	16.5%	16.5%	0.0%	20.4%

Source: UCAS

1002 Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of applicants in 2012/13 have been excluded from this analysis

Table 11.6: Applicants to mechanical engineering (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	3,797	3,839	3,560	3,888	4,515	5,417	6,090	6,604	6,699	7,416	10.7%	95.3%
EU (excluding UK)	386	449	412	483	447	588	667	782	818	854	4.4%	121.2%
Non-EU	1,174	1,265	1,149	1,307	1,460	1,619	1,757	1,834	1,996	2,243	12.4%	91.1%
Total non-UK	1,560	1,714	1,561	1,790	1,907	2,207	2,424	2,616	2,814	3,097	10.1%	98.5%
Female	386	378	339	427	450	554	545	661	754	878	16.4%	127.5%
Total	**5,357**	**5,553**	**5,121**	**5,678**	**6,422**	**7,624**	**8,514**	**9,220**	**9,513**	**10,513**	**10.5%**	**96.2%**
Percentage of non-EU	21.9%	22.8%	22.4%	23.0%	22.7%	21.2%	20.6%	19.9%	21.0%	21.3%	1.4%	-2.7%
Percentage of female applicants	7.2%	6.8%	6.6%	7.5%	7.0%	7.3%	6.4%	7.2%	7.9%	8.4%	6.3%	16.7%

Source: UCAS

Table 11.7: Applicants to aerospace engineering (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	1,628	1,673	1,647	1,714	1,760	2,101	2,399	2,454	2,281	2,431	6.6%	49.3%
EU (excluding UK)	112	113	151	146	145	201	254	277	264	282	6.8%	151.8%
Non-EU	379	472	447	465	493	609	710	612	613	584	-4.7%	54.1%
Total non-UK	491	585	598	611	638	810	964	889	877	866	-1.3%	76.4%
Female	204	205	170	236	252	270	353	382	324	345	6.5%	69.1%
Total	**2,119**	**2,258**	**2,245**	**2,325**	**2,398**	**2,911**	**3,363**	**3,343**	**3,158**	**3,297**	**4.4%**	**55.6%**
Percentage of non-EU	17.9%	20.9%	19.9%	20.0%	20.6%	20.9%	21.1%	18.3%	19.4%	17.7%	-8.8%	-1.1%
Percentage of female applicants	9.6%	9.1%	7.6%	10.2%	10.5%	9.3%	10.5%	11.4%	10.3%	10.5%	1.9%	7.1%

Source: UCAS

Table 11.8: Applicants to electronic and electrical engineering (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	3,146	2,934	2,462	2,381	2,504	2,766	2,937	3164	2,915	3,070	5.3%	-2.4%
EU (excluding UK)	376	335	336	397	339	399	442	494	463	444	-4.1%	18.1%
Non-EU	2,330	2,190	1,696	1,621	1,773	1,729	1,705	1543	1,551	1,534	-1.1%	-34.2%
Total non-UK	2706	2525	2032	2018	2112	2128	2,147	2,037	2,014	1,978	-1.8%	-26.9%
Female	630	527	424	425	422	498	491	484	502	521	3.8%	-17.3%
Total	**5,852**	**5,459**	**4,494**	**4,399**	**4,616**	**4,894**	**5,084**	**5201**	**4,929**	**5,048**	**2.4%**	**-13.7%**
Percentage of non-EU	39.8%	40.1%	37.7%	36.8%	38.4%	35.3%	33.4%	29.7%	31.5%	30.4%	-3.5%	-23.6%
Percentage of female applicants	10.8%	9.7%	9.4%	9.7%	9.1%	10.2%	9.7%	9.3%	10.2%	10.3%	1.0%	-4.6%

Source: UCAS

Table 11.9: Applicants to production and manufacturing engineering (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	801	721	467	424	376	369	401	355	280	265	-5.4%	-66.9%
EU (excluding UK)	31	29	13	31	12	26	20	18	21	0	-100.0%	-100.0%
Non-EU	91	96	68	65	44	69	35	42	35	25	-28.6%	-72.5%
Total non-UK	122	125	81	96	56	95	55	60	56	25	-55.4%	-79.5%
Female	125	138	103	121	98	102	95	82	72	68	-5.6%	-45.6%
Total	**923**	**846**	**548**	**520**	**432**	**464**	**456**	**415**	**336**	**290**	**-13.7%**	**-68.6%**
Percentage of non-EU	9.9%	11.3%	12.4%	12.5%	10.2%	14.9%	7.7%	10.1%	10.4%	8.6%	-17.3%	-13.1%
Percentage of female applicants	13.5%	16.3%	18.8%	23.3%	22.7%	22.0%	20.8%	19.8%	21.4%	23.4%	9.3%	73.3%

Source: UCAS

Table 11.10: Applicants to chemical, process and energy engineering (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	561	683	713	877	1,042	1,240	1,302	1,499	1,701	2,144	26.0%	282.2%
EU (excluding UK)	48	51	62	84	91	105	128	148	148	190	28.4%	295.8%
Non-EU	420	494	493	553	681	786	855	902	1,002	1,135	13.3%	170.2%
Total non-UK	468	545	555	637	772	891	983	1,050	1,150	1,325	15.2%	183.1%
Female	267	323	335	388	475	569	618	673	761	891	17.1%	233.7%
Total	**1,029**	**1,228**	**1,268**	**1,514**	**1,814**	**2,131**	**2,285**	**2,549**	**2,851**	**3,469**	**21.7%**	**237.1%**
Percentage of non-EU	40.8%	40.2%	38.9%	36.5%	37.5%	36.9%	37.4%	35.4%	35.1%	32.7%	-6.8%	-19.9%
Percentage of female applicants	25.9%	26.3%	26.4%	25.6%	26.2%	26.7%	27.0%	26.4%	26.7%	25.7%	-3.7%	-0.8%

Source: UCAS

11.4.4 Female applicants to selected engineering sub-disciplines[1003]

The proportion of female applicants to different engineering sub-disciplines over a 10-year period is shown in Figure 11.12. It shows that chemical, process and energy engineering, which was identified in the previous section as having the highest percentage growth over the 10-year period, also had the highest proportion of women for each of the 10 years. From 2003/04 to 2012/13, at least a quarter of applicants to chemical, process and energy engineering were female. If the engineering community wants to understand how to attract more women into engineering, then understanding why women are attracted to this sub-discipline would provide a valuable insight.

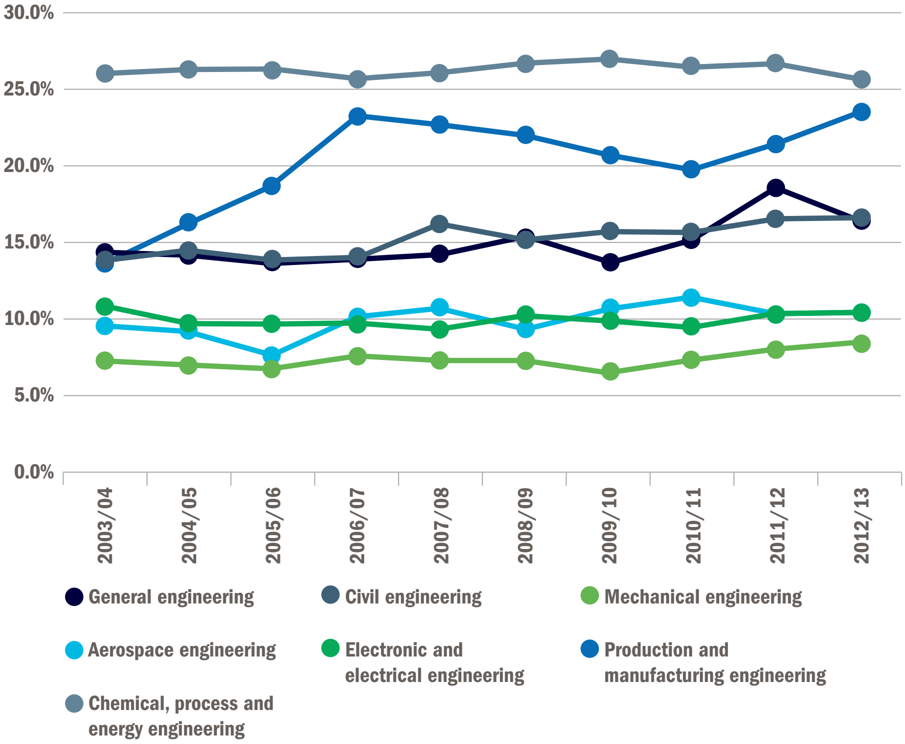
Similarly, in 2003/04 13.5% of applicants to production and manufacturing engineering were female. However, by 2012/13 this had increased to 23.4%. While chemical, process and energy engineering had only 290 applicants in 2012/13, understanding what has changed in the last 10 years to encourage women to apply to this subject area would also provide valuable insights into how to potentially increase the proportion of female applicants in other engineering sub-disciplines.

In each of the 10 years considered, mechanical engineering had the lowest proportion of female engineers, ranging from 6.4% in 2009/10 to 8.4% in 2012/13.

Although there has been some fluctuation over the last ten years, the proportion of female applicants for aerospace engineering and electronic and electrical engineering has hovered around one in 10, with the exception of 2005/06 when the proportion of female applicants to aerospace engineering declined to 7.6%.

The proportion of female applicants in general engineering and civil engineering was similar in 2012 and 2013 (16.4% and 16.5% respectively). This is a slight increase on 2003/04 when it was 14.3% and 13.7%.

Fig. 11.12: Proportion of female applicants by sub discipline (2003/04-2012/13) – all domiciles



Source: UCAS

11.4.5 Educational backgrounds of applicants to full-time undergraduate HE courses[1004]

When you look at the educational background of UK-based applicants by engineering sub-discipline, some interesting differences appear (Figure 11.13). Overall, 15.4% of applicants to all subjects come from students with a Further Education (FE) background. However, looking at different engineering sub-disciplines shows that nearly a quarter (23.9%) of applicants to electronic and electrical engineering came from an FE background. By comparison, the proportion of applicants to general engineering (10.5%), production and manufacturing engineering (6.6%) and chemical, process and energy engineering were well below the average for all subjects (5.8%).

Across all subjects, 6.1% of all applicants had an independent school background. However, production and manufacturing engineering and general engineering had more than double this average (15.3% and 15.0% respectively). In addition, one in 10 (10.7%) applicants to mechanical engineering had an independent school background.

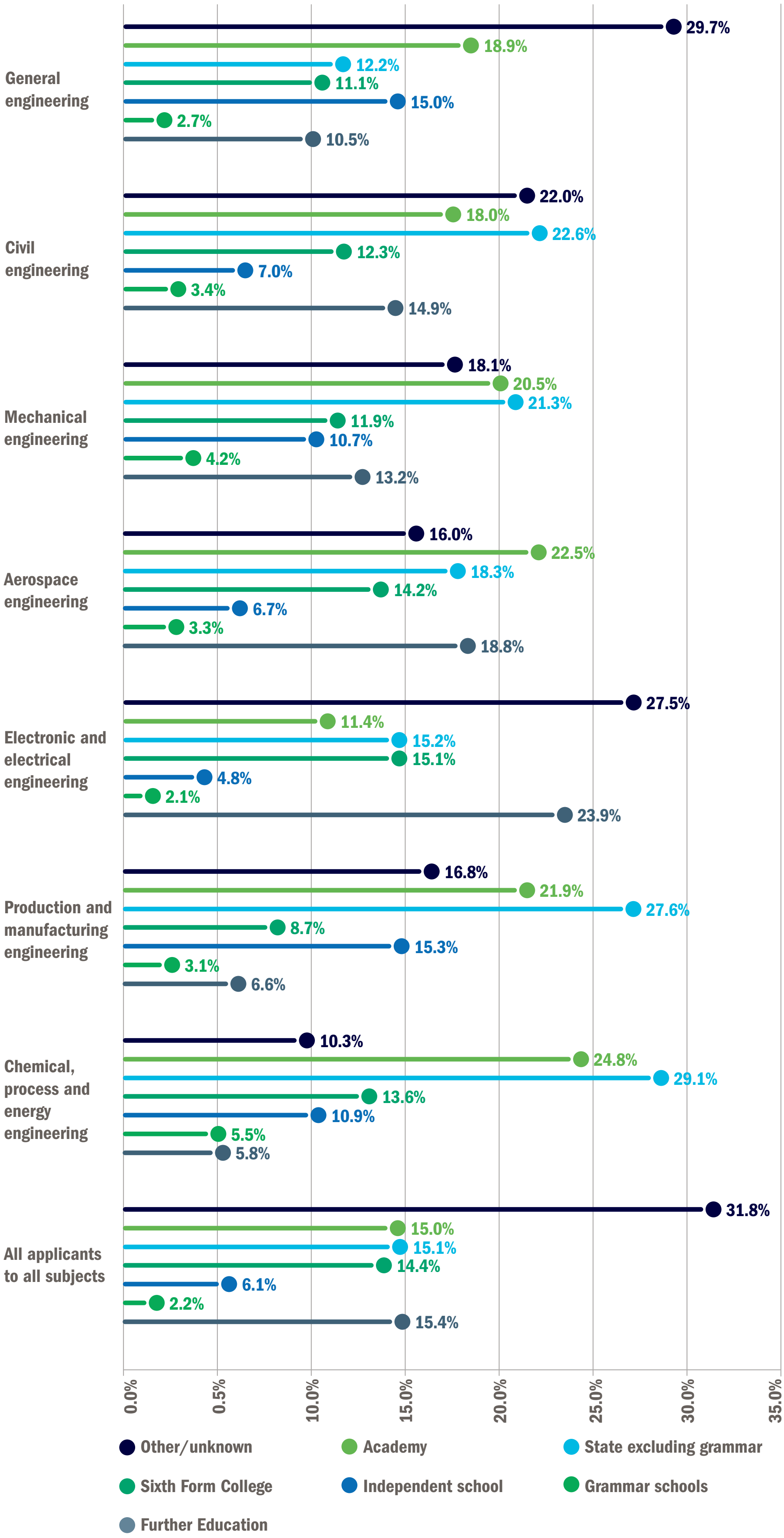
Although only 7% of UK school students attend an independent school, around 90% of students from the top independent schools go on to HE, compared with 48% of state-educated students.[1005]

Nearly one in seven (15.1%) of all applicants had a state education (excluding grammar schools). But almost double (29.1%) the average number of applicants to chemical, process and energy engineering were state educated. Production and manufacturing engineering (27.6%), civil engineering (22.6%) and mechanical engineering (21.3%) all had well above the average number of state-educated applicants.

Overall, 15.0% of all students have an Academy school background. However, 24.8% of applicants to chemical, process and energy engineering went to Academy schools, along with 22.5% of aerospace engineering applicants, 21.9% of production and manufacturing engineering applicants and 20.5% of mechanical engineering applicants. The only engineering sub-discipline to have fewer than average applicants from Academy schools was electronic and electrical engineering (11.4%).

1003 Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of applicants in 2012/13 have been excluded from this analysis **1004** Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of applicants in 2012/13 have been excluded from this analysis **1005** *Schools United Ending the divide between independent and state*, Social Market Foundation, 2014, p17

Fig. 11.13: Educational background of applicants to engineering undergraduate level full-time HE courses by selected sub-discipline (2012/13) – UK domiciled



Source: UCAS

A total of 14.4% of all applicants across all subjects had a Sixth Form College background. The only engineering sub-discipline to have a noteworthy variation from this average was production and manufacturing engineering at 8.7%.

Finally, 2.2% of all applicants went to a grammar school. There was little variation from this average for different engineering sub-disciplines, with the largest variation being 3.3 percentage points for chemical, process and energy engineering (5.5%).

Analysis by the Sixth Form Colleges' Association[1006] has shown that nearly two thirds (65.1%) of students in Sixth Form Colleges progress to HE compared with Academy sixth forms (64.0%), maintained schools sixth forms (62.7%) and general FE Colleges (44.9%).

11.4.6 Ethnicity of applicants[1007]

The ethnic breakdown of applicants to different subject areas is shows in Figure 11.14. It shows that veterinary science, agriculture and related was the subject area with the highest proportion of white applicants (98.3%) while medicine and dentistry had the lowest proportion (57.0%).

Looking at the different STEM subjects it can be seen that nearly three quarters (73.7%) of applicants to engineering were white. The second largest ethnic group was Asian with 14.0%, followed by black (7.8%).

Computer science was the STEM subject with the lowest percentage of white applicants (72.0%). Like engineering, the second largest ethnic group was Asian (16.1%), followed by black (7.5%).

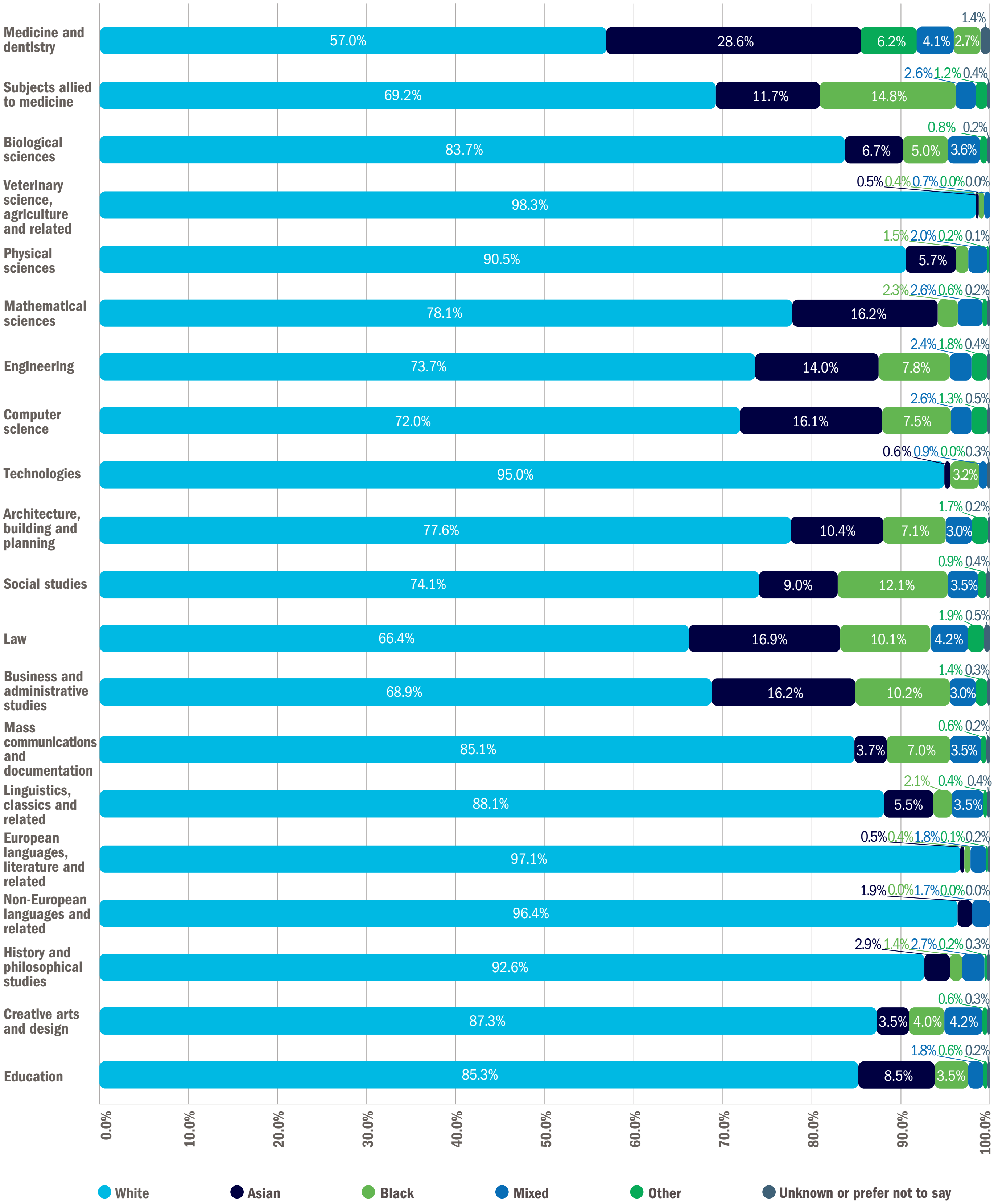
Physical sciences was the STEM subject with the largest proportion of white applicants (90.5%), followed by Asian (5.7%) and those of a mixed ethnic background (2.0%).

Over three quarters (78.1%) of applicants to mathematical sciences were white, with Asians being the next largest ethnic group (16.2%). All other ethnic groups made up a small proportion of applicants to mathematical sciences, with mixed ethnic background being the third largest group, representing 2.6% of all applicants.

For biological sciences, 83.7% of applicants were white, followed by Asian (6.7%) and black (5.0%) applicants.

1006 *Assessing value for money in sixth form education*, London Econometrics and the Sixth Form Colleges' Association, June 2014, p12 **1007** Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of applicants in 2012/13 have been excluded from this analysis

Fig. 11.14: Breakdown by ethnicity of applicants across HE subject areas (2012/13) – UK domiciled[1008]



Source: UCAS

1008 Subject areas Y combined subjects and Z general, other combined and unknown plus no preferred subject lines have been excluded from this analysis

Table 11.11 shows that the proportion of white applicants to engineering has declined each year from 2005/06 to 2010/11 (from 75.8% to 70.9%). However, it increased in 2011/12 to reach 73.8% and has barely changed in the last year.

The proportion of Asian applicants has, with the exception of a couple of blips, increased over the 10-year trend period, from 11.2% in 2003/04 to 14.0% in 2012/13. There has also been an increase in the proportion of black applicants, reaching a high point of 8.8% in 2010/11. However, in the last two years this proportion has declined slightly.

Table 11.11: Percentage split of engineering applicants by ethnic group (2003/04-2012/13) – UK domiciled

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Asian	11.2%	10.7%	11.7%	12.0%	12.7%	12.9%	13.4%	14.2%	13.8%	14.0%
Black	5.6%	6.4%	7.1%	7.8%	7.8%	8.2%	8.3%	8.8%	7.9%	7.8%
Mixed	1.7%	2.5%	2.3%	2.8%	2.7%	3.0%	3.1%	3.2%	2.4%	2.4%
Other	1.1%	1.3%	1.5%	1.5%	1.3%	1.5%	1.5%	1.9%	1.9%	1.8%
Unknown or prefer not to say	4.9%	3.9%	1.6%	1.8%	1.7%	0.9%	1.1%	1.0%	0.3%	0.4%
White	75.6%	75.2%	75.8%	74.1%	73.8%	73.5%	72.6%	70.9%	73.8%	73.7%

Source: UCAS

11.5 Accepted applicants to STEM degrees[1009]

The closest measure of the number of starts in a subject area is accepted applicants. The breakdown of accepted applicants to different STEM subjects is shown in Table 11.12. Overall, accepted applicants increased by 6.0% in the last year. Accepted applicants from the UK rose faster than average, increasing by 6.5% compared with 3.0% for non-EU students and 1.1% for EU students. However, if you look at the 10-year trend the pattern is slightly different. All accepted applicants increased by 30.5%, but the only domicile group to increase by more than average was EU accepted applicants, which rose by 52.0%. Accepted applicants from the UK increased by 29.8%, while non-EU accepted applicants rose by 27.1%.

The number of accepted applicants to engineering increased by more than the average for all subjects in 2012/13, rising by 6.8%. Those from the UK increased by 8.2%, compared with 5.7% rise from outside the EU and a decline of 4.7% from those in the EU. Over 10 years, the number of accepted applicants from the UK increased by a third (33.3%) from 15,505 in 2003/04 to 20,669 in 2012/13. This increase was larger than the corresponding increase for the EU (9.1%), while accepted applicants from outside the EU actually fell by 5.2%. However, it should also be noted that the proportion of all accepted applicants to engineering who are female has declined from 13.4% in 2011/12 to 13.1% in 2012/13. Looking just at UK domiciled accepted applicants shows that 11.6% were female, which is lower than the proportion of all accepted applicants.

The STEM subject with the largest number of accepted applicants is biological sciences, with a total of 44,245 in 2012/13 – an increase of 11.7%. The number of accepted applicants from the UK increased by 12.1%, compared with 5.9% for those from the EU and 6.8% for those from outside the EU. However, when you look at the 10-year trend the pattern is different, with those from the EU rising by 73.6%, compared with an increase of 54.5% from outside the EU and 46.8% from the UK. Biological sciences is also the only STEM subject where more than half of accepted applicants are female, at 58.4% in 2012/13.

The smallest of the STEM subjects is technology, which in 2012/13 had 2,398 accepted applicants. This was an increase of 2.3% on the previous year, which is below the average for all subjects. In 2012/13, the number of accepted applicants increased by 4.6% for those from the UK, compared with a decline of 18.8% from the EU and 4.8% from outside the EU. However, the proportion of female applicants did increase to 18.1% compared with 16.4% the previous year.

The only other STEM subject to have a below-average increase in the number of accepted applicants in 2012/13 was physical sciences, which increased by 5.0%. Examining the data by domicile status shows that UK accepted applicants increased by 5.5%, compared with 4.6% for those from the EU, while there was a decline amongst those from outside the EU (down by 4.7%). Over the 10-year trend period, the pattern by domicile status is different. Overall, the number of accepted applicants has increased by 37.4%, with those from the EU almost doubling (up 94.7%), while those from outside the EU are up by almost half (46.4%). By comparison, accepted applicants from the UK increased by just over a third (35.4%). Finally, it is worth noting that the proportion of female applicants in 2012/13 was 39.3%, up from 38.6% the previous year but still behind the peak of 40.6%.

The final STEM subject is mathematical and computer sciences. When you look at the one-year and 10-year trends for this subject area some interesting patterns emerge. Over 10 years, the total number of accepted applicants increased by 17.3%, but most of this increase – 9.2% – occurred in the last year. Similarly, accepted applicants from the UK increased by a fifth (20.3%) over 10 years and by 10.7% in the last year. However, the pattern for accepted applicants from outside the UK is very different to the pattern described above. Accepted applicants from the EU increased by two thirds (67.2%) over 10 years, but in 2012/13 only increased by 1.6%. Meanwhile, for those outside the EU, numbers have decreased by a quarter (26.0%) over 10 years and decreased by 3.4% in the last year.

Table 11.12: Number of accepted applicants to STEM degrees by subject area and domicile (2003/04-2012/13)

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
Biological sciences	UK	27,735	30,662	29,051	30,976	33,189	34,316	35,781	36,978	36,305	40,715	12.1%	46.8%
	EU	1,101	1,182	1,294	1,366	1,372	1,594	1,736	1,902	1,804	1,911	5.9%	73.6%
	Non-EU	1,048	1,123	976	979	1,037	1,139	1,375	1,347	1,516	1,619	6.8%	54.5%
	Total	**29,884**	**32,967**	**31,321**	**33,321**	**35,598**	**37,049**	**38,892**	**40,227**	**39,625**	**44,245**	**11.7%**	**48.1%**
	All female accepted applicants	18,386	19,925	18,968	20,147	21,221	21,780	22,424	23,446	23,089	25,821	11.8%	40.4%
	Percentage female accepted applicants	61.5%	60.4%	60.6%	60.5%	59.6%	58.8%	57.7%	58.3%	58.3%	58.4%	0.2%	-5.0%
	Percentage non-UK	7.2%	7.0%	7.2%	7.0%	6.8%	7.4%	8.0%	8.1%	8.4%	8.0%	-4.8%	11.1%
	Percentage non-EU	3.5%	3.4%	3.1%	2.9%	2.9%	3.1%	3.5%	3.3%	3.8%	3.7%	-2.6%	5.7%

Source: UCAS

1009 Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of accepted applicants in 2012/13 have been excluded from this analysis

Table 11.12: Number of accepted applicants to STEM degrees by subject area and domicile (2003/04-2012/13) – continued

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
Physical sciences	UK	13,006	14,064	13,928	14,583	15,182	15,803	16,363	16,843	16,694	17,610	5.5%	35.4%
	EU	376	406	461	612	602	719	777	783	700	732	4.6%	94.7%
	Non-EU	571	604	623	615	739	806	901	838	877	836	-4.7%	46.4%
	Total	**13,953**	**15,074**	**15,012**	**15,810**	**16,523**	**17,328**	**18,041**	**18,464**	**18,271**	**19,178**	**5.0%**	**37.4%**
	All female accepted applicants	5,549	6,066	6,066	6,416	6,706	6,948	7,216	7,323	7,049	7,536	6.9%	35.8%
	Percentage female accepted applicants	39.8%	40.2%	40.4%	40.6%	40.6%	40.1%	40.0%	39.7%	38.6%	39.3%	1.8%	-1.3%
	Percentage non-UK	6.8%	6.7%	7.2%	7.8%	8.1%	8.8%	9.3%	8.8%	8.6%	8.2%	-4.7%	20.6%
	Percentage non-EU	4.1%	4.0%	4.2%	3.9%	4.5%	4.7%	5.0%	4.5%	4.8%	4.4%	-8.3%	7.3%
Mathematical and computer sciences	UK	22,166	22,209	21,046	21,287	23,057	24,920	24,990	25,607	24,079	26,656	10.7%	20.3%
	EU	867	923	999	1,127	1,193	1,379	1,524	1,688	1,427	1,450	1.6%	67.2%
	Non-EU	2,538	2,492	2,119	2,208	2,222	2,239	2,434	1,970	1,945	1,878	-3.4%	-26.0%
	Total	**25,571**	**25,624**	**24,164**	**24,622**	**26,472**	**28,538**	**28,948**	**29,265**	**27,451**	**29,984**	**9.2%**	**17.3%**
	All female accepted applicants	5,372	5,432	5,266	5,459	5,959	6,369	6,390	6,517	5,820	5,958	2.4%	10.9%
	Percentage female accepted applicants	21.0%	21.2%	21.8%	22.2%	22.5%	22.3%	22.1%	22.3%	21.2%	19.9%	-6.1%	-5.2%
	Percentage non-UK	13.3%	13.3%	12.9%	13.5%	12.9%	12.7%	13.7%	12.5%	12.3%	11.1%	-9.8%	-16.5%
	Percentage non-EU	9.9%	9.7%	8.8%	9.0%	8.4%	7.8%	8.4%	6.7%	7.1%	6.3%	-11.3%	-36.4%
Engineering	UK	15,505	15,911	14,814	15,184	16,790	18,313	18,700	19,496	19,097	20,669	8.2%	33.3%
	EU	1,629	1,613	1,854	2,073	1,899	2,077	2,116	2,088	1,865	1,777	-4.7%	9.1%
	Non-EU	4,828	4,535	4,318	4,657	4,830	5,062	5,254	4,438	4,331	4,576	5.7%	-5.2%
	Total	**21,962**	**22,059**	**20,986**	**21,914**	**23,519**	**25,452**	**26,070**	**26,022**	**25,293**	**27,022**	**6.8%**	**23.0%**
	All female accepted applicants	2,681	2,608	2,479	2,739	2,968	3,135	3,258	3,249	3,384	3,553	5.0%	32.5%
	Percentage female accepted applicants	12.2%	11.8%	11.8%	12.5%	12.6%	12.3%	12.5%	12.5%	13.4%	13.1%	-2.2%	7.4%
	Percentage non-UK	29.4%	27.9%	29.4%	30.7%	28.6%	28.0%	28.3%	25.1%	24.5%	23.5%	-4.1%	-20.1%
	Percentage non-EU	22.0%	20.6%	20.6%	21.3%	20.5%	19.9%	20.2%	17.1%	17.1%	16.9%	-1.2%	-23.2%
Technology	UK	2,098	2,117	2,246	2,468	2,592	2,746	2,762	2,460	1,981	2,073	4.6%	-1.2%
	EU	98	103	120	134	147	161	165	137	154	125	-18.8%	27.6%
	Non-EU	303	246	297	312	229	270	317	220	210	200	-4.8%	-34.0%
	Total	**2,499**	**2,466**	**2,663**	**2,914**	**2,968**	**3,177**	**3,244**	**2,817**	**2,345**	**2,398**	**2.3%**	**-4.0%**
	All female accepted applicants	792	746	669	786	638	698	592	517	384	435	13.3%	-45.1%
	Percentage female accepted applicants	31.7%	30.3%	25.1%	27.0%	21.5%	22.0%	18.2%	18.4%	16.4%	18.1%	10.4%	-42.9%
	Percentage non-UK	16.0%	14.2%	15.7%	15.3%	12.7%	13.6%	14.9%	12.7%	15.5%	13.6%	-12.3%	-15.0%
	Percentage non-EU	12.1%	10.0%	11.2%	10.7%	7.7%	8.5%	9.8%	7.8%	9.0%	8.3%	-7.8%	-31.4%
All subject areas	UK	334,295	360,244	345,564	364,544	405,024	425,063	424,634	431,235	407,391	433,929	6.5%	29.8%
	EU	15,452	17,247	18,280	20,661	21,363	23,807	25,607	26,701	23,233	23,485	1.1%	52.0%
	Non-EU	27,797	27,878	27,046	28,225	30,240	32,984	37,088	34,094	34,286	35,328	3.0%	27.1%
	Total	**377,544**	**405,369**	**390,890**	**413,430**	**456,627**	**481,854**	**487,329**	**492,030**	**464,910**	**492,742**	**6.0%**	**30.5%**
	All female accepted applicants	201,887	216,972	210,334	223,745	251,932	263,669	267,244	270,154	256,623	272,089	6.0%	34.8%
	Percentage female accepted applicants	53.5%	53.5%	53.8%	54.1%	55.2%	54.7%	54.8%	54.9%	55.2%	55.2%	0.0%	3.2%
	Percentage non-UK	11.5%	11.1%	11.6%	11.8%	11.3%	11.8%	12.9%	12.4%	12.4%	11.9%	-4.0%	3.4%
	Percentage non-EU	7.4%	6.9%	6.9%	6.8%	6.6%	6.8%	7.6%	6.9%	7.4%	7.2%	-2.7%	-2.7%

Source: UCAS

HEFCE has analysed changes in recruitment trends over recent years and determined that the HE Institutions that have seen an increase of at least 10% in undergraduate full-time entrant numbers tend to be those with high average tariff scores or specialist institutions.[1010] Meanwhile, the HE Institutions where applicant numbers declined by more than 10% tended to be those where entrants had low or medium average tariff scores.

11.5.1 Accepted applicants by selected engineering sub-disciplines[1011]

Tables 11.13 to 11.19 show the breakdown of accepted applicants to different engineering sub-disciplines. Mechanical engineering had the largest number of accepted applicants (7,510), while production and manufacturing engineering had the fewest, at only 631.

It is interesting to note that there were 1,962 (Table 11.4) applicants for general engineering courses in 2012/13, but 3,757 applicants were accepted. This implies that general engineering acquired a sizable number of accepted applicants who didn't apply for the subject. This might help explain why non-continuation rates for general engineering[1012] are above average. However, it should also be noted that those students who qualify in general engineering have a good graduate starting salary.[1013]

Table 11.13: Accepted applicants to First Degrees in general engineering (2003/04-2012/13)

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	2,118	2,347	2,236	2,364	2,597	2,755	2,664	2,305	2,738	3,120	14.0%	47.3%
EU (excluding UK)	170	189	251	275	211	232	218	198	200	219	9.5%	28.8%
Non-EU	443	465	442	443	445	388	355	360	441	418	-5.2%	-5.6%
Total non-UK	613	654	693	718	656	620	573	558	641	637	-0.6%	3.9%
Female	402	406	365	398	441	427	451	426	572	603	5.4%	50.0%
Total	**2,731**	**3,001**	**2,929**	**3,082**	**3,253**	**3,375**	**3,237**	**2,863**	**3,379**	**3,757**	**11.2%**	**37.6%**
Percentage of non-EU	16.2%	15.5%	15.1%	14.4%	13.7%	11.5%	10.8%	12.6%	13.1%	11.1%	-15.3%	-31.5%
Proportion of female students	14.7%	13.5%	12.5%	12.9%	13.6%	12.7%	14.2%	14.9%	16.9%	16.1%	-4.7%	9.5%

Source: UCAS

Table 11.14: Accepted applicants to First Degrees in civil engineering (2003/04-2012/13)

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	One year change	Change over 10 years
UK	2,335	2,563	2,563	2,790	3,281	3,398	3,428	3,564	3,109	2,994	-3.7%	28.2%
EU (excluding UK)	427	425	496	585	687	683	622	511	350	272	-22.3%	-36.3%
Non-EU	629	567	505	571	607	641	892	779	772	812	5.2%	29.1%
Total non-UK	1,056	992	1,001	1,156	1,294	1,324	1,514	1,290	1,122	1,084	-3.4%	2.7%
Female students	448	519	506	571	714	708	790	720	676	654	-3.3%	46.0%
Total	**3,391**	**3,555**	**3,564**	**3,946**	**4,575**	**4,722**	**4,942**	**4,854**	**4,231**	**4,078**	**-3.6%**	**20.3%**
Percentage of non-EU	18.5%	15.9%	14.2%	14.5%	13.3%	13.6%	18.0%	16.0%	18.2%	19.9%	9.3%	7.6%
Proportion of female students	13.2%	14.6%	14.2%	14.5%	15.6%	15.0%	16.0%	14.8%	16.0%	16.0%	0.0%	21.2%

Source: UCAS

1010 *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p7 **1011** Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of accepted applicants in 2012/13 have been excluded from this analysis **1012** See Section 11.6.4 for more details on non-continuation rates **1013** See Section 13.1.1 for more details on graduate starting salaries by engineering sub-discipline

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Table 11.15: Accepted applicants to First Degrees in mechanical engineering (2003/04-2012/13)

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	3,568	3,630	3,380	3,511	4,182	4,679	4,954	5,246	5,277	5,814	10.2%	62.9%
EU (excluding UK)	321	340	372	390	364	442	446	457	485	499	2.9%	55.5%
Non-EU	864	896	875	1,030	1,027	1,154	1,202	1,008	1,086	1,197	10.2%	38.5%
Total non-UK	1,185	1,236	1,247	1,420	1,391	1,596	1,648	1,465	1,571	1,696	8.0%	43.1%
Female students	336	323	293	372	383	465	463	502	550	631	14.7%	87.8%
Total	**4,753**	**4,866**	**4,627**	**4,931**	**5,573**	**6,275**	**6,602**	**6,711**	**6,848**	**7,510**	**9.7%**	**58.0%**
Percentage of non-EU	18.2%	18.4%	18.9%	20.9%	18.4%	18.4%	18.2%	15.0%	15.9%	15.9%	0.0%	-12.6%
Proportion of female students	7.1%	6.6%	6.3%	7.5%	6.9%	7.4%	7.0%	7.5%	8.0%	8.4%	5.0%	18.3%

Source: UCAS

Table 11.16: Accepted applicants to First Degrees in aerospace engineering (2003/04-2012/13)

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	1,433	1,527	1,498	1,454	1,521	1,779	1,809	1,936	1,916	2,100	9.6%	46.5%
EU (excluding UK)	87	80	120	111	95	140	161	173	174	169	-2.9%	94.3%
Non-EU	256	302	303	308	330	427	465	424	304	305	0.3%	19.1%
Total non-UK	343	382	423	419	425	567	626	597	478	474	-0.8%	38.2%
Female students	167	176	163	206	205	222	250	281	256	268	4.7%	60.5%
Total	**1,776**	**1,909**	**1,921**	**1,873**	**1,946**	**2,346**	**2,435**	**2,533**	**2,394**	**2,574**	**7.5%**	**44.9%**
Percentage of non-EU	14.6%	15.8%	15.9%	16.4%	17.0%	18.2%	18.1%	16.7%	12.7%	11.8%	-7.1%	-19.2%
Proportion of female students	9.4%	9.2%	8.5%	11.0%	10.5%	9.5%	10.4%	11.1%	10.7%	10.4%	-2.8%	10.6%

Source: UCAS

Table 11.17: Accepted applicants to First Degrees in electronic and electrical engineering (2003/04-2012/13)

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	3,782	3,624	3,066	2,932	2,946	3,282	3,256	3,579	3,212	3,426	6.7%	-9.4%
EU (excluding UK)	331	329	315	396	309	351	381	397	376	376	0.0%	13.6%
Non-EU	2,004	1,647	1,514	1,570	1,555	1,472	1,504	1,098	1,057	1,038	-1.8%	-48.2%
Total non-UK	2,335	1,976	1,829	1,966	1,864	1,823	1,885	1,495	1,433	1,414	-1.3%	-39.4%
Female students	764	603	543	552	513	564	549	498	469	469	0.0%	-38.6%
Total	**6,117**	**5,600**	**4,895**	**4,898**	**4,810**	**5,105**	**5,141**	**5,074**	**4,645**	**4,840**	**4.2%**	**-20.9%**
Percentage of non-EU	32.8%	29.4%	30.9%	32.1%	32.3%	28.8%	29.3%	21.6%	22.8%	21.4%	-6.1%	-34.8%
Proportion of female students	12.5%	10.8%	11.1%	11.3%	10.7%	11.0%	10.7%	9.8%	10.1%	9.7%	-4.0%	-22.4%

Source: UCAS

Table 11.18: Accepted applicants to First Degrees in production and manufacturing engineering (2003/04-2012/13)

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	1,099	929	684	624	609	576	662	627	566	567	0.2%	-48.4%
EU (excluding UK)	44	37	36	49	44	41	26	58	54	32	-40.7%	-27.3%
Non-EU	119	107	109	103	101	94	49	41	28	32	14.3%	-73.1%
Total non-UK	163	144	145	152	145	135	75	99	82	64	-22.0%	-60.7%
Female students	211	203	167	189	175	144	155	154	148	135	-8.8%	-36.0%
Total	**1,262**	**1,073**	**829**	**776**	**754**	**711**	**737**	**726**	**648**	**631**	**-2.6%**	**-50.0%**
Percentage of non-EU	9.4%	10.0%	13.1%	13.3%	13.4%	13.2%	6.6%	5.6%	4.3%	5.1%	18.6%	-45.7%
Proportion of female students	16.7%	18.9%	20.1%	24.4%	23.2%	20.3%	21.0%	21.2%	22.8%	21.4%	-6.1%	28.1%

Source: UCAS

Table 11.19: Accepted applicants to First Degrees in chemical, process and energy engineering (2003/04-2012/13)

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	692	776	861	962	1,094	1,201	1,205	1,482	1,602	2,009	25.4%	190.3%
EU (excluding UK)	47	46	58	80	62	75	87	115	104	125	20.2%	166.0%
Non-EU	366	391	394	423	496	552	554	537	515	668	29.7%	82.5%
Total non-UK	413	437	452	503	558	627	641	652	619	793	28.1%	92.0%
Female students	278	313	356	369	431	492	498	551	601	714	18.8%	156.8%
Total	**1,105**	**1,213**	**1,313**	**1,465**	**1,652**	**1,828**	**1,846**	**2,134**	**2,221**	**2,802**	**26.2%**	**153.6%**
Percentage of non-EU	33.1%	32.2%	30.0%	28.9%	30.0%	30.2%	30.0%	25.2%	23.2%	23.8%	2.5%	-28.1%
Proportion of female students	25.2%	25.8%	27.1%	25.2%	26.1%	26.9%	27.0%	25.8%	27.1%	25.5%	-5.9%	1.2%

Source: UCAS

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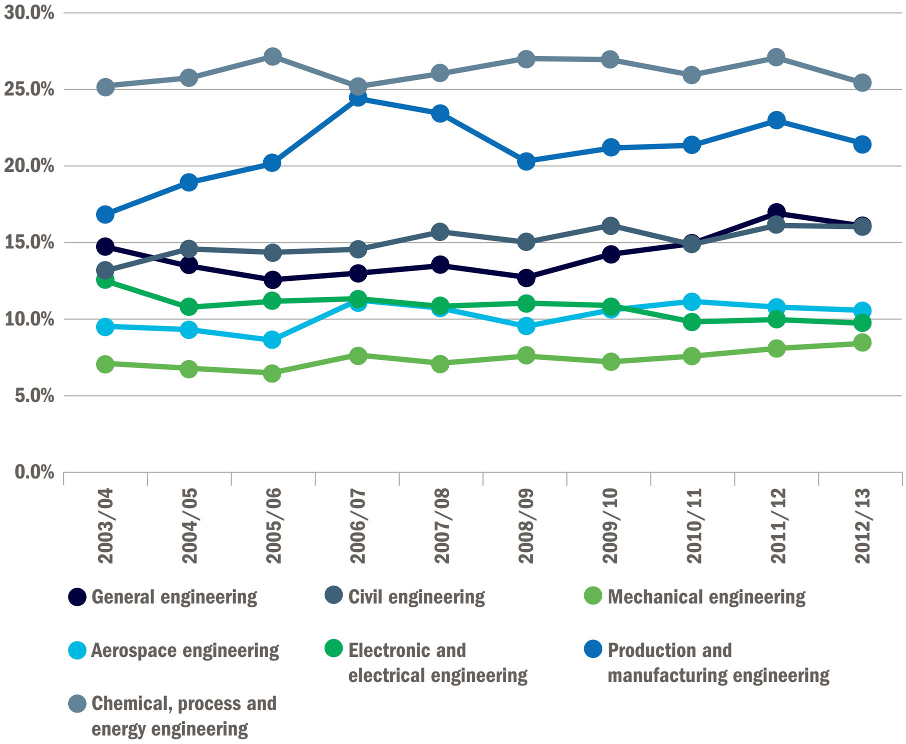
11.5.2 Gender of accepted applicants to selected engineering sub-disciplines[1014]

The proportion of female accepted applicants over a 10-year period is shown in Figure 11.15. In each year, over a quarter of accepted applicants to chemical, process and energy engineering were female, which is the highest proportion of all engineering sub-disciplines. It also shows that the sub-discipline with the second largest proportion of female accepted applicants was production and manufacturing engineering. Although there has been some fluctuation over the 10 years, it shows that the proportion of female accepted applicants has risen from 16.7% in 2003/04 to 21.4% in 2012/13.

By comparison, the proportion of female accepted applicants to mechanical engineering over the 10 years has never been higher than 8.4%, and at its lowest point in 2005/06 females accounted for just 6.3% of applicants.

The only engineering sub-discipline to have a lower proportion of female accepted applicants in 2012/13 than in 2003/04 was electronic and electrical engineering. In 2003/04, 12.5% of accepted applicants were female, whereas in 2012/13 it was 9.7%, the lowest recorded over the 10-year period.

Fig. 11.15: Proportion of female accepted applicants to degree courses by engineering discipline (2003/04-2012/13) – all domiciles



Source: UCAS

1014 Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of accepted applicants in 2012/13 have been excluded from this analysis

11.5.3 Accepted applicants by the region the university accepting their application is based in[1015]

Table 11.20 shows the regional breakdown of accepted applicants for different engineering sub-disciplines. For general engineering, there is a particular concentration of accepted applicants in the West Midlands (622). There are smaller concentrations of accepted applicants in the North West (458) and the South East (415).

Civil engineering has a particular concentration of accepted applicants in London (535) and Scotland (459). It should also be noted that there were only 76 accepted applicants in the East of England.

Four regions have a particular concentration of accepted applicants to mechanical engineering:

- West Midlands (733)
- Scotland (689)
- South East (664)
- East Midlands (611)

For aerospace engineering, there were three regions with more than 200 accepted applicants: Yorkshire and the Humber (243), the South East (221) and the South West (216). It should also be noted that there were only 23 accepted applicants in the North East.

Electronic and electrical engineering was particularly concentrated in just two regions: Scotland (643) and London (592). Northern Ireland (79) and the East of England (76) both had fewer than a hundred accepted applicants in this field.

Production and manufacturing engineering is the engineering sub-discipline with the highest degree of concentration within specific regions. Three regions have at least 100 accepted applicants: the East Midlands (214), Scotland (113) and London (102). All the other regions had fewer than 50 accepted applicants, with three (the North East, the East of England and Wales) having no accepted applicants.

Of the 2,010 accepted applicants for chemical, process and energy engineering, 344 were in Scotland, 283 in Yorkshire and the Humber and 274 in the West Midlands. By comparison, the East of England had only 25.

Table 11.20: Accepted applicants for selected engineering sub-disciplines by region of accepting university (2012/13) – UK domiciled[1016]

Selected engineering sub-disciplines	North East	Yorkshire and The Humber	North West	East Midlands	West Midlands	East	London	South East	South West	Wales	Northern Ireland	Scotland	Total for UK
General engineering	170	181	458	192	622	197	346	415	252	98	42	147	3,120
Civil engineering	177	282	206	261	192	76	535	173	312	179	144	459	2,996
Mechanical engineering	372	499	439	611	733	191	574	664	488	307	251	689	5,818
Aerospace engineering	23	243	198	152	119	135	370	221	216	188	52	187	2,104
Electronic and electrical engineering	221	336	324	206	189	76	592	360	191	209	79	643	3,426
Production and manufacturing engineering	0	41	5	214	5	0	102	49	4	0	37	113	570
Chemical, process and energy engineering	186	283	156	171	274	25	211	122	88	77	73	344	2,010
All engineering accepted applicants	1,214	1,915	1,875	1,845	2,153	700	2,772	2,078	1,635	1,106	692	2,713	20,698

Source: UCAS

1015 Due to a way in which UCAS suppresses data, for data protection reasons, a very small percentage of accepted applicants in 2012/13 have been excluded from this analysis **1016** There is a slight discrepancy in the total number of accepted applicants between this table and table 11.13. This is because a small number of accepted applicants accepted offers at universities in different regions and so have been counted twice

11.6 Engineering students

11.6.1 Prior qualifications of engineering students

The Higher Education Statistics Agency (HESA) provides data on the highest qualification status of first year full-time undergraduates (Table 11.21).[1017 1018] The table shows that the highest qualification of students in engineering and technology is similar to that for all subjects. The proportion of first year engineering students who have a level 3 qualification is slightly higher for engineering and technology (86.6%) than it is for all subjects (85.5%). At the same time, the proportion of engineering students who have other undergraduate qualifications (10.2%) or other qualifications (0.9%) is slightly higher than it is for all subjects (9.6% and 0.6% respectively). By comparison, engineering and technology students are slightly less likely to have qualifications at level 2 and below (0.8%) than the average across all subjects (1.1%).

11.6.2 Number of engineering students

In 2012/13, a total of 2,340,275 students studied for a First Degree or a postgraduate qualification in engineering (Table 11.22), a decline of 6.3% on the comparable figure for 2011/12, which was nearly 2.5 million.[1019] In 2012/13, a quarter (25.0%) of all HE students were studying a STEM qualification. The proportion of males (35.8%) studying STEM subjects was double the proportion of females (16.5%). Out of the 548,420 students on a STEM course, 158,115 were studying engineering and technology, which was the second largest STEM subject behind biological sciences.

The proportion of students studying a STEM subject was higher at undergraduate level than it was for all HE students, with 28.6% of full-time and 27.2% of part-time students on a STEM course. Looking specifically at undergraduate First Degree students, 91,455 were studying engineering and technology full-time while 12,525 were studying part-time.

At postgraduate level, there is a very noticeable difference between the proportion of students on a full-time course who were studying a STEM subject (27.1%) and the proportion of part-time students (13.5%). There were 27,660 postgraduate students studying engineering and technology full-time compared with 11,205 part-time students.

Table 11.21: First year undergraduate full-time First Degree students by highest qualification on entry (2012/13) – UK domiciled

	Postgraduate (excluding PGCE)	PGCE	First Degree	Other undergraduate qualification	Other qualification	Level 3 qualification (including A levels and Highers)	Qualifications at level 2 and below	No formal qualification	Not known	Total
Engineering and technology students	25	5	150	2,025	180	17,170	160	90	20	19,825
Percentage for engineering and technology students	0.1%	0.0%	0.8%	10.2%	0.9%	86.6%	0.8%	0.5%	0.1%	100.0%
All subjects	1,205	165	7,320	34,305	2,075	305,425	4,020	1,670	835	357,020
Percentage of all subjects	0.3%	0.0%	2.1%	9.6%	0.6%	85.5%	1.1%	0.5%	0.2%	100.0%

Source: HESA student record

1017 HESA cannot accept responsibility for any inferences or conclusions derived from the data by third parties 1018 Data for Liverpool Hope University is routinely excluded from many types of data supplied through the HESA Information and Analytical services 1019 *Engineering UK Report 2014 The state of engineering*, EngineeringUK, December 2013, p157

Table 11.22: Number of STEM students by study level, mode and proportion of all students (2012/13) – all domiciles[1020]

	All HE students			Postgraduate						Undergraduate First Degree					
				Full-time			Part-time			Full-time			Part-time		
	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total
Biological sciences	123,135	78,305	201,520	13,195	7,440	20,635	8,030	3,850	11,880	79,835	55,420	135,260	15,995	6,880	22,875
Physical sciences	37,115	55,930	93,050	6,205	9,640	15,855	1,480	1,895	3,375	24,745	38,100	62,845	3,095	4,095	7,190
Mathematical sciences	16,340	25,890	42,235	1,620	3,030	4,655	295	820	1,110	11,785	17,720	29,505	2,250	3,750	6,005
Computer science	15,535	73,955	89,500	2,840	8,825	11,665	1,055	3,790	4,845	8,860	47,840	56,705	1,635	8,655	10,295
Engineering and technology	24,975	133,115	158,115	6,560	21,100	27,660	2,195	9,005	11,205	13,715	77,730	91,455	1,115	11,410	12,525
Total STEM	217,100	367,195	584,420	30,420	50,035	80,470	13,055	19,360	32,415	138,940	236,810	375,770	24,090	34,790	58,890
All subject areas	1,314,820	1,025,030	2,340,275	157,295	139,145	296,470	140,865	99,075	239,965	715,215	597,050	1,312,335	125,585	90,550	216,145
Proportion STEM	16.5%	35.8%	25.0%	19.3%	36.0%	27.1%	9.3%	19.5%	13.5%	19.4%	39.7%	28.6%	19.2%	38.4%	27.2%

Source: HESA student record

Table 11.23 shows that the decline in overall student numbers has been driven by a decline in postgraduate students and part-time students.

Looking specifically at full-time postgraduate students shows that student numbers have declined by 4.2%, while the number on STEM courses has declined by 5.8%. However, there is a wide degree of variation between different STEM subjects. The number studying mathematical sciences has actually increased by 1.1%. In addition, while biological sciences and physical sciences have both declined, this has been by less than the average for all subjects (3.5% and 2.6% respectively). By comparison, engineering and technology has declined by 6.8% while computer science has declined by 13.3%.

The decline in part-time postgraduate students has been higher than the decline for full-time students, at 7.4%. It is noticeable that while mathematical sciences student numbers grew for full-time study, for part-time study they have declined by 15.9%.

The number of students studying computer science (down 13.8%), engineering and technology (down 8.9%) and physical sciences (down 7.0%) have all declined by more than the average for all STEM subjects (down 5.9%). However the number of students studying biological sciences has increased by 2.6%.

For full-time undergraduate First Degree students, there was no percentage point change in the number of students in 2012/13 compared with the previous year. The number of students on STEM courses increased by 1.8% with only one STEM subject, computer science (down 0.8%), showing a decline. Engineering and technology increased by 1.7%, which was less than mathematical sciences (2.0%), physical sciences (2.3%) and biological sciences (2.8%).

For part-time undergraduate First Degree study, there was a decline of 5.7% in 2012/13. However, the decline for STEM subjects was less at 3.4%. Part-time student numbers studying computer science grew by 1.0% while all other STEM subjects declined.

The largest decline was for physical sciences which fell by 12.3%, while engineering and technology fell by 3.9%. The declines for biological sciences (2.5%) and mathematical sciences (0.9%) were less than the decline for all STEM subjects.

Table 11.23: Number of students in STEM subjects by study level and mode (2011/12-2012/13) – all domiciles

	2011/12				2012/13				Percentage change in 2012/13			
	Postgraduate		Undergraduate First Degree		Postgraduate		Undergraduate First Degree		Postgraduate		Undergraduate First Degree	
	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time
Biological sciences	21,385	11,580	131,560	23,450	20,635	11,880	135,260	22,875	-3.5%	2.6%	2.8%	-2.5%
Physical sciences	16,270	3,630	61,425	8,200	15,855	3,375	62,845	7,190	-2.6%	-7.0%	2.3%	-12.3%
Mathematical sciences	4,605	1,320	28,925	6,060	4,655	1,110	29,505	6,005	1.1%	-15.9%	2.0%	-0.9%
Computer science	13,455	5,620	57,165	10,190	11,665	4,845	56,705	10,295	-13.3%	-13.8%	-0.8%	1.0%
Engineering and technology	29,685	12,300	89,915	13,035	27,660	11,205	91,455	12,525	-6.8%	-8.9%	1.7%	-3.9%
Total STEM	85,400	34,450	368,990	60,935	80,470	32,415	375,770	58,890	-5.8%	-5.9%	1.8%	-3.4%
All subject areas	309,425	259,075	1,312,115	229,250	296,470	239,965	1,312,335	216,145	-4.2%	-7.4%	0.0%	-5.7%

Source: HESA

1020 Other undergraduates have been excluded from this section

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 in as IEng or CEng.

Bachelors degrees with or without honours may be accredited as fully meeting the academic requirements for IEng status. Bachelors 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 EngDoc) may be accredited as further learning for the purposes of CEng (for holders of accredited Bachelors 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 (ICT*Tech*).

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, which individuals should check to confirm whether a degree is accredited.[1021]

Accredited degrees are delivered in a range of study modes to diverse learners. There are opportunities for working engineers to study to Bachelors or Masters level and beyond without necessarily leaving their jobs. Engineering degrees may be achieved through part time study, distance learning, blended learning and work-based routes such as Engineering Gateways.[1022] 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.[1023] 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.

Engineering Council accredited degree

Engineering Council gradd achrededig

11.6.2.1 Part-time students

HESA defines part-time students as students those who don't meet the definition for a full-time student, which is those who are not normally required to attend a HE institution for at least 21 hours per week for 24 weeks per academic year.[1024] Therefore part-time students encompass a number of different types of study, including those attending in the evening and employees on block release during the day.

From 2012/13, part-time students are eligible to tuition fee loans of up to £6,850[1025] per year, provided they meet certain criteria:[1026]

- the qualification they are aiming for is not at an equivalent or lower level than one they already hold (unless certain exceptions apply)
- they are studying at an intensity of at least 25% of the full-time equivalent ie a 3-year full-time degree would need to be completed in 12 years part-time
- they must be following a full course which leads to a specified qualification[1027]

Part-time students are not eligible for maintenance grants as it is assumed that they will be able to combine study with work.[1028] However HEFCE[1029] has shown some potential part-time students are no longer able or willing to finance their own studies due to increased unemployment and low growth in real disposable income.

Figure 11.16 shows the pattern for part-time entrants to HE for the different nations of the UK. Compared with 2010/11, there has been a sharp decline in England and also a decline in Scotland. Wales has maintained its part-time student numbers, while there has been a slight increase in part-time students in Northern Ireland.

Oxford Econometrics[1030] has shown that between 2008 and 2012 English part-time entrant numbers fell by 42% and that the decline in England has dominated the UK trend.[1031] Reasons for the decline in part-time student numbers are complex but research has identified a range of issues.

In 2008, funding for students studying towards an equivalent or lower qualification to one they already held was phased out for part-time students.[1032] This results in some part-time providers losing up to 40% of their teaching funding. The research has shown that this policy change was a key driver in the decline in part-time student numbers in the period immediately after 2008.

Another factor in the decline in England was the new funding regime, which in some cases led to a tripling of fees for part-time students.[1033]

1021 www.engc.org.uk/courses **1022** See Section 11.0 for more details on Engineering Gateways **1023** www.engc.org.uk/education--skills/international-recognition-agreements **1024** *Employer support for part-time Higher Education students*, Department for Business, Innovation and Skills, October 2013, p10 **1025** If they are studying at a publically funded institution, if they are studying at a privately funded institution then the maximum loan is £4,500 **1026** *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p17 **1027** This means those students studying for individual modules or credits are not eligible **1028** *Modernisation of Higher Education in Europe Access, Retention and Employability 2014*, Eurydice, 2014, p47 **1029** *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p19 **1030** *Macroeconomic influences on the demand for part-time Higher Education in the UK*, Oxford Econometrics and the Higher Education Funding Council for England, April 2014, piv **1031** *Macroeconomic influences on the demand for part-time Higher Education in the UK*, Oxford Econometrics and the Higher Education Funding Council for England, April 2014, piii **1032** *Macroeconomic influences on the demand for part-time Higher Education in the UK*, Oxford Econometrics and the Higher Education Funding Council for England, April 2014, piv **1033** *Macroeconomic influences on the demand for part-time Higher Education in the UK*, Oxford Econometrics and the Higher Education Funding Council for England, April 2014, piv

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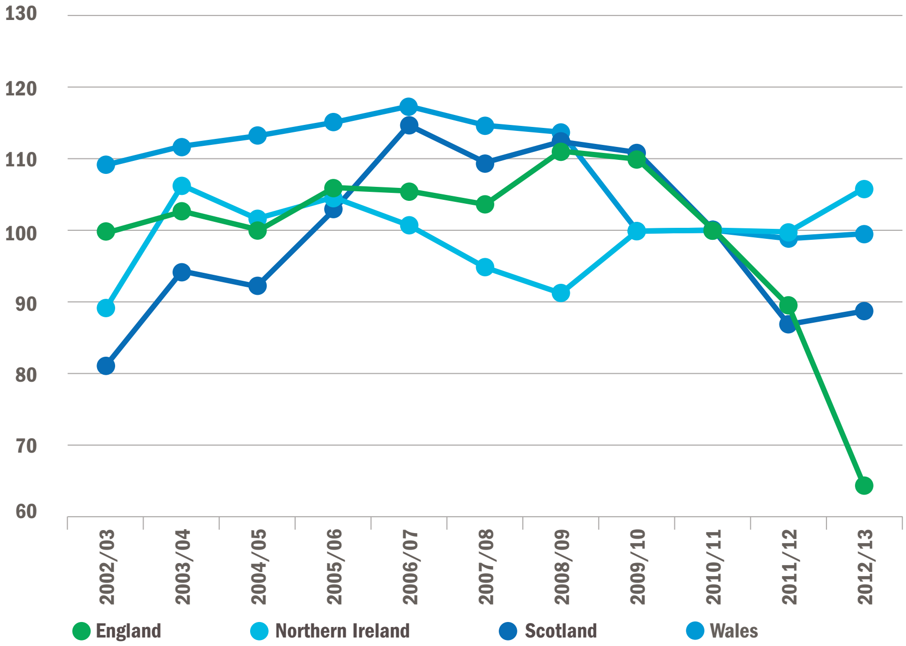
Although tuition fee loans have been introduced, approximately two thirds of part-time students are ineligible for loans, meaning that they have to directly fund the increased fees they are being charged.

There is also a strong regional dimension to the decline in part-time student numbers in England between 2011 and 2012. The North East and the North West had the worst macroeconomic conditions and also suffered the largest decline in part-time student numbers.[1034]

Finally, HEFCE has also shown that the number of part-time students receiving direct funding from their employers remained fairly constant, at around 40,000, until 2011/12 but fell to about 23,000 in 2012/13.[1035]

HEFCE has also pointed out that in the financial forecasts for 2013/14, the HE sector expects the number of UK and EU part-time students to decline further, with undergraduate part-time students projected to fall by 10.2%.[1037]

Fig. 11.16: Part-time entrants to Higher Education (2002/03-2012/13) – UK domicile



Source: HEFCE[1036]

11.6.2.2 Postgraduate students

There is no cap on how much universities can charge for most postgraduate courses.[1038] However, analysis has shown that the median net fee for a full-time postgraduate taught course at an HE Institution in 2012/13 was about £8,000 and the comparable fee for a part-time course was £5,900.[1039] This is less than the maximum fees universities can charge for full-time undergraduate students (£9,000) and part-time undergraduate students (£6,750).[1040] [1041] Fees for postgraduate research courses are broadly based on the level set by Research Councils UK, which is approximately £3,900 for 2013/14: again, less than the maximum that universities can charge for undergraduate students.[1042]

The Government provides support for postgraduate students to fund their course costs via Professional Career Development Loans.[1043] These loans can provide up to £10,000 on the condition that the course is approved by the Skills Funding Agency as leading to a trade, occupation or profession. However, as Professor John Perkins has highlighted, take-up of these loans has been limited, although the reasons why are unclear.

It is worth recognising that the full-time postgraduate masters market is very reliant on international students. In 2012/13, three quarters (74%) of entrants came from outside the UK.[1044]

Finally, in the budget, the Chancellor announced Government will investigate options to support increased participation in postgraduate studies.[1045]

1034 *Macroeconomic influences on the demand for part-time Higher Education in the UK*, Oxford Econometrics and the Higher Education Funding Council for England, April 2014, pv **1035** *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p19 **1036** *Pressure from all sides Economic and policy influences on part-time Higher Education*, Higher Education Funding Council for England, April 2014, p22 **1037** *Financial health of the Higher Education sector 2012-13 financial results and 2013-14 forecasts*, Higher Education Funding Council for England, March 2014, p2 **1038** *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p26 **1039** *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p26 **1040** Website accessed on the 18 June 2014 (https://www.gov.uk/student-finance-calculator/y/2014-2015/uk-full-time) **1041** For details of tuition fee arrangements across the different nations of the UK look at Engineering UK 2014 The state of engineering p129 **1042** *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p27 **1043** *Professor John Perkins' Review of Engineering Skills, Department for Business*, Innovation and Skills, November 2013, p40 **1044** *Global demand for English Higher Education An analysis of international student entry to English Higher Education courses*, Higher Education Funding Council for England, April 2014, p4 **1045** *Budget 2014*, HM Treasury, March 2014, p38

11.6.3 Sandwich degrees

In the *Engineering UK Report 2014*[1046] we demonstrated that the number of students studying for a sandwich degree was declining. At the same time, employers were calling for graduates to have work experience and the Department for Business, Innovation and Skills had identified that graduates from a sandwich course had a higher employment rate six months after graduation than those who hadn't done a sandwich course.

Table 11.24 therefore shows the proportion of students on STEM subjects and for all subjects who are studying on a sandwich degree. Overall, 8.3% of students across all subjects are studying for a sandwich degree, with male students (10.8%) more likely to be on a sandwich degree than female students (6.2%).

Of the STEM subjects, computer science had a greater than average proportion of students on a sandwich course, at a quarter (24.2%). Males were slightly more likely than females to be taking a sandwich course in computer science (24.4% compared to 23.4%).

The only other STEM subject to have a higher than average proportion of students on a sandwich course was engineering and technology, at 18.3%. Again male students (18.7%) are more likely than female students (15.7%) to be taking this route.

The STEM subject with the lowest proportion of sandwich students was biological sciences (5.9%), and there is marginal difference between male (6.0%) and female (5.8%) students.

Finally, both physical sciences and mathematical sciences have a below average proportion of students on sandwich courses (6.9% and 7.5% respectively). However, unlike all the other STEM subjects the proportion of female students on a sandwich course is higher than the proportion of male students.

Table 11.24: Proportion of undergraduate First Degree students who are on a sandwich course, by gender (2012/13) – all domiciles

	Undergraduate First Degree students			Sandwich students			Percentage sandwich students		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Biological sciences	95,830	62,300	158,135	5,530	3,760	9,285	5.8%	6.0%	5.9%
Physical sciences	27,840	42,195	70,035	2,075	2,735	4,810	7.5%	6.5%	6.9%
Mathematical sciences	14,035	21,470	35,510	1,110	1,560	2,670	7.9%	7.3%	7.5%
Computer science	10,495	56,495	67,000	2,460	13,770	16,230	23.4%	24.4%	24.2%
Engineering and technology	14,830	89,140	103,980	2,330	16,695	19,025	15.7%	18.7%	18.3%
Total STEM	163,030	271,600	434,660	13,505	38,520	52,020	8.3%	14.2%	12.0%
All subject areas	840,800	687,600	1,528,480	52,450	74,260	126,710	6.2%	10.8%	8.3%

Source: HESA student record

1046 *Engineering UK Report 2014 The state of engineering*, EngineeringUK, December 2013, p159

11.6.4 Non-continuation rates

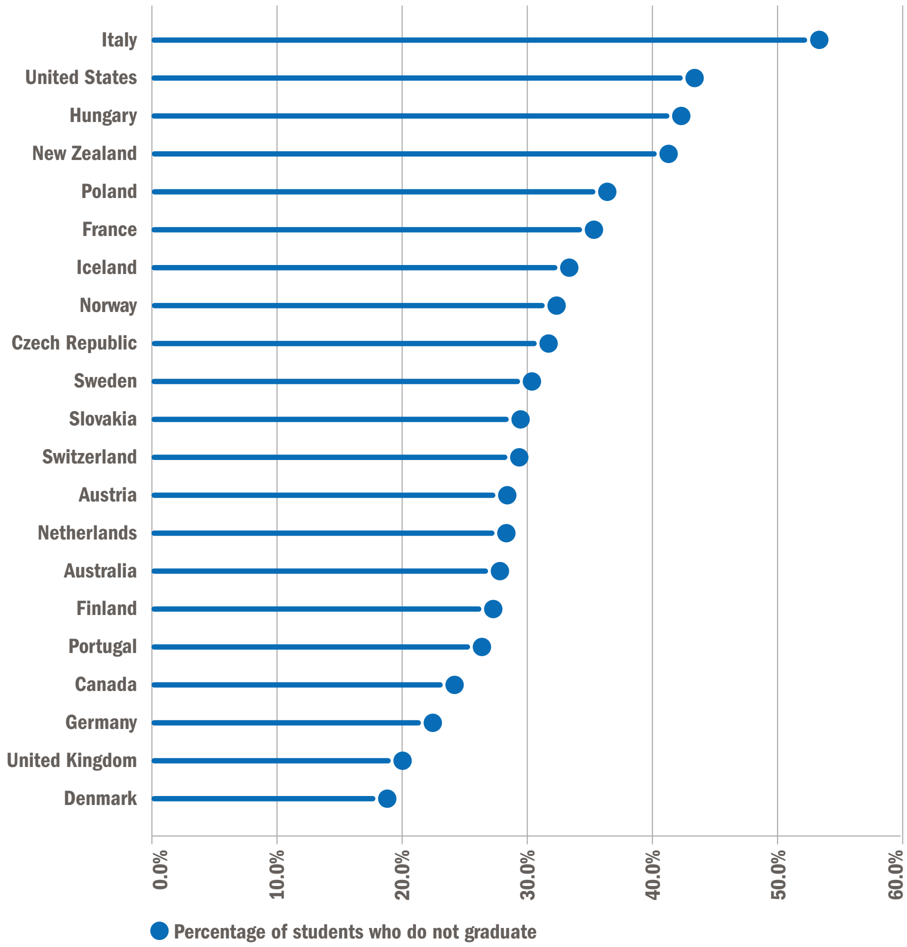
In last year's Engineering UK Report[1047] we highlighted the issue of non-completion rates for engineering graduates. In this year's report we expand on this analysis and explore some of the issues affecting non-completion rates. However, before we explore non-continuation rates in the UK, Figure 11.17 gives an international comparison showing that non-continuation rates in the UK are smaller than they are in many other advanced economies.

Table 11.25 shows that the overall non-continuation rate[1049 1050 1051] for First Degrees was 14.2%. Six subject areas had an above average non-continuation rate. Three of these were STEM subjects:

- computer science – 18.1%
- engineering and technology – 15.6%
- mathematical sciences – 14.6%

By comparison, the non-continuation rate for physical sciences was below average at 12.7%.

Fig. 11.17: The percentage of undergraduate students who leave without a qualification



Source: Sutton Trust[1048]

Table 11.25: Non-continuation rates, by subject area (2011/12) – UK domicile

Subject area	Non-continuation rate
Medicine and dentistry	2.6%
Subjects allied to medicine	14.7%
Biological sciences	13.8%
Veterinary science	2.0%
Agriculture and related subjects	9.2%
Physical sciences	12.7%
Mathematical sciences	14.6%
Computer science	18.1%
Engineering and technology	15.6%
Architecture, building and planning	10.4%
Social studies	13.1%
Law	14.9%
Business and administrative studies	13.7%
Mass communications and documentation	10.4%
Languages	11.0%
Historical and philosophical studies	12.9%
Creative arts and design	10.2%
Education	11.6%
Combined	52.1%
Total	14.2%

Source: HESA bespoke data request

1047 *Engineering UK 2014 The state of engineering*, EngineeringUK, December 2013, p159 1048 *Family Background and access to 'high status' universities*, Sutton Trust, p7 1049 The non-continuation rate has been defined, in this report, as students whose non-continuation marker is either dormant or left with no award. For further details on non-continuation markers please see https://www.hesa.ac.uk/content/view/2880/#ContStat 1050 The continuation categories have been calculated using the unistats methodology 1051 Specific engineering qualifications included in this analysis are First Degrees and the analysis is based on first year students

In Table 11.24, we showed that engineering and technology had an above average non-continuation rate (15.6% compared with 14.2%). In Table 11.26 we look at non-continuation rates for selected engineering sub-disciplines. It shows that for five of the seven sub-disciplines, non-continuation rates are below average, with production and manufacturing engineering (9.2%) and chemical, process and energy (9.7%) having a particularly low non-continuation rate.

Electronic and electrical engineering has a non-continuation rate which is slightly above average (15.9%). However, the non-continuation rate for general engineering is nearly double the average for all subjects at 27.1%.

Table 11.26: Non-continuation rates, by selected engineering sub-disciplines (2011/12) – UK domicile

Principal subject	Non continuation rate
General engineering	27.1%
Civil engineering	12.1%
Mechanical engineering	12.6%
Aerospace engineering	11.0%
Electronic and electrical engineering	15.9%
Production and manufacturing engineering	9.2%
Chemical, process and energy engineering	9.7%

Source: HESA bespoke data request

Table 11.27 shows that for each of the selected engineering sub-disciplines male students have a higher non-continuation rate than female students. For aerospace engineering, the non-continuation rate for male students was 11.6% compared with 4.1% for female students.

Table 11.27: Non-continuation rates for selected engineering sub-disciplines, by gender (2011/12) – UK domicile

Principal subject	Gender	Non continuation rate
General engineering	Male	28.0%
	Female	19.9%
Civil engineering	Male	12.1%
	Female	12.1%
Mechanical engineering	Male	12.9%
	Female	9.4%
Aerospace engineering	Male	11.6%
	Female	4.1%
Electronic and electrical engineering	Male	16.3%
	Female	13.1%
Production and manufacturing engineering	Male	9.5%
	Female	7.6%
Chemical, process and energy engineering	Male	10.2%
	Female	7.8%

Source: HESA bespoke data request

Table 11.28 shows that overall 23.1% of students who didn't have an A level/Higher in maths and/or physics failed to complete their course – a total of 2,779 students. In general engineering, a third (34.0%) of students without an A level/Higher in maths and/or physics failed to complete their course. This compares to around one in 10 students who had an A level in either maths or physics or had an A level in both.

Restricting the data to just those students who didn't continue and who are known not to have an A level/Higher in either maths or physics, shows that 53.0% of these students are at 10 universities and 28.9% are at just one university.

Table 11.28: Total number of students used in continuation calculation and the number not continuing by whether they had A level/Higher maths and/or physics (2011/12) UK domicile

	Not continuing					
	Known to hold A level/higher in maths and physics	Known to hold an A level/higher in maths but not physics	Known to hold an A level/Higher in physics but not maths	Known to not hold an A level/ higher in maths or physics	Total number of students used in non continuation calculation	Actual number of students not continuing
General engineering	10.7%	10.6%	10.9%	34.0%	3,445	935
Civil engineering	6.8%	9.3%	14.7%	18.2%	3,045	370
Mechanical engineering	6.7%	14.7%	9.6%	21.1%	4,165	525
Aerospace engineering	4.6%	12.3%	*	19.7%	1,490	165
Electronic and electrical engineering	7.3%	12.3%	9.6%	19.7%	4,045	645
Production and manufacturing engineering	4.7%	6.5%	*	11.8%	780	70
Chemical, process and energy engineering	5.4%	9.9%	*	19.0%	730	70
Total for all engineering sub-disciplines	6.9%	11.1%	10.9%	23.1%	17,695	2,780
Actual number for all engineering sub-disciplines	450	180	45	2,105		2,780

Source: HESA bespoke data request

11.7 Qualifications obtained

This section looks at the number of students qualifying in different STEM degrees and thus able to enter the job market.

HESA collects data from all publically-funded universities on their HE students. This data is presented in Table 11.29 and shows that over 10 years, the number of First Degree qualifiers in all subjects has risen by 38.2%. By comparison, qualifiers in all STEM subjects have risen by 24.9%. Therefore, the proportion of qualifiers from a STEM subject has decreased from 28.5% in 2003/04 to 25.8% in 2012/13.

Three STEM subjects have grown by more than the average for all subjects:

- mathematical sciences – 56.3%
- biological sciences – 50.0%
- physical sciences – 36.7%

By comparison, engineering and technology has grown by less than average (25.2%) while computer science has decreased by nearly a quarter (23.0%).

The number of qualifiers in engineering and technology 2012/13 increased by 4.9% to 24,755 in 2012/13. This percentage increase was higher than the average for all subjects (3.3%) but below the average for all STEM subjects (6.7%).

11.7.1 Qualifications obtained in 2012/13

Table 11.30 shows the qualifications obtained in 2012/13 by subject area, qualification level and domicile. A total of 593,640 qualifications were obtained by UK-domiciled qualifiers alone. Of these, 28,365 were in engineering and technology, with First Degrees (16,600) forming the largest contribution. For all domiciles, there were a total of 50,345 qualifiers, 28,365 of whom were from the UK.

After engineering and technology, biological sciences was the STEM subject with the highest number of UK-domiciled qualifiers, at 52,665. Physical sciences was the second largest STEM subject with 22,000 qualifiers, 14,290 of whom were First Degree qualifiers. They were closely followed by computer science with 19,610 qualifiers. Mathematical sciences was the smallest STEM subject with 9,105 qualifiers.

Professor John Perkins in his *Review of Engineering Skills*[1052] highlighted the fact that the number of UK students enrolling on masters level engineering and technology courses is flattening. One reason given for this was the difficulty in funding postgraduate courses, with funding coming from a variety of sources. In particular, he points out that over the last five years the proportion of self-funded students has risen from 42% to 68%.

Professor Perkins also highlighted that the Engineering and Physical Sciences Research Council is investing £350 million to set up a series of Centres of Doctoral Training in universities.[1053] These centres will focus on key sectors, technologies and competitive future markets. Sectors include aerospace, automotive and construction.

In addition, the Higher Education Funding Council for England is investing £25 million to test ways of supporting progression into postgraduate study,[1054] while in the budget the Chancellor announced the investment over two years to support apprenticeships up to postgraduate level.[1055]

Table 11.29: Number of First Degrees achieved in STEM (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
Biological sciences	25,955	27,200	27,840	29,095	31,185	30,720	32,185	33,800	35,920	38,945	8.4%	50.0%
Physical sciences	11,995	12,530	12,900	12,480	13,015	13,510	13,795	14,745	15,360	16,400	6.8%	36.7%
Mathematical sciences	5,395	5,270	5,500	5,645	5,815	5,980	6,470	6,965	7,445	8,430	13.2%	56.3%
Computer science	20,205	20,095	18,840	16,445	14,915	14,035	14,255	14,505	15,225	15,565	2.2%	-23.0%
Engineering and technology	19,780	19,575	19,765	19,900	20,420	20,805	21,955	22,905	23,595	24,755	4.9%	25.2%
Total STEM	83,330	84,670	84,845	83,565	85,350	85,050	88,660	92,920	97,545	104,095	6.7%	24.9%
All subjects	292,090	306,365	315,985	319,260	334,890	333,720	350,860	369,010	390,985	403,770	3.3%	38.2%
STEM proportion of all degrees	28.5%	27.6%	26.9%	26.2%	25.5%	25.5%	25.3%	25.2%	24.9%	25.8%	3.6%	-9.5%

Source: HESA qualifications table

1052 *Professor John Perkins' Review of Engineering Skills*, Department for Business, Innovation and Skills, November 2013, p40 **1053** *Professor John Perkins' Review of Engineering Skills*, Department for Business, Innovation and Skills, November 2013, p41 **1054** Website accessed on the 1 August 2014 (http://www.hefce.ac.uk/news/newsarchive/2013/news85254.html) **1055** *Budget 2014*, HM Treasury, March 2014, p85

Table 11.30: Qualifications obtained, by study level and subject area (2012/13) – all domiciles

Subject area	Domicile	Other undergraduate	Foundation Degree	First Degree	Postgraduate	Doctorate	Total
Medicine and dentistry	UK	315	0	9,185	3,880	1,470	14,850
	EU	10	0	225	510	225	970
	Non-EU	15	0	775	1,415	395	2,605
	Total	340	0	10,180	5,810	2,090	18,425
Subjects allied to medicine	UK	26,610	2,890	36,115	13,510	870	79,995
	EU	265	35	1,335	945	150	2,725
	Non-EU	510	10	2,035	2,475	330	5,360
	Total	4,745	1,825	38,945	11,275	3,365	60,150
Biological sciences	UK	4,460	1,795	36,005	8,060	2,345	52,665
	EU	160	15	1,565	1,190	470	3,395
	Non-EU	125	15	1,375	2,025	550	4,090
	Total	4,745	1,825	38,945	11,275	3,365	60,150
Veterinary science	UK	10	0	725	90	50	875
	EU	0	0	15	20	5	40
	Non-EU	10	0	105	25	10	145
	Total	15	0	845	130	65	1,060
Agriculture and related subjects	UK	600	1,335	2,530	705	75	5,240
	EU	45	20	90	155	35	345
	Non-EU	20	15	155	450	75	715
	Total	665	1,370	2,775	1,310	185	6,300
Physical sciences	UK	1,800	485	14,920	2,980	1,815	22,000
	EU	95	10	620	620	435	1,780
	Non-EU	95	0	860	1,840	595	3,390
	Total	1,990	495	16,400	5,440	2,845	27,170
Mathematical sciences	UK	1,015	0	6,995	750	340	9,105
	EU	25	0	325	355	110	810
	Non-EU	60	0	1,115	1,155	205	2,530
	Total	1,095	0	8,430	2,260	655	12,445
Computer science	UK	3,040	1,035	12,665	2,490	380	19,610
	EU	90	10	930	920	120	2,070
	Non-EU	180	10	1,970	4,070	430	6,665
	Total	3,310	1,055	15,565	7,480	925	28,340
Engineering and technology	UK	4,410	1,790	16,600	4,425	1,145	28,365
	EU	145	30	1,925	2,380	400	4,880
	Non-EU	565	55	6,230	8,910	1,340	17,100
	Total	5,115	1,875	24,755	15,715	2,885	50,345
Architecture, building and planning	UK	2,025	565	8,220	4,565	125	15,500
	EU	85	0	710	735	25	1,555
	Non-EU	105	5	1,110	2,310	140	3,670
	Total	2,215	575	10,040	7,610	290	20,730

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Table 11.30: Qualifications obtained, by study level and subject area (2012/13) – all domiciles – continued

Subject area	Domicile	Other undergraduate	Foundation Degree	First Degree	Postgraduate	Doctorate	Total
Social studies	UK	7,560	2,355	34,615	11,195	830	56,550
	EU	145	30	2,175	2,685	350	5,385
	Non-EU	285	15	3,325	8,320	700	12,650
	Total	7,990	2,400	40,115	22,205	1,875	74,585
Law	UK	2,450	95	13,740	6,155	155	22,590
	EU	65	0	1,020	1,590	55	2,730
	Non-EU	130	0	2,735	4,320	190	7,370
	Total	2,645	95	17,495	12,065	400	32,695
Business and administrative studies	UK	11,095	3,275	39,045	16,925	375	70,720
	EU	1,050	160	5,010	5,615	150	11,995
	Non-EU	1,330	200	16,835	36,895	515	55,775
	Total	13,480	3,640	60,890	59,435	1,040	138,490
Mass communications and documentation	UK	895	455	10,025	2,845	90	14,315
	EU	70	20	780	765	30	1,665
	Non-EU	50	5	810	2,610	65	3,540
	Total	1,015	480	11,615	6,215	190	19,515
Languages	UK	2,625	15	21,575	3,750	675	28,640
	EU	180	0	1,135	1,020	190	2,525
	Non-EU	1,980	0	1,060	2,415	330	5,790
	Total	4,785	15	23,770	7,185	1,200	36,955
Historical and philosophical studies	UK	1,940	355	17,125	4,295	785	24,500
	EU	70	0	550	625	165	1,410
	Non-EU	80	0	465	1,415	350	2,310
	Total	2,085	360	18,145	6,335	1,300	28,220
Creative arts and design	UK	3,620	3,225	37,105	5,865	395	50,210
	EU	180	120	2,030	1,655	95	4,085
	Non-EU	405	185	2,360	3,805	130	6,885
	Total	4,210	3,535	41,495	11,325	620	61,175
Education	UK	6,850	4,555	17,930	42,055	520	71,905
	EU	115	10	150	135	80	1,725
	Non-EU	125	10	190	2,545	290	3,155
	Total	7,085	4,580	18,270	45,970	885	76,785
Combined	UK	1,465	10	4,455	70	0	6,000
	EU	190	0	50	0	0	240
	Non-EU	135	5	50	5	0	195
	Total	1,790	15	4,555	75	0	6,435
Total	UK	82,785	24,235	339,570	134,610	12,445	593,640
	EU	2,975	470	20,640	23,160	3,085	50,330
	Non-EU	6,205	540	43,560	86,995	6,630	143,930
	Total	91,965	25,240	403,770	244,765	22,160	787,900

Source: HESA qualifications bespoke analysis

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Table 11.31 shows the degree classification, by subject area, for all First Degrees. The subject area with the highest percentage of students getting a first or upper second overall is historical and philosophical studies (79.8%), followed by languages (79.4%).

Looking at the average for all subjects, nearly two thirds (63.6%) of graduates got a first or upper second overall. Physical sciences (68.0%), mathematical sciences (67.9%), engineering and technology (64.5%) and architecture, building and planning (63.8%) were all above this average. By comparison, computer science (59.5%) was below this average.

Research by the Higher Education Funding Council for England has shown the importance of prior qualifications to degree outcomes.[1056] HEFCE showed that 80% of students with AAB or above at A level achieved a first or upper second degree, compared with just half (50%) of those with CCC or lower grades. It also showed that female students with AAB grades at A level were more likely to achieve a first or upper second and that the gap between female and male students was nine percentage points.[1057]

The average A level attainment for students from the independent sector is AAB compared with BBC from the state sector.[1058] However, once at university, students who have been in the state sector throughout secondary school do better in their degrees than students with the same prior attainment from the independent sector.[1059] White students also achieve higher degree outcomes than ethnic minorities: of those entering higher education with BBB grades, 72% of white students achieved a first or upper second compared with 56% of Asian students and 53% of black students.[1060]

Table 11.31: Classification of undergraduate First Degrees by subject area (2012/13) – all domiciles

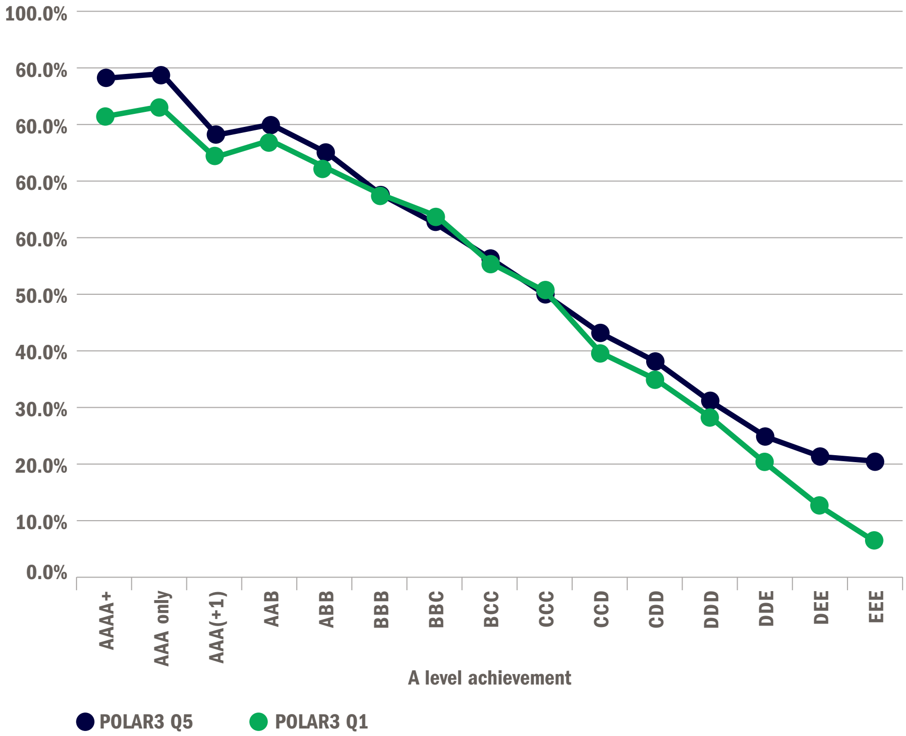
	First	Upper second	Lower second	Third/ pass	Unclassified	Total number of qualifiers	Percentage of degrees that are first or upper second overall	Percentage of degrees that are first class or upper second (when unclassified is excluded)	Percentage of degrees that are unclassified
Medicine and dentistry	610	845	105	40	8,580	10,180	14.3%	90.9%	84.3%
Subjects allied to medicine	7,245	15,970	9,175	2,670	4,165	39,480	58.8%	66.2%	10.5%
Biological sciences	6,210	19,575	10,275	2,070	815	38,945	66.2%	67.6%	2.1%
Veterinary science	5	35	10	0	790	845	4.7%	80.0%	93.5%
Agriculture and related subjects	450	1,230	805	180	115	2,775	60.5%	63.0%	4.1%
Physical sciences	3,760	7,385	4,010	900	345	16,400	68.0%	69.4%	2.1%
Mathematical sciences	2,790	2,930	1,855	630	225	8,430	67.9%	69.7%	2.7%
Computer science	3,575	5,685	4,045	1,545	720	15,565	59.5%	62.4%	4.6%
Engineering and technology	6,295	9,665	5,675	1,590	1,530	24,755	64.5%	68.7%	6.2%
Architecture, building and planning	1,700	4,705	2,510	695	430	10,040	63.8%	66.6%	4.3%
Social studies	5,970	21,085	10,190	2,155	715	40,115	67.4%	68.7%	1.8%
Law	1,845	9,385	4,890	925	445	17,495	64.2%	65.9%	2.5%
Business and administrative studies	9,195	26,055	18,510	4,810	2,320	60,890	57.9%	60.2%	3.8%
Mass communications and documentation	1,625	6,370	2,970	495	155	11,615	68.8%	69.8%	1.3%
Languages	4,365	14,510	4,115	555	225	23,770	79.4%	80.2%	0.9%
Historical and philosophical studies	3,105	11,375	3,035	440	190	18,145	79.8%	80.6%	1.0%
Creative arts and design	7,680	20,720	10,065	2,315	715	41,495	68.4%	69.6%	1.7%
Education	2,715	8,530	5,115	1,105	810	18,270	61.5%	64.4%	4.4%
Combined	475	1,305	800	340	1,635	4,555	39.1%	61.0%	35.9%
Total	69,625	187,365	98,145	23,465	24,915	403,770	63.6%	67.9%	6.2%

Source: HESA student record

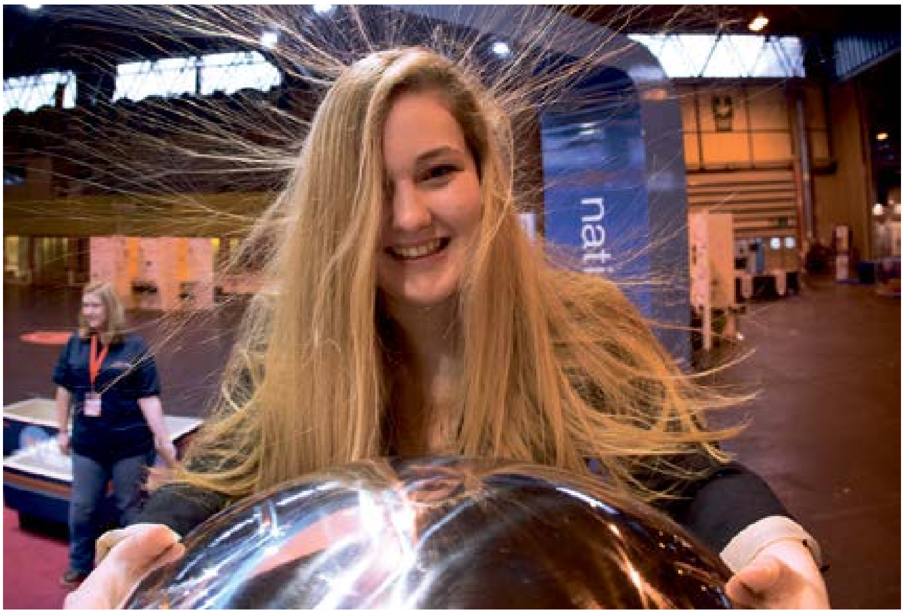
1056 *Differences in degree outcomes: Key findings*, Higher Education Funding Council for England, March 2014, p3 **1057** *Differences in degree outcomes: Key findings*, Higher Education Funding Council for England, March 2014, p3 **1058** *Differences in degree outcomes: Key findings*, Higher Education Funding Council for England, March 2014, p4 **1059** *Differences in degree outcomes: Key findings*, Higher Education Funding Council for England, March 2014, p4 **1060** *Differences in degree outcomes: Key findings*, Higher Education Funding Council for England, March 2014, p3

Finally, Figure 11.18 shows the proportion of students attaining a first or upper second, by prior A level attainment for POLAR quintiles 1 and 5.[1061] It shows that students from quintile 1 (who are least likely to progress to university) on average do worse than students from quintile 5 (students who are most likely to progress to university), even though they have the same A level attainment.

Fig. 11.18: First degree HE achievement by POLAR quintile and A level achievement



Source: Higher Education Funding Council for England[1062]



11.8 Domicile status and gender of engineering qualifiers[1063]

The number of First Degree qualifiers in engineering in 2012/13 was 22,265, an increase of 6.8% on the previous year (Table 11.32). Looking at the number of qualifiers by the different domicile statuses shows that non-EU qualifiers increased by 7.9% in the last year, while UK qualifiers increased by 6.9%. By comparison, qualifiers from the EU increased by only 2.2%, which was well below average. Overall in 2012/13, a quarter (26.5%) of all engineering qualifiers came from outside the EU, compared with an average for all courses of 10.8%.

In 2012/13, 3,170 qualifiers were female: an increase of 8.5% on the previous year. As the House of Commons Science and Technology Committee said,[1064] if the UK is to meet the demand for STEM workers we need to increase the numbers of women in STEM.

The number of postgraduate qualifiers in engineering declined by 10.5% in the last year to 13,985 (Table 13.33). There was a decline in the number of qualifiers from all domiciles, with non-EU declining the most (14.0%) followed by UK (6.3%). The smallest percentage decline was for qualifiers from the EU (2.9%). However, it is interesting to note that while the overall number of qualifiers declined in 2012/13, the number of female qualifiers actually increased by 0.2%.

It is also worth noting that although the number of qualifiers in 2012/13 declined by 10.5%, over 10 years there has been an increase of 78.7%.

In 2012/13, the number of doctorates awarded in engineering was 2,555 – an increase of 6.0% on the previous year (Table 11.34). However, when you look at the one year change by domicile, an interesting picture emerges: UK qualifiers increased by 15.5% and EU qualifiers increased by 9.0% but non-EU qualifiers declined by 1.4%.

1061 For further information on POLAR please see Section 11.3 **1062** *Differences in degree outcomes: Key findings*, Higher Education Funding Council for England, March 2014, p26 **1063** In this chapter engineering graduates has been defined as general engineering, civil engineering, mechanical engineering, aerospace engineering, naval engineering, electronic and electrical engineering, production and manufacturing engineering, chemical, process and energy engineering and others in engineering **1064** *Women in scientific careers Sixth Report of Session 2013–14*, House of Commons Science and Technology Committee, 15 January 2014, p3

Table 11.32: Number of First Degrees achieved in engineering (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	12,915	12,435	11,900	11,990	11,955	12,085	12,295	12,865	13,680	14,620	6.9%	13.2%
EU	1,655	1,575	1,625	1,690	1,745	1,715	1,860	1,780	1,720	1,755	2.2%	6.2%
Non-EU	3,185	3,380	3,940	3,740	4,085	4,350	4,970	5,320	5,460	5,890	7.9%	84.8%
Total non-UK	4,840	4,960	5,565	5,430	5,830	6,065	6,835	7,105	7,175	7,645	6.6%	58.0%
All female students	2,435	2,260	2,430	2,280	2,370	2,405	2,650	2,710	2,925	3,170	8.5%	30.3%
Total	**17,755**	**17,395**	**17,465**	**17,420**	**17,785**	**18,155**	**19,125**	**19,970**	**20,855**	**22,265**	**6.8%**	**25.4%**
Percentage of non-EU	18.0%	19.4%	22.6%	21.5%	23.0%	24.0%	26.0%	26.6%	26.2%	26.5%	1.1%	14.7%
Proportion of female students	13.7%	13.0%	13.9%	13.1%	13.3%	13.2%	13.9%	13.6%	14.0%	14.2%	1.4%	3.6%
Percentage of non-EU (for all courses)	6.9%	7.3%	8.0%	8.2%	8.0%	8.5%	9.2%	10.2%	10.5%	10.8%	2.9%	56.5%

Source: HESA bespoke data request

Table 11.33: Number of postgraduate degrees (excluding doctorates and PGCE) achieved in engineering (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	2,665	2,960	2,860	2,760	2,815	2,925	3,170	4,030	3,900	3,655	-6.3%	37.2%
EU	1,700	1,735	1,665	1,755	1,550	1,420	1,670	2,105	2,235	2,170	-2.9%	27.4%
Non EU	3,460	4,565	5,175	5,025	5,640	5,690	7,560	9,145	9,485	8,160	-14.0%	135.8%
Total non-UK	5,160	6,300	6,840	6,780	7,190	7,110	9,230	11,250	11,720	10,330	-11.9%	100.1%
All female students	1,415	1,780	1,865	1,735	1,880	1,790	2,140	2,775	2,945	2,950	0.2%	108.9%
Total	**7,825**	**9,260**	**9,700**	**9,540**	**10,005**	**10,035**	**12,400**	**15,285**	**15,620**	**13,985**	**-10.5%**	**78.7%**
Percentage of non-EU	44.2%	49.3%	53.4%	52.7%	56.4%	56.7%	60.9%	59.8%	60.7%	58.4%	-3.8%	32.1%
Proportion of female students	18.1%	19.2%	19.2%	18.2%	18.8%	17.8%	17.3%	18.2%	18.9%	21.1%	11.6%	16.6%
Percentage of non-EU (for all courses)	28.8%	30.8%	31.8%	32.2%	34.7%	35.6%	38.1%	39.2%	40.8%	39.7%	-2.7%	37.8%

Source: HESA bespoke data request

Table 11.34: Number of doctorates achieved in engineering (2003/04-2012/13) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
UK	780	750	760	850	690	780	810	810	855	985	15.5%	26.5%
EU	245	265	300	285	295	320	350	345	330	360	9.0%	47.7%
Non-EU	780	790	910	1,010	915	1,000	1,060	1,135	1,225	1,205	-1.4%	54.7%
Total non-UK	1,025	1,060	1,210	1,295	1,210	1,320	1,410	1,485	1,555	1,570	0.8%	53.0%
All female students	350	320	385	425	350	430	430	465	530	530	-0.1%	52.6%
Total	**1,805**	**1,810**	**1,965**	**2,145**	**1,900**	**2,100**	**2,225**	**2,290**	**2,410**	**2,555**	**6.0%**	**41.6%**
Percentage of non-EU	43.2%	43.8%	46.2%	47.2%	48.2%	47.6%	47.7%	49.6%	50.8%	47.2%	-7.1%	9.3%
Proportion of female students	19.3%	17.8%	19.6%	19.8%	18.5%	20.4%	19.4%	20.2%	22.1%	20.8%	-5.9%	7.2%
Percentage of non-EU (for all courses)	24.9%	25.8%	27.7%	28.0%	28.7%	29.5%	29.3%	30.7%	32.2%	29.9%	-7.1%	20.1%

Source: HESA bespoke data request

11.8.1 Degrees achieved in selected engineering sub-disciplines

Table 11.35 shows the number of First Degrees achieved in different engineering sub-disciplines by gender. Overall across the selected sub-disciplines, the number of qualifiers has increased by 7.1%, and six of the seven sub-disciplines have also seen growth in the last year:

- mechanical engineering – 14.5%
- chemical, process and energy engineering – 13.1%
- aerospace engineering – 8.5%
- electronic and electrical engineering – 8.1%
- civil engineering – 2.4%
- production and manufacturing engineering – 1.6%

However, by comparison, general engineering declined by 5.1% in 2012/13.

Table 11.35: Number of First Degrees achieved in engineering subjects (2003/04-2012/13) – UK domiciled

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
General engineering	Female	285	225	260	245	230	205	200	190	230	230	1.1%	-18.9%
	Male	1,430	1,455	1,420	1,500	1,235	1,220	1,155	1,280	1,280	1,200	-6.2%	-16.0%
	Male and female	**1,715**	**1,680**	**1,680**	**1,745**	**1,470**	**1,420**	**1,350**	**1,475**	**1,510**	**1,430**	**-5.1%**	**-16.5%**
Civil engineering	Female	240	235	220	275	310	355	385	405	430	470	9.1%	95.1%
	Male	1,310	1,500	1,380	1,620	1,920	2,160	2,255	2,430	2,510	2,545	1.2%	94.0%
	Male and female	**1,550**	**1,735**	**1,605**	**1,900**	**2,230**	**2,515**	**2,640**	**2,835**	**2,940**	**3,010**	**2.4%**	**94.2%**
Mechanical engineering	Female	235	205	205	210	225	215	230	270	260	310	19.1%	31.8%
	Male	2,400	2,430	2,445	2,555	2,570	2,680	2,755	2,885	3,175	3,625	14.1%	50.9%
	Male and female	**2,640**	**2,635**	**2,650**	**2,765**	**2,800**	**2,895**	**2,980**	**3,155**	**3,435**	**3,935**	**14.5%**	**49.2%**
Aerospace engineering	Female	110	95	105	105	90	105	100	105	100	115	15.4%	7.4%
	Male	905	945	925	895	875	940	900	895	990	1,070	7.8%	18.4%
	Male and female	**1,010**	**1,035**	**1,030**	**1,000**	**965**	**1,050**	**1,000**	**1,000**	**1,095**	**1,185**	**8.5%**	**17.2%**
Electronic and electrical engineering	Female	430	360	310	280	315	255	275	290	335	340	2.7%	-20.7%
	Male	3,510	3,210	2,915	2,775	2,655	2,515	2,490	2,485	2,675	2,910	8.8%	-17.1%
	Male and female	**3,940**	**3,565**	**3,222**	**3,060**	**2,980**	**2,770**	**2,765**	**2,775**	**3,005**	**3,250**	**8.1%**	**-17.5%**
Production and manufacturing engineering	Female	160	155	140	145	115	130	135	95	110	100	-10.8%	-38.4%
	Male	1,090	955	870	730	690	620	600	570	525	550	4.2%	-49.7%
	Male and female	**1,250**	**1,105**	**1,010**	**875**	**805**	**755**	**735**	**665**	**640**	**650**	**1.6%**	**-48.2%**
Chemical, process and energy engineering	Female	130	125	140	120	140	130	155	195	185	250	35.1%	96.4%
	Male	410	405	385	380	430	450	535	615	705	760	8.0%	84.9%
	Male and female	**540**	**535**	**520**	**500**	**570**	**580**	**690**	**810**	**890**	**1,010**	**13.7%**	**87.6%**
Total of selected sub-disciplines		**12,645**	**12,295**	**11,720**	**11,485**	**11,815**	**11,985**	**12,165**	**12,715**	**13,515**	**14,475**	**7.1%**	**14.4%**

Source: HESA bespoke data request

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In the last year the number of postgraduate qualifiers for the selected engineering sub-disciplines has declined by 7.1% (Table 11.36). However when you look at the individual sub-disciplines it can be seen that four have declined as follows:

- Aerospace engineering – 41.5%
- Civil engineering – 20.0%
- Chemical, process and energy engineering – 4.6%
- Production and manufacturing engineering – 4.1%

By comparison, three sub-disciplines have shown growth in the last year, with general engineering (9.6%) growing the most, followed by electronic and electrical engineering (8.5%) and mechanical engineering (3.1%).

Table 11.36: Number of postgraduate degrees (excluding doctorates and PGCE) achieved in engineering sub-disciplines (2003/04-2012/13) – UK domiciled

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one years	Change over 10 years
General engineering	Female	60	110	110	85	80	85	100	110	90	105	14.4%	71.0%
	Male	360	625	610	535	500	465	490	515	535	580	8.7%	60.4%
	Male and female	**420**	**735**	**720**	**620**	**575**	**550**	**595**	**625**	**625**	**685**	**9.6%**	**61.9%**
Civil engineering	Female	160	160	140	195	205	230	260	370	310	220	-29.5%	36.9%
	Male	390	390	410	470	545	665	740	1,005	1,000	830	-17.0%	113.9%
	Male and female	**550**	**550**	**555**	**670**	**750**	**895**	**1,000**	**1,375**	**1,310**	**1,050**	**-20.0%**	**91.4%**
Mechanical engineering	Female	35	35	25	20	70	35	35	45	40	35	*[1065]	*
	Male	260	265	225	235	310	275	295	425	385	405	4.7%	53.4%
	Male and female	**295**	**300**	**250**	**255**	**380**	**310**	**330**	**470**	**425**	**440**	**3.1%**	**48.4%**
Aerospace engineering	Female	20	20	20	20	10	15	20	25	20	15	*	*
	Male	80	105	115	90	115	130	120	165	205	115	-42.6%	41.6%
	Male and female	**105**	**125**	**135**	**110**	**125**	**140**	**135**	**190**	**225**	**130**	**-41.5%**	**26.3%**
Electronic and electrical engineering	Female	130	150	105	100	80	75	50	65	75	65	-13.6%	-51.5%
	Male	590	555	525	505	445	475	495	530	460	515	12.0%	-13.0%
	Male and female	**720**	**700**	**635**	**605**	**525**	**550**	**545**	**595**	**530**	**575**	**8.5%**	**-20.0%**
Production and manufacturing engineering	Female	45	50	50	30	45	30	35	55	40	50	*	*
	Male	305	250	230	220	185	175	175	250	245	225	-8.8%	-26.7%
	Male and female	**350**	**300**	**280**	**250**	**230**	**210**	**210**	**305**	**290**	**275**	**-4.1%**	**-20.9%**
Chemical, process and energy engineering	Female	60	60	60	40	30	50	50	60	70	70	0.5%	17.0%
	Male	115	130	125	125	110	135	195	240	270	255	-5.8%	122.9%
	Male and female	**170**	**190**	**185**	**160**	**140**	**185**	**245**	**300**	**335**	**320**	**-4.6%**	**87.2%**
Total of selected sub-disciplines		**2,615**	**2,900**	**2,765**	**2,680**	**2,730**	**2,840**	**3,060**	**3,865**	**3,745**	**3,480**	**-7.1%**	**33.1%**

Source: HESA bespoke data request

1065 Data suppressed to due to HESA data rounding policy

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Table 11.37 shows that overall the number of doctoral qualifiers in the last year increased by 15.5%. The largest increase occurred in civil engineering (43.5%), followed by mechanical engineering (21.8%), electronic and electrical engineering (19.1%), and chemical, process and energy engineering (4.9%). However, there was a small decline in general engineering (0.4%).

Table 11.37: Number of doctorates achieved in engineering sub-disciplines (2003/04-2012/13) – UK domiciled

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
General engineering	Female	35	25	40	25	20	30	35	40	30	35	*[1066]	*
	Male	155	140	135	150	125	135	160	150	180	175	-3.4%	10.5%
	Male and female	**190**	**170**	**175**	**175**	**145**	**165**	**190**	**190**	**210**	**210**	**-0.4%**	**10.8%**
Civil engineering	Female	20	25	25	30	30	30	25	30	30	35	*	*
	Male	75	70	75	70	65	50	60	65	55	90	59.3%	24.3%
	Male and female	**95**	**95**	**105**	**105**	**90**	**80**	**85**	**95**	**90**	**130**	**43.5%**	**36.5%**
Mechanical engineering	Female	25	15	20	25	15	20	25	20	30	20	*	*
	Male	115	110	115	150	90	105	115	125	120	160	32.9%	40.7%
	Male and female	**140**	**125**	**135**	**180**	**105**	**125**	**140**	**145**	**150**	**180**	**21.8%**	**30.7%**
Aerospace engineering	Female	0	5	0	10	5	10	5	5	5	10	*	*
	Male	20	20	25	40	20	40	35	35	35	40	*	*
	Male and female	**20**	**25**	**25**	**50**	**30**	**45**	**40**	**40**	**40**	**45**	*	*
Electronic and electrical engineering	Female	25	25	30	30	25	40	25	30	25	35	*	*
	Male	160	175	145	205	165	185	210	180	200	230	15.2%	42.7%
	Male and female	**190**	**200**	**175**	**235**	**190**	**230**	**235**	**210**	**225**	**265**	**19.1%**	**41.0%**
Production and manufacturing engineering	Female	10	15	15	5	10	10	10	15	10	15	*	*
	Male	35	25	30	20	35	30	20	25	25	30	*	*
	Male and female	**45**	**35**	**45**	**30**	**45**	**40**	**30**	**40**	**35**	**45**	*	*
Chemical, process and energy engineering	Female	30	20	25	20	30	20	25	30	35	40	*	*
	Male	60	60	65	55	60	75	60	55	70	65	-2.9%	11.8%
	Male and female	**90**	**80**	**90**	**75**	**85**	**90**	**85**	**85**	**105**	**110**	**4.9%**	**21.3%**
Total of selected sub-disciplines		**765**	**730**	**745**	**845**	**690**	**780**	**810**	**805**	**850**	**980**	**15.5%**	**28.5%**

Source: HESA bespoke data request

1066 Data suppressed to due to HESA data rounding policy

11.8.2 Ethnicity of engineering graduates

The ethnicity of First Degree qualifiers for the last 10 years is shown in Table 11.38. The largest percentage increases in the last year came from other Asian backgrounds (21.0%), followed by Chinese (18.7%), Asian or Asian British-Indian (15.9%) and Asian or Asian British-Pakistani (13.5%).

In comparison, three groups had a percentage decline in the last year. These were those of unknown ethnicity (2.8%), other (including mixed) ethnicity (0.9%), and black or black British-Caribbean (0.5%).

Over the ten year period, the proportion of white qualifiers has declined from 78.9% to 73.9%.

Table 11.38: First Degrees achieved in engineering by ethnic origin (2003/04-2012/13) – UK domiciled

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over 10 years
White	10,195	9,835	9,240	9,420	9,270	9,235	9,345	9,725	10,170	10,810	6.3%	6.0%
Black or black British – Caribbean	85	75	85	85	75	75	110	100	110	110	-0.5%	33.9%
Black or black British – African	290	305	375	360	485	515	530	640	750	820	9.5%	181.2%
Other black background	50	25	40	35	25	20	45	35	40	30	*[1067]	*
Asian or Asian British – Indian	565	485	510	450	515	460	525	545	550	635	15.9%	12.1%
Asian or Asian British – Pakistani	265	265	270	240	265	300	290	310	340	385	13.5%	45.5%
Asian or Asian British – Bangladeshi	100	90	75	70	90	90	95	105	115	120	1.4%	19.3%
Chinese	275	240	215	250	230	260	220	225	200	240	18.7%	-13.4%
Other Asian background	190	190	230	215	235	285	285	315	375	455	21.0%	139.8%
Other (including mixed) ethnicity	285	280	295	360	365	450	440	475	600	595	-0.9%	108.0%
Unknown	610	650	565	505	400	400	415	400	430	420	-2.8%	-31.4%
Percentage white	78.9%	79.1%	77.6%	78.6%	77.5%	76.4%	76.0%	75.6%	74.3%	73.9%	-0.5%	-6.3%
Total	12,915	12,435	11,900	11,990	11,955	12,085	12,295	12,865	13,680	14,620	6.9%	13.2%

Source: HESA bespoke data request

1067 Data suppressed to due to HESA data rounding policy

The proportion of white qualifiers in 2012/13 varied by engineering sub-discipline (Table 11.39). In production and manufacturing engineering, the proportion of white qualifiers was 84.7%. However, this compares to 60.8% in chemical, process and energy engineering and 65.3% in aerospace engineering.

Within chemical, process and energy engineering, one in 10 (10.1%) qualifiers were black or black British-African, while 6.6% were Asian or Asian British-Indian. There was also a large proportion of people from an Asian or Asian British-Indian background in aerospace engineering (8.7%), while 5.4% of qualifiers in this sub-discipline were also from other Asian backgrounds. In electronic or electrical engineering, 7.7% of qualifiers were from black or black British-African backgrounds.

Table 11.39: Percentage breakdown of First Degrees achieved by ethnic origin in selected engineering sub-disciplines (2012/13) – UK domiciled

	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) ethnicity	Unknown
General engineering	78.9%	0.7%	4.4%	*[1068]	3.3%	1.8%	0.2%	1.7%	1.6%	3.7%	3.4%
Civil engineering	74.5%	0.8%	5.3%	*	3.1%	2.5%	0.8%	1.8%	3.9%	4.6%	2.4%
Mechanical engineering	78.0%	0.4%	4.4%	*	4.0%	2.3%	0.8%	1.4%	2.4%	3.4%	2.7%
Aerospace engineering	65.3%	0.6%	4.9%	*	8.7%	3.6%	1.4%	2.4%	5.4%	4.4%	3.1%
Electronic and electrical engineering	70.5%	1.4%	7.7%	*	4.4%	2.7%	1.1%	1.1%	3.0%	4.0%	3.5%
Production and manufacturing engineering	84.7%	0.6%	1.8%	*	3.1%	1.2%	0.4%	0.9%	1.2%	2.7%	3.1%
Chemical, process and energy engineering	60.8%	0.6%	10.1%	*	6.6%	5.5%	0.5%	3.1%	4.8%	6.0%	1.8%
Total of selected sub-disciplines	73.8%	0.8%	5.7%	*	4.4%	2.7%	0.8%	1.6%	3.1%	4.1%	2.9%

Source: HESA bespoke data request

1068 Data suppressed to due to HESA data rounding policy

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Table 11.40 shows that, with the exception of aerospace engineering and production and manufacturing engineering, female First Degree qualifiers were more likely to come from an ethnic minority background than male qualifiers.

For chemical, process and energy engineering, only half (52.5%) of female qualifiers were white.

Table 11.40: Percentage breakdown by gender of First Degrees achieved by ethnic origin in selected engineering sub-disciplines (2012/13) – UK domiciled

		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)	Unknown
General engineering	Female	71.5%	1.3%	5.6%	0.0%	4.9%	2.6%	0.7%	4.1%	2.2%	4.8%	2.4%
	Male	80.3%	0.6%	4.2%	0.1%	3.0%	1.7%	0.2%	1.3%	1.5%	3.4%	3.6%
Civil engineering	Female	72.3%	1.3%	5.9%	0.0%	2.4%	0.8%	0.4%	3.2%	4.6%	7.0%	2.1%
	Male	74.9%	0.7%	5.2%	0.2%	3.3%	2.8%	0.9%	1.5%	3.7%	4.2%	2.5%
Mechanical engineering	Female	72.9%	0.1%	6.1%	0.0%	6.0%	2.5%	1.0%	1.9%	3.2%	3.9%	2.5%
	Male	78.5%	0.4%	4.3%	0.2%	3.9%	2.3%	0.8%	1.4%	2.3%	3.4%	2.7%
Aerospace engineering	Female	66.8%	0.6%	4.3%	0.9%	6.0%	3.4%	0.9%	4.3%	5.1%	5.1%	2.6%
	Male	65.2%	0.6%	4.9%	0.1%	9.0%	3.7%	1.5%	2.2%	5.5%	4.3%	3.2%
Electronic and electrical engineering	Female	63.1%	2.6%	7.4%	0.3%	6.9%	2.2%	1.0%	1.4%	3.8%	5.1%	6.0%
	Male	71.4%	1.2%	7.8%	0.4%	4.1%	2.8%	1.1%	1.1%	2.9%	3.9%	3.3%
Production and manufacturing engineering	Female	89.8%	0.0%	1.2%	1.0%	2.0%	1.5%	0.0%	0.0%	3.0%	1.5%	0.0%
	Male	83.8%	0.7%	1.9%	0.1%	3.3%	1.1%	0.4%	1.1%	0.9%	3.0%	3.7%
Chemical, process and energy engineering	Female	52.5%	0.4%	15.4%	0.8%	7.2%	4.2%	1.2%	4.0%	5.6%	7.2%	1.6%
	Male	63.5%	0.7%	8.3%	0.0%	6.4%	5.9%	0.3%	2.9%	4.6%	5.7%	1.8%

Source: HESA bespoke data request

Overall, for the selected engineering sub-disciplines, fewer than two thirds (59.4%) of postgraduate qualifiers had a white ethnic background (Table 11.41). The subject area with the largest proportion of white qualifiers is general engineering (70.5%). By comparison, fewer than half (45.0%) of qualifiers in electronic and electrical engineering were white.

One in 11 (8.9%) postgraduate qualifiers were black or black British-African. But amongst aerospace engineering they formed just 2.3% of all qualifiers.

Table 11.41: Percentage breakdown of postgraduate degrees (excluding PGCE and doctorates) achieved by ethnic origin in selected engineering sub-disciplines (2012/13) – UK domiciled

	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) ethnicity	Unknown
General engineering	70.5%	*	6.2%	*	4.1%	2.7%	*	2.0%	2.7%	4.8%	5.7%
Civil engineering	59.8%	*	7.3%	*	2.7%	2.9%	*	2.4%	4.7%	4.7%	15.0%
Mechanical engineering	60.8%	*	9.4%	*	4.3%	3.9%	*	0.9%	3.4%	6.3%	9.6%
Aerospace engineering	65.1%	*	2.3%	*	9.5%	4.6%	*	3.0%	3.8%	5.7%	5.2%
Electronic and electrical engineering	45.0%	*	11.9%	*	4.7%	4.3%	*	5.1%	3.6%	4.8%	18.8%
Production and manufacturing engineering	57.8%	*	11.7%	*	8.1%	4.5%	*	2.3%	2.9%	4.8%	6.8%
Chemical, process and energy engineering	57.6%	*	14.1%	*	5.0%	5.3%	*	1.6%	3.7%	4.6%	7.1%
Total of selected sub-disciplines	59.4%	*	8.9%	*	4.4%	3.6%	*	2.5%	3.7%	5.0%	11.4%

Source: HESA bespoke data request

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11.8.3 Geographical location of qualifiers

Table 11.42 shows the number of qualifiers by region for selected engineering First Degrees. Within England, the largest concentration of First Degrees is in London, with 2,130. The English region with the second highest number of qualifiers is the North West with 1,485. The English region with the lowest number of qualifiers is the East of England with 635.

Nationally, there were 11,385 qualifiers in England, compared with 1,910 in Scotland, 770 in Wales and 415 in Northern Ireland.

It is also noteworthy that there were no aerospace engineering graduates in the North East.

Table 11.42: Location of institution for selected First Degree engineering graduates (2012/13) – UK domiciled

	North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East of England	London	South East	South West	England	Wales	Scotland	Northern Ireland	Total
General engineering	125	80	85	75	60	215	175	310	65	1,190	40	160	40	1,430
Civil engineering	140	310	310	310	195	40	535	165	265	2,270	180	430	135	3,015
Mechanical engineering	190	390	380	340	450	140	455	440	285	3,060	220	540	115	3,935
Aerospace engineering	0	135	135	85	65	80	270	95	105	970	100	95	20	1,185
Electronic and electrical engineering	285	375	285	250	375	110	510	315	190	2,695	170	340	45	3,250
Production and manufacturing engineering	5	70	65	160	70	15	10	50	30	470	35	125	15	650
Chemical, process and energy engineering	45	120	80	95	100	40	175	30	45	730	20	225	40	1,010
All engineering sub-disciplines	790	1,485	1,345	1,310	1,310	635	2,130	1,400	980	11,385	770	1,910	415	14,475

Source: HESA bespoke data request

In Table 11.43 we can see the proportion of male and female graduates in each of the selected engineering sub-disciplines by region. This information can be used to explore discrepancies in the proportion of male and female graduates in each region. For example, in general engineering a fifth (20.4%) of all female qualifiers were in the East of England compared with 14.0% of male qualifiers. Similarly, one in nine (11.6%) male qualifiers in production and manufacturing engineering are in the West Midlands, compared with just 5.2% of female qualifiers.

Better understanding the causes of these variations will help the engineering community to recruit a higher proportion of females into engineering degrees.

Table 11.43: Proportion of graduates, by gender, for selected engineering First Degree (2012/13) – UK domiciled

	Gender	North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East of England	London	South East	South West	England	Wales	Scotland	Northern Ireland	Total number of graduates
General engineering	Female	10.4%	4.5%	8.2%	3.2%	2.2%	20.4%	13.9%	19.9%	3.2%	85.9%	3.9%	5.4%	4.8%	230
	Male	8.5%	5.9%	5.4%	5.5%	4.6%	14.0%	12.0%	22.1%	4.6%	82.6%	2.7%	12.2%	2.4%	1,200
Civil engineering	Female	4.4%	8.7%	14.9%	9.7%	5.8%	0.4%	15.1%	6.4%	9.2%	74.6%	7.2%	13.2%	4.9%	470
	Male	4.7%	10.6%	9.5%	10.4%	6.6%	1.4%	18.2%	5.4%	8.7%	75.5%	5.7%	14.4%	4.4%	2,545
Mechanical engineering	Female	5.9%	9.8%	6.7%	6.1%	10.4%	1.6%	19.6%	10.4%	5.5%	76.1%	3.9%	16.8%	3.2%	310
	Male	4.7%	10.0%	9.9%	8.8%	11.5%	3.7%	10.8%	11.2%	7.4%	77.9%	5.7%	13.4%	2.9%	3,625
Aerospace engineering	Female	0.0%	10.9%	12.9%	11.1%	4.3%	6.9%	23.1%	7.7%	10.3%	87.1%	6.0%	5.1%	1.7%	115
	Male	0.0%	11.4%	11.4%	6.9%	5.4%	6.8%	22.7%	7.9%	8.6%	81.2%	8.8%	8.3%	1.7%	1,070
Electronic and electrical engineering	Female	10.5%	13.5%	5.9%	9.5%	10.7%	3.7%	25.1%	6.0%	4.1%	89.1%	2.5%	7.0%	1.5%	340
	Male	8.5%	11.3%	9.2%	7.5%	11.6%	3.3%	14.5%	10.2%	6.1%	82.2%	5.5%	10.8%	1.4%	2,910
Production and manufacturing engineering	Female	0.0%	6.8%	10.0%	32.5%	5.2%	3.5%	0.0%	7.0%	1.0%	66.0%	6.0%	25.0%	3.0%	100
	Male	0.6%	11.3%	10.0%	23.2%	11.6%	1.9%	1.6%	7.5%	5.7%	73.5%	5.7%	18.3%	2.6%	550
Chemical, process and energy engineering	Female	4.6%	10.6%	4.8%	9.0%	12.6%	5.2%	21.5%	2.0%	3.6%	73.9%	2.0%	17.4%	6.8%	250
	Male	4.5%	12.2%	9.3%	9.3%	9.2%	3.3%	16.2%	3.0%	4.6%	71.5%	2.0%	23.6%	2.9%	760
All engineering sub-disciplines	Female	6.1%	9.6%	9.2%	9.5%	7.8%	5.0%	18.2%	8.2%	5.7%	79.2%	4.5%	12.4%	3.9%	1,820
	Male	5.4%	10.3%	9.3%	9.0%	9.2%	4.3%	14.2%	9.9%	6.9%	78.6%	5.4%	13.3%	2.7%	12,655

Source: HESA bespoke data request

Looking at postgraduate qualifiers in England shows that overall 735 qualifiers for selected engineering sub-disciplines were in London (Table 11.44). The South East had the second largest number of qualifiers with 345. The South West had the lowest number of qualifiers, at 135. Comparing the different regions shows that 2,725 were in England, compared with 550 in Scotland, 175 in Wales and 30 in Northern Ireland.

Table 11.44: Location of institution for selected postgraduate degrees (excluding doctorates and PGCE) engineering graduates (2012/13) – UK domiciled

	North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East of England	London	South East	South West	England	Wales	Scotland	Northern Ireland	Total
General engineering	0	80	45	30	80	115	80	85	15	530	5	140	10	685
Civil engineering	45	90	60	45	110	10	235	135	50	780	80	180	10	1,050
Mechanical engineering	40	20	30	15	25	25	125	35	15	335	10	90	5	440
Aerospace engineering	0	5	5	0	0	50	40	5	15	120	10	5	0	130
Electronic and electrical engineering	35	90	50	65	20	35	125	60	25	505	35	35	5	580
Production and manufacturing engineering	10	5	10	15	55	75	30	15	0	215	30	35	0	275
Chemical, process and energy engineering	20	15	25	20	20	20	95	10	15	240	5	70	0	320
All engineering sub-disciplines	150	305	225	195	310	325	735	345	135	2,725	175	550	30	3,480

Source: HESA bespoke data request

11.9 Entrants to BTEC Higher National Certificates (HNCs), Higher National Diplomas (HNDs) and to Foundation Degrees

Foundation Degrees are a degree level qualification equivalent to around two thirds of a full honours degree. Foundation Degrees are designed in association with employers and they have a particular focus on a specific job or profession. They are intended to increase the professional and technical skills of current or potential staff who are either within a profession or intending to go into that profession. A Foundation Degree can be studied either full-time or part-time.

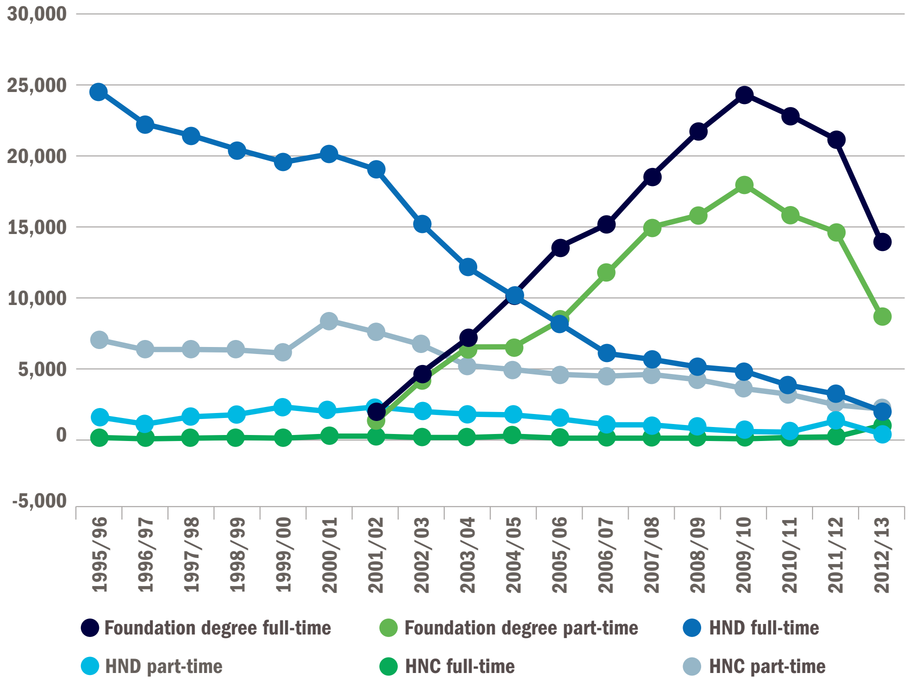
HNCs[1069] and HNDs[1070] are highly flexible and can be studied part-time, full-time, as a sandwich course or through distance learning. They are assessed through projects and practical tasks rather than formal written exams and all involve work-related experience. They provide a recognised route to related degree courses; HNC/D holders may move on to the second or third year of a related degree course.

Changes to national qualifications frameworks (NQF) mean that HNC and HND qualifications are now at different levels within the NQF. An HNC is now a level 4 qualification and, as a result, HNCs started on or after 1 September 2010 are no longer exemplifying qualifications for Incorporated Engineer (IEng) registration. An HND qualification, however, remains a level 5 qualification and is still an exemplifying qualification for IEng registration.

The Further Education sector is critical to the delivery of Foundation Degrees and HNC/Ds. Analysis by the Association of Colleges[1071] has shown that half of all Foundation Degrees, 85% of HNCs and 58% of HNDs are taught in the Further Education sector. Currently, the Government is consulting on the idea of moving some qualifications, including HNCs and HNDs, from Higher Education funding to Advanced Learning Loans.[1072]

Figure 11.19 shows the trends in full-time and part-time entrants to HNCs, HNDs and Foundation Degrees from 1995/96 to 2012/13. It shows that for HNCs and HNDs there has been a steady decline in overall student numbers since 1995/96. The introduction of Foundation Degrees seems to have accelerated the decline in HNDs, as many were converted to Foundation Degrees.[1073]

Fig. 11.19: Entrants to Foundation Degrees, HNCs and HNDs (1995/96-2012/13) – English HEIs



Source: Higher Education Funding Council for England[1075]

Up until 2009/10, there was growth in the number of Foundation Degree students, and from 2006/07-2009/10 the growth in Foundation Degrees was faster than the decline in HNDs – perhaps suggesting that Foundation Degrees were accessing new markets not served by HNDs.[1074] Since 2009/10, there has been a decline in both full-time and part-time provision for Foundation Degrees.

In 2009/10, 45% of qualifiers in Foundation Degrees and 61% of qualifiers of HNDs delivered in a HEI progressed onto First Degrees in the same institution. By comparison, the corresponding figures for Further Education Colleges were 31% and 10%.[1076]

Table 11.45 shows the number of entrants to HNCs, HNDs and Foundation Degrees by study mode and subject area. Overall, half (52.3%) of HNCs were in engineering and technology, compared with a quarter (26.8%) of HNDs and one in 11 (8.3%) Foundation Degrees. Looking specifically at engineering and technology shows that the majority of the provision for HNCs is part-time (4,155 out of 4,800). However, for HNDs and Foundation Degrees, there is a slightly bias towards full-time provision. The table also shows that at HNC level most STEM provision is in engineering and technology (4,800 out of 5,680), but for HNDs (2,185 out of 3,695) and Foundation Degrees (3,055 out of 8,710), engineering and technology makes up a smaller proportion of all STEM entrants.

1069 If studied full-time, an HNC takes one year to complete. **1070** If studied full-time, an HND takes two years to complete. **1071** *College Key Facts 2013/14*, Association of Colleges, 2013, p3 **1072** *Further Education – Future Development of Loans Expanding and simplifying the programme*, Department for Business, Innovation and Skills, June 2014, p6 **1073** *Undergraduate courses other than First Degrees An analysis of recent trends*, Higher Education Funding Council for England, April 2014, p9 **1074** *Undergraduate courses other than First Degrees An analysis of recent trends*, Higher Education Funding Council for England, April 2014, p9 **1075** *Undergraduate courses other than First Degrees An analysis of recent trends*, Higher Education Funding Council for England, April 2014, p9 **1076** *Undergraduate courses other than First Degrees An analysis of recent trends*, Higher Education Funding Council for England, April 2014, p9

Table 11.45: Entrants to Foundation Degrees, HNDs and HNCs by broad subject area of study (2012/13)

	Entrants to HNC programmes			Entrants to HND programmes			Entrants to Foundation Degree programmes		
Subject area of study (broad)	**Full-time programmes**	**Part-time programmes**	**Total entrants**	**Full-time programmes**	**Part-time programmes**	**Total entrants**	**Full-time programmes**	**Part-time programmes**	**Total entrants**
Biological sciences	210	35	245	400	10	405	2,525	500	3,025
Physical sciences	0	40	45	55	15	70	335	140	475
Mathematical sciences	0	15	15	0	0	0	5	0	5
Computer sciences	210	330	540	915	120	1,035	1,645	510	2,150
Engineering and technology	640	4,155	4,800	1,285	900	2,185	1,715	1,340	3,055
Subtotal: STEM	1,060	4,580	5,640	2,650	1,045	3,695	6,225	2,485	8,710
Percentage of all subjects that are STEM subjects	45.0%	67.1%	61.4%	40.0%	67.9%	45.3%	24.3%	22.2%	23.7%
Percentage of all subjects that is engineering and technology	27.2%	60.8%	52.3%	19.4%	58.4%	26.8%	6.7%	12.0%	8.3%
Clinical subjects	0	0	0	0	0	0	20	0	20
Agriculture and related subjects	10	35	40	155	5	160	1,710	250	1,960
Arts, humanities, social sciences and languages	1,285	2,220	3,505	3,810	495	4,305	17,625	8,415	26,040
Unknown and combined subjects	0	0	0	0	0	0	5	30	35
Total	**2,355**	**6,830**	**9,185**	**6,620**	**1,540**	**8,160**	**25,585**	**11,180**	**36,765**

Source: Higher Education Funding Council for England

The five year trend in entrants to engineering and technology is shown in Table 11.46. It shows a decline in both full-time and part-time entrants to HND programmes and Foundation Degree programmes over the period. However, full-time HNC entrants have risen by 374.1% compared with a decline of 8.7% in part-time entrants.

The picture is slightly more positive over the last year than the five-year trend. There has been growth in both full-time and part-time entrants to HNCs (48.8% and 7.4% respectively) and growth in full-time HND entrants (13.2%), but part-time entrants nearly halved (down 48.0%). Entrants to Foundation Degrees declined by 17.9% overall, with part-time dropping by a quarter (24.1%), which was double the percentage decline for full-time students (12.3%).

Table 11.46: Entrants to engineering and technology Foundation Degrees, HNDs and HNCs (2008/09 – 2012/13)

		2008/09	2009/10	2010/11	2011/12	2012/13	Change over one year	Change over five years
Entrants to HNC programmes	Full-time programmes	135	195	530	430	640	48.8%	374.1%
	Part-time programmes	4,550	4,285	4,275	3,870	4,155	7.4%	-8.7%
	Total entrants	**4,685**	**4,485**	**4,810**	**4,300**	**4,800**	**11.6%**	**2.5%**
Entrants to HND programmes	Full-time programmes	1,515	1,665	1,210	1,135	1,285	13.2%	-15.2%
	Part-time programmes	945	675	740	1,730	900	-48.0%	-4.8%
	Total entrants	**2,460**	**2,335**	**1,950**	**2,865**	**2,185**	**-23.7%**	**-11.2%**
Entrants to Foundation Degree programmes	Full-time programmes	2,210	2,545	2,285	1,955	1,715	-12.3%	-22.4%
	Part-time programmes	1,375	1,295	1,665	1,765	1,340	-24.1%	-2.5%
	Total entrants	**3,585**	**3,840**	**3,945**	**3,720**	**3,055**	**-17.9%**	**-14.8%**

Source: Higher Education Funding Council for England

The proportion of entrants by gender is shown in Table 11.47. For HNCs and HNDs, regardless of study mode, around 4-5% on entrants were female. By comparison, 12.2% of full-time entrants to Foundation Degrees were female, but only 5.2% of those studying part-time.

Table 11.47: Entrants to engineering and technology Foundation Degrees, HNDs and HNCs by gender (2012/13)

	Entrants to full-time HNC programmes	Entrants to part-time HNC programmes	Entrants to full-time HND programmes	Entrants to part-time HND programmes	Entrants to full-time Foundation Degree programmes	Entrants to part-time Foundation Degree programmes
Female	25	220	70	40	210	70
Male	620	3,935	1,215	860	1,505	1,275
Percentage female	3.9%	5.3%	5.4%	4.4%	12.2%	5.2%
Total	**640**	**4,155**	**1,285**	**900**	**1,715**	**1,340**

Source: Higher Education Funding Council for England

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Table 11.48 shows the regional breakdown of entrants to Foundation Degrees, HNCs and HNDs by study mode. There are some interesting variations in the proportion of entrants to different qualifications across the regions. For example, a fifth (21%) of entrants to full-time Foundation Degrees were in the South West, whilst the corresponding proportion for HNCs is 5% and for HNDs it is 4%. Similarly, 28% of full-time HNC provision is in the North West – for HNDs it is 23%, but for Foundation Degrees it is much lower (14%). Again, this implies that Foundation Degrees are accessing different markets to HNCs and HNDs.

Table 11.48: Entrants to engineering and technology Foundation Degrees, HNDs and HNCs by English region (2012/13)

	Entrants to full-time HNC programmes		Entrants to part-time HNC programmes		Entrants to full-time HND programmes		Entrants to part-time HND programmes		Entrants to full-time Foundation Degree programmes		Entrants to part-time Foundation Degree programmes	
	Number	Proportion	Number	Proportion	Number	Proportion	Number	Proportion	Number	Proportion	Number	Proportion
East Midlands	55	11%	390	10%	90	11%	110	13%	180	12%	130	11%
East of England	55	10%	225	6%	85	10%	100	12%	85	6%	140	11%
London	45	9%	185	5%	120	14%	65	8%	180	12%	75	6%
North East	40	8%	515	13%	50	6%	95	11%	105	7%	95	8%
North West	140	28%	920	23%	190	23%	115	13%	220	14%	95	8%
South East	40	8%	490	12%	85	10%	125	14%	185	12%	185	15%
South West	25	5%	405	10%	35	4%	70	8%	330	21%	140	11%
West Midlands	70	13%	375	9%	90	11%	65	7%	150	10%	175	14%
Yorkshire and the Humber	40	8%	460	11%	85	10%	115	14%	110	7%	185	15%
Unknown English region	0	0%	45	1%	0	0%	0	0%	10	1%	0	0%
England	510		4,010		830		855		1,555		1,230	

Source: Higher Education Funding Council for England

11.9.1 BTEC HNC and HND completions

Table 11.49 shows the number of students completing selected level 4 and 5 BTEC HNCs and HND subjects, by gender and domicile for the last 10 years. Overall in 2013/14, there were 27,127 completions for all BTEC subjects, which was down 8.0% on the previous year.

For engineering specifically there were 5,920 completions in the last year. This was a decline on the previous year (down 4.5%) but still less than the average decline for all subjects. It can also be seen that in 2013/14, 13.3% of those completing were female.

Construction had the largest percentage decline in 2013/14, falling by 23.4% to 1,952. One in 11 (8.9%) of those competing were female.

ICT/computing had 3,341 completions in 2013/14, which was 4.3% lower than the previous year. However, a fifth (20.2%) of those completing were female.

Table 11.49: Number of students completing selected STEM BTEC HNC and HND subjects, by gender and domicile (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 one year	Change over 10 years
Biology	UK	192	152	119	79	84	49	78	71	118	139	17.8%	-27.6%
	International	0	0	0	0	0	0	0	105	40	51	27.5%	
	Female	90	88	68	40	29	32	52	101	94	126	34.0%	40.0%
	Aged under 19	0	0	0	1	0	0	0	1	0	3		
	Aged 19-24	96	52	49	34	45	34	51	155	123	158	28.5%	64.6%
	Aged 25+	40	22	46	25	20	15	27	20	35	29	-17.1%	-27.5%
	Total	**192**	**152**	**119**	**79**	**84**	**49**	**78**	**176**	**158**	**190**	**20.3%**	**-1.0%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	59.7%	25.3%	26.8%	5.9%	
	Percentage female	46.9%	57.9%	57.1%	50.6%	34.5%	65.3%	66.7%	57.4%	59.5%	66.3%	11.4%	41.2%
Chemistry	UK	71	127	53	53	56	41	79	67	65	58	-10.8%	-18.3%
	International	0	0	0	0	0	0	0	157	66	99	50.0%	
	Female	25	40	16	20	27	11	41	103	64	96	50.0%	284.0%
	Aged under 19	1	1	0	0	0	0	1	0	0	1		0.0%
	Aged 19-24	41	36	24	22	25	26	40	158	103	137	33.0%	234.1%
	Aged 25+	18	26	10	11	29	15	32	63	26	16	-38.5%	-11.1%
	Total	**71**	**127**	**53**	**53**	**56**	**41**	**79**	**224**	**131**	**157**	**19.8%**	**121.1%**
	Percentage non-UK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	70.1%	50.4%	63.1%	25.2%	
	Percentage female	35.2%	31.5%	30.2%	37.7%	48.2%	26.8%	51.9%	46.0%	48.9%	61.1%	24.9%	73.6%
Other sciences	UK	666	477	298	401	476	476	298	139	31	30	-3.2%	-95.5%
	International	0	34	14	12	19	10	11	24	31	62	100.0%	
	Female	117	92	74	44	40	26	35	45	35	52	48.6%	-55.6%
	Aged under 19	1	2	1	1	1	0	1	0	0	0		-100.0%
	Aged 19-24	149	96	73	107	149	85	182	93	31	47	51.6%	-68.5%
	Aged 25+	451	364	212	295	345	401	126	70	31	45	45.2%	-90.0%
	Total	**666**	**511**	**312**	**413**	**495**	**486**	**309**	**163**	**62**	**92**	**48.4%**	**-86.2%**
	Percentage non-UK	0.0%	6.7%	4.5%	2.9%	3.8%	2.1%	3.6%	14.7%	50.0%	67.4%	34.8%	
	Percentage female	17.6%	18.0%	23.7%	10.7%	8.1%	5.3%	11.3%	27.6%	56.5%	56.5%	0.0%	221.0%

Table 11.49: Number of students completing selected STEM BTEC HNC and HND subjects, by gender and domicile (2004/05-2013/14) – all domiciles – continued

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change over one year	Change over 10 years
Engineering	UK	5,658	4,829	3,648	3,660	3,667	3,604	4,268	4,204	4,290	4,243	-1.1%	-25.0%
	International	1,230	1,007	1,093	1,208	981	1,257	1,026	2,142	1,908	1,677	-12.1%	36.3%
	Female	562	543	467	513	508	579	590	742	670	790	17.9%	40.6%
	Aged under 19	9	10	10	5	8	8	19	32	23	29	26.1%	222.2%
	Aged 19-24	3,505	2,722	2,507	2,688	2,904	3,328	3,448	4,318	4,159	3,967	-4.6%	13.2%
	Aged 25+	2,137	1,876	1,681	1,685	1,729	1,525	1,825	1,994	2,016	1,924	-4.6%	-10.0%
	Total	**6,888**	**5,836**	**4,741**	**4,868**	**4,648**	**4,861**	**5,294**	**6,346**	**6,198**	**5,920**	**-4.5%**	**-14.1%**
	Percentage non-UK	17.9%	17.3%	23.1%	24.8%	21.1%	25.9%	19.4%	33.8%	30.8%	28.3%	-8.1%	58.1%
	Percentage female	8.2%	9.3%	9.9%	10.5%	10.9%	11.9%	11.1%	11.7%	10.8%	13.3%	23.1%	62.2%
ICT/computing	UK	3,736	2,352	1,740	1,499	1,218	1,096	1,224	1,135	1,209	1,205	-0.3%	-67.7%
	International	1,869	1,972	2,394	1,413	1,732	1,271	1,427	2,344	2,283	2,136	-6.4%	14.3%
	Female	1,310	1,060	1,023	905	964	565	583	822	744	675	-9.3%	-48.5%
	Aged under 19	18	18	31	14	13	19	19	23	40	30	-25.0%	66.7%
	Aged 19-24	2,427	2,243	2,230	1,698	1,828	1,681	1,998	2,558	2,655	2,524	-4.9%	4.0%
	Aged 25+	1,963	1,440	1,449	975	1,095	663	634	898	797	787	-1.3%	-59.9%
	Total	**5,605**	**4,324**	**4,134**	**2,912**	**2,950**	**2,367**	**2,651**	**3,479**	**3,492**	**3,341**	**-4.3%**	**-40.4%**
	Percentage non-UK	33.3%	45.6%	57.9%	48.5%	58.7%	53.7%	53.8%	67.4%	65.4%	63.9%	-2.3%	91.9%
	Percentage female	23.4%	24.5%	24.7%	31.1%	32.7%	23.9%	22.0%	23.6%	21.3%	20.2%	-5.2%	-13.7%
Construction	UK	2,892	2,655	2,533	2,646	2,753	2,800	2,569	2,197	2,045	1,451	-29.0%	-49.8%
	International	252	205	479	444	391	815	711	610	504	501	-0.6%	98.8%
	Female	347	390	438	481	468	604	430	364	270	173	-35.9%	-50.1%
	Aged under 19	2	3	4	1	3	2	3	1	4	8	100.0%	300.0%
	Aged 19-24	1,197	1,121	1,256	1,282	1,609	1,937	1,759	1,509	1,194	904	-24.3%	-24.5%
	Aged 25+	1,161	1,048	1,099	1,122	1,519	1,674	1,518	1,297	1,351	1,040	-23.0%	-10.4%
	Total	**3,144**	**2,860**	**3,012**	**3,090**	**3,144**	**3,615**	**3,280**	**2,807**	**2,549**	**1,952**	**-23.4%**	**-37.9%**
	Percentage non-UK	8.0%	7.2%	15.9%	14.4%	12.4%	22.5%	21.7%	21.7%	19.8%	25.7%	29.8%	221.0%
	Percentage female	11.0%	13.6%	14.5%	15.6%	14.9%	16.7%	13.1%	13.0%	10.6%	8.9%	-16.0%	-19.1%
All subjects (including STEM and non STEM)	UK	29,277	24,195	18,948	17,121	15,605	15,517	16,974	16,216	18,107	16,380	-9.5%	-44.1%
	International	4,654	4,708	5,862	11,009	12,880	21,393	15,434	11,372	11,388	10,747	-5.6%	130.9%
	Female	12,250	10,807	8,893	12,402	12,476	17,278	13,331	9,332	9,826	10,019	2.0%	-18.2%
	Aged under 19	62	63	97	605	762	972	822	199	279	278	-0.4%	348.4%
	Aged 19-24	15,163	12,905	12,163	16,954	19,129	27,152	23,095	19,050	20,326	18,608	-8.5%	22.7%
	Aged 25+	11,353	9,278	8,208	7,654	8,338	8,750	8,485	8,337	8,890	8,241	-7.3%	-27.4%
	Total	**33,931**	**28,903**	**24,810**	**28,130**	**28,485**	**36,910**	**32,408**	**27,588**	**29,495**	**27,127**	**-8.0%**	**-20.1%**
	Percentage non-UK	13.7%	16.3%	23.6%	39.1%	45.2%	58.0%	47.6%	41.2%	38.6%	39.6%	2.6%	189.1%
	Percentage female	36.1%	37.4%	35.8%	44.1%	43.8%	46.8%	41.1%	33.8%	33.3%	36.9%	10.8%	2.2%

Source: Pearson

11.10 Higher Education staff

Higher Education Institutions are required by HESA to return staff data with staff allocated to cost centres. HEIs map their departments/faculties to one or more cost centres.[1077]

The House of Commons Science and Technology Committee[1078] has identified that early academic STEM careers often involve short term contracts which creates job insecurity. It also identified that women are more likely than men to end their STEM career at this early stage.

An analysis of staff by cost centre in 2012/13 shows that fewer than a fifth (17.4%) of staff in engineering and technology were female, compared with an average for all staff of 39.3% (Table 11.50). This means that engineering and technology has the lowest proportion of women of all the cost centres. By comparison, the proportion of women in architecture and planning (28.8%) and biological, mathematical and physical sciences (29.1%) is much higher.

The cost centre with the largest proportion of women was education, at just over half (53.9%).

Table 11.51 shows that the engineering and technology cost centre is very dependent on non-UK academic staff. Overall, 14.2% of academic staff are non-UK and 4.6% are non-EU. However, for engineering the comparable figures are 34.9% and 19.3% – the highest for all the different cost centres. This shows that engineering and technology departments are very dependent on non-UK staff.

Biological, mathematical and physical sciences are also very dependent on non-UK staff, with a third (33.2%) being non-UK and 13.5% being non-EU.

Table 11.50: Full-time academic staff (excluding atypical) by cost centre group and gender (2012/13)

	All sources of finance			
Cost centre group	**Female**	**Male**	**Total**	**Percentage of staff who are female**
Medicine, dentistry and health	16,750	14,960	31,710	52.8%
Agriculture, forestry and veterinary science	795	995	1,790	44.4%
Biological, mathematical and physical sciences	6,490	15,840	22,330	29.1%
Engineering and technology	2,910	13,795	16,700	17.4%
Architecture and planning	630	1,555	2,185	28.8%
Administrative and business	3,770	5,800	9,570	39.4%
Social studies	5,750	8,445	14,195	40.5%
Humanities and language based studies and archaeology	4,350	5,505	9,855	44.1%
Design, creative and performing arts	2,160	3,220	5,375	40.2%
Education	3,575	3,055	6,630	53.9%
Other[1079]	985	1,180	2,160	45.6%
All staff	48,155	74,345	122,500	39.3%

Source: Higher Education Statistics Agency staff record 2012/13

1077 *Academic physics staff in UK Higher Education Institutions Updated with data for 2010/11 and 2011/12*, Institute of Physics, December 2013, p6 **1078** *Women in scientific careers Sixth Report of Session 2013–14*, House of Commons Science and Technology Committee, 15 January 2014, p3 **1079** Other includes academic services, central administration and services, staff and student facilities, plus residences and catering.

Table 11.51: All academic staff (excluding atypical) by nationality and cost centre (2012/13)

	Medicine, dentistry and health	Agriculture, forestry and veterinary science	Biological, mathematical and physical sciences	Engineering and technology	Architecture and planning	Administrative and business	Social studies	Humanities and language based studies and archaeology	Design, creative and performing arts	Education	Total academic services	Other[1060]	Total
UK	34,700	1,750	18,190	13,585	2,770	9,785	15,835	11,210	12,135	11,310	1,000	1,925	134,195
EU (excluding the UK)	5,540	320	5,515	3,345	450	1,910	3,445	3,435	1,145	755	115	110	26,090
Non-EU	3,870	165	3,795	4,140	395	2,145	2,535	2,045	830	450	55	115	20,540
Unknown	795	20	525	375	140	465	575	335	1,140	265	25	105	4,755
All academic staff	44,905	2,260	28,025	21,440	3,760	14,305	22,390	17,025	15,245	12,775	1,195	2,260	185,585
Percentage non-UK	21.0%	21.5%	33.2%	34.9%	22.5%	28.3%	26.7%	32.2%	13.0%	9.4%	14.2%	10.0%	25.1%
Percentage non-EU	8.6%	7.3%	13.5%	19.3%	10.5%	15.0%	11.3%	12.0%	5.4%	3.5%	4.6%	5.1%	11.1%

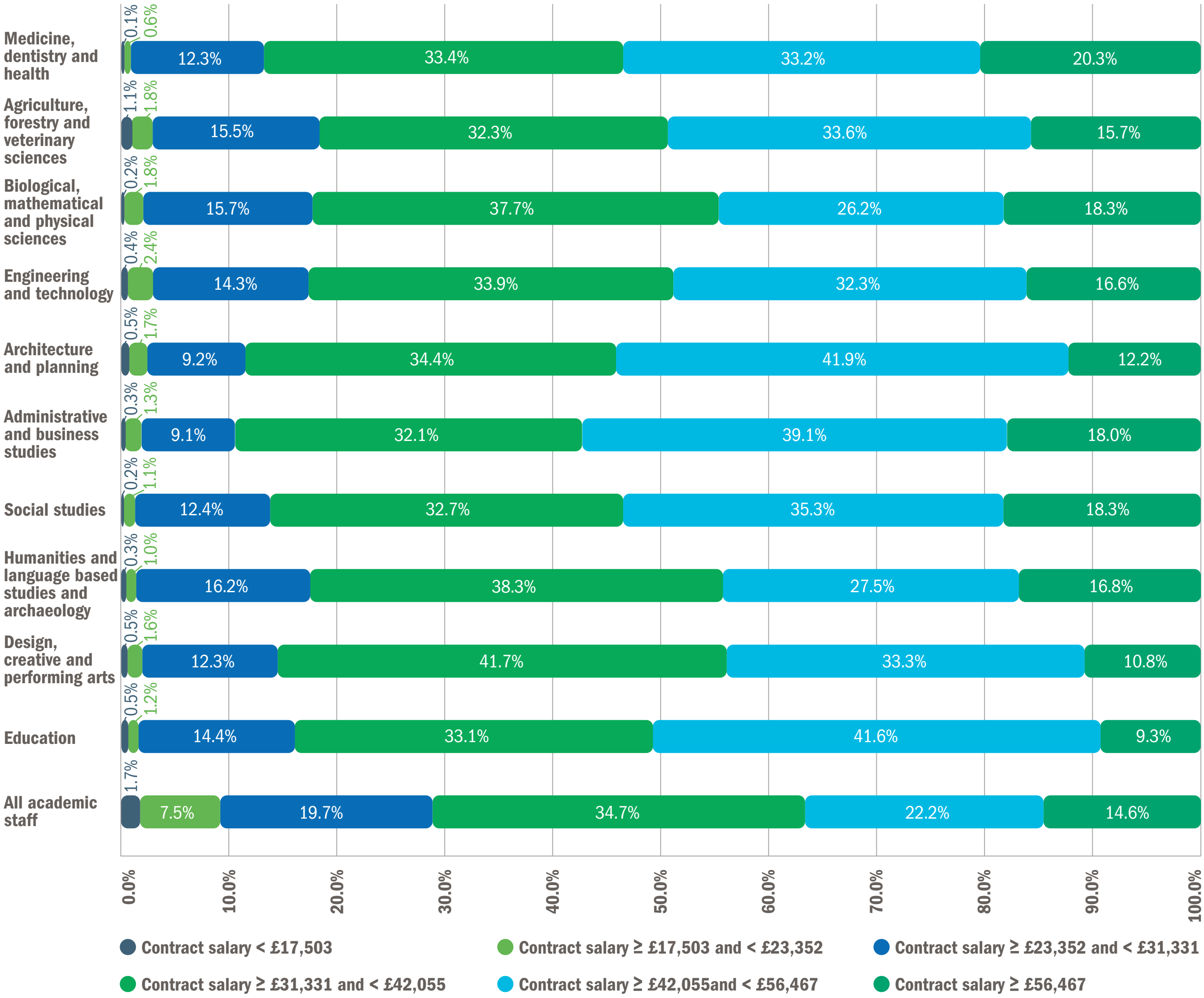
Source: Higher Education Statistics Agency staff record 2012/13

1080 Other includes academic services, central administration and services, staff and student facilities, plus residences and catering.

Overall, a third (34.7%) of academic staff earn between £31,331 and £42,055, while a fifth (22.2%) earn between £42,055 and £56,467 and a further fifth (19.7%) earn between £23,352 and £31,331 (Figure 11.20).

Looking at the engineering and technology cost centre reveals that average salaries are above this level, with a third earning between £31,331 and £42,055 and a further third (32.3%) earning between £42,055 and £56,467.

Fig. 11.20 – Academic staff (excluding atypical) by cost centre group and salary range (2012/13)



Source: Higher Education Statistics Agency staff record 2012/13

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11.11 Transnational education[1081]

Along with students who come to the UK to study, it is important to recognise the transnational students who study for a UK qualification outside of the UK.

There are many different types of transnational education and the UK Government doesn't collect data for earnings from transnational education.[1082] In addition, the collection of transnational data is not comparable to HE education delivered in the UK.[1083] However, there are more international students doing degrees via transnational education with English HE Institutions than there are international students studying in England.[1084]

Table 11.52 shows that in total there were 598,925 transnational students studying wholly overseas in 2012/13. It also shows that 17.2% of the provision was at postgraduate level and that 82.7% was at undergraduate level. Most transnational students are based in Asia and one institution accounts for 48% of these students.[1085]

Table 11.52: Number of students studying wholly overseas for a UK qualification by region and study level (2012/13)

	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
Number of students	22,375	51,610	3,255	0	77,240	80,755	429,135	11,350	440	521,685	598,925

Source: Higher Education Statistics Agency student record 2012/13

1081 Transnational education refers to students who study for a qualification outside of the country of the awarding institution **1082** *Industrial Strategy: government and industry in partnership*, HM Government, July 2013, p17 **1083** *Higher Education in England 2014 Analysis of latest shifts and trends*, Higher Education Funding Council for England, April 2014, p32 **1084** *Global demand for English Higher Education An analysis of international student entry to English Higher Education courses*, Higher Education Funding Council for England, April 2014, p17 **1085** *Global demand for English Higher Education An analysis of international student entry to English Higher Education courses*, Higher Education Funding Council for England, April 2014, p17

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Part 3 - Engineering in Employment
12.0 Graduate destinations

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Engineering and technology graduates are very employable: our analysis shows that 66.3% were in full-time employment within six months of graduating from their course. This is higher than the percentage of all graduates who are going into full-time employment (57.7%). Additionally, new analysis shows the significant contribution that some other disciplines make to the engineering work force, with three disciplines – architecture, building and planning, and computer science and physical sciences – feeding over a third of their graduates into the engineering sector.

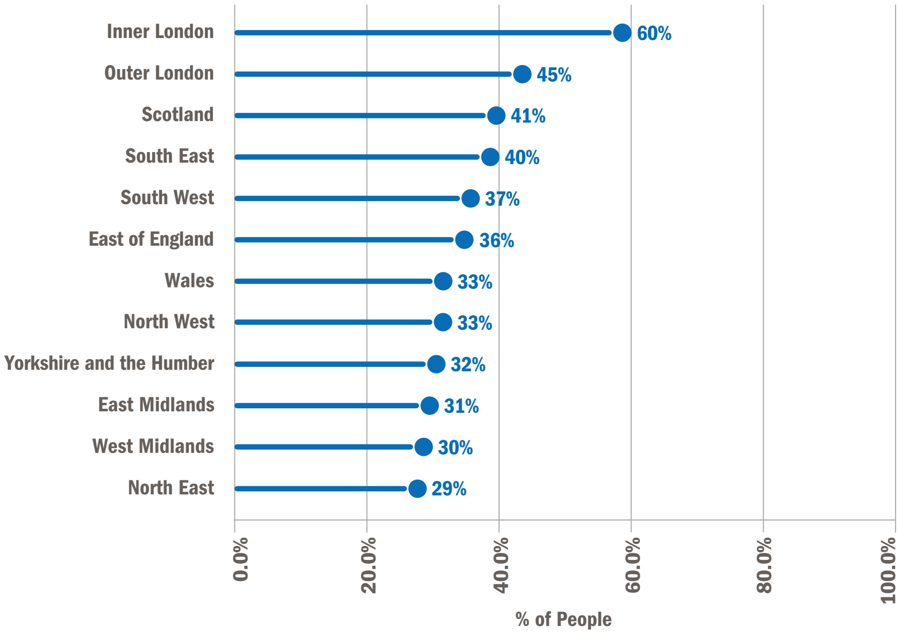
Looking at those who were either working full-time, part-time or combining work with study, over three quarters (77.5%) of engineering and technology graduates were in some form of employment. Two thirds (64.1%) of engineering and technology graduates who were in employment were working as engineers and, similarly, two thirds (64.3%) were working for engineering companies. Only 2.1% of engineering graduates went to work in financial services, which is below the average for all graduates (3.6%) and contradicts the widely held belief that many engineering graduates go into finance. Furthermore, of those who went to work in finance, nearly a quarter (22.7%) were working in a financial company in an engineering capacity.

A degree improves a person's chances of being in employment. In April to June 2013, 87% of graduates were in employment, compared with 83% of those educated to A level and 76% of those educated to GCSE level.[1086] The percentage of the population who are graduates has also been rising, reaching 12 million people (38%) in 2013.[1087 1088]

However, the concentration of graduates is not even across the different nations and regions of the UK. As Figure 12.0 shows, in inner London, 60% of people are graduates, while 45% are in outer London. By comparison, the density of graduates drops to 29% in the North West. Of the devolved nations, Scotland has the highest concentration of graduates (41%) compared with 33% in Wales.

The Department for Business, Innovation and Skills has shown that two thirds (69%) of institutions have a strategy for enhancing student employability and calls for all institutions to embed an employability strategy into their development processes.[1090]

Fig. 12.0: Graduates across areas of Great Britain (2012)



Source: Office for National Statistics[1089]

12.1 Destination of graduates[1091]

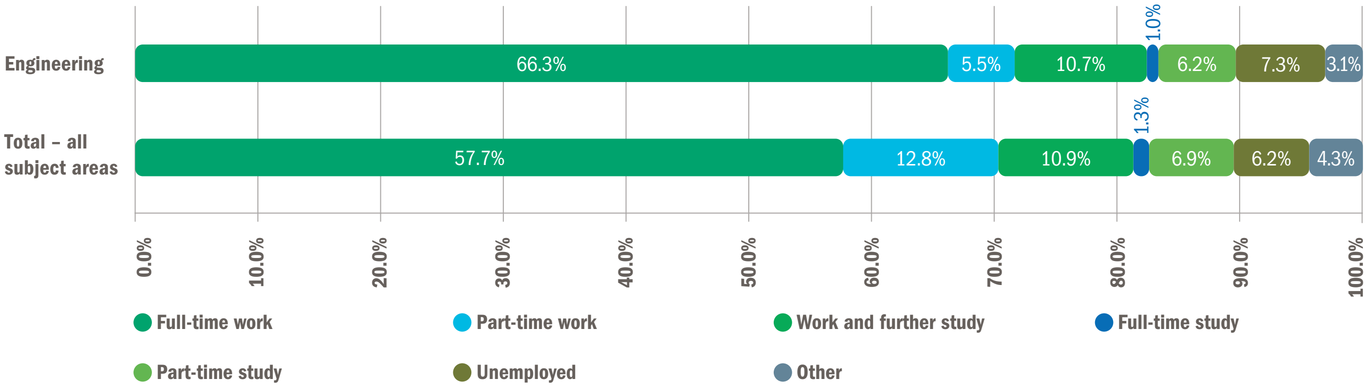
The Higher Education Statistics Agency (HESA) runs the Destination of Leavers from Higher Education (DLHE) survey, which is administered[1092] about six months after graduation. The DLHE survey covers UK, EU and non-EU domiciled students, but data on non-EU leavers is not published.[1093] For the bespoke data extract used in this chapter, the DLHE population was restricted to just UK domiciled students. Out of a total of 593,640[1094] qualifiers, 401,800[1095] completed the DLHE survey giving a response rate of 67.7%.

Figure 12.1 shows the destinations of engineering graduates compared with all graduates. Overall, 57.7% of graduates went into full-time employment within six months of graduating. A further 12.8% went into part-time employment. By comparison, two thirds (66.3%) of engineering graduates went into full-time employment, while only 5.5% went into part-time employment. The total percentage of graduates going into some form of employment was 77.3%, while amongst engineering graduates it was slightly higher at 77.9%.

Overall 6.2% of graduates were classed as unemployed six months after graduating. SKOPE[1096] has shown that while there is high unemployment affecting graduates in the short term, as the economy recovers long term, demand for graduates will increase. However, the Confederation of British Industry and Pearson Education have voiced concerns over whether people with the right STEM skills will be available.[1097] In their survey, 42% of businesses saw increasing the number of STEM graduates as a priority.

1086 *Full report – Graduates in the UK labour market 2013,* Office for National Statistics, 19th November 2013, p5 **1087** *Full report – Graduates in the UK labour market 2013,* Office for National Statistics, 19th November 2013, p1 **1088** *Full report – Graduates in the UK labour market 2013,* Office for National Statistics, 19th November 2013, p3 **1089** *Full report – Graduates in the UK labour market 2013,* Office for National Statistics, 19th November 2013, p27 **1090** *National strategy for access and student success in Higher Education,* Office for Fair Access and Higher Education funding Council for England, April 2014, p88 **1091** In this chapter engineering graduates has been defined as general engineering, civil engineering, mechanical engineering, aerospace engineering, naval engineering, electronic and electrical engineering, production and manufacturing engineering, chemical, process and energy engineering and others in engineering **1092** Data collection is undertaken by individual HEIs using a questionnaire and procedure set by HESA, with the data collected returned to HESA for analysis. Returned DLHE data is linked to earlier student returns submitted by HEIs **1093** Website accessed on 18 July 2014 (https://www.hesa.ac.uk/content/view/2889/#RefDate) **1094** This number has been rounded in accordance with the HESA rounding policy **1095** This number has been rounded in accordance with the HESA rounding policy **1096** *We need to talk about graduates The changing nature of the UK graduate labour market,* SKOPE, 15 December 2013, p7 **1097** *Gateway to growth CBI/Pearson education and skills survey 2014,* Confederation of British Industry and Pearson Education, 2014, p71

Fig. 12.1: Destinations of leavers of HE (all qualifications) in all subjects and engineering (2012/13) – UK domiciled



Source: HESA/Destination of Leavers from Higher Education bespoke data request

Research by the Department for Business, Innovation and Skills has shown that for young graduates in full-time employment an estimated 71% who come from the most advantaged backgrounds were in the most advantaged occupations within six months of graduating in 2011/12. By comparison, only two thirds (67%) of those from less advantaged backgrounds were in the most advantaged occupations.[1098] The Social Mobility and Child Poverty Commission[1099] has shown that this gap is eliminated if you control for other differences – specifically, prior attainment, degree subject, degree class and institution attended. The commission has also shown that graduates from less advantaged backgrounds have a six percentage points lower employment rate in graduates roles.[1100] This means that graduates from less advantaged backgrounds are potentially being under-utilised and better utilisation could provide capacity for growth.

Table 12.0 shows that for all subject areas there is very little difference in the percentage of male and female students who go into full-time employment (57.8% and 57.6% respectively). For engineering graduates, there is a difference of three percentage points between the proportion of male and female graduates going into full-time employment (66.7% and 63.6% respectively). However, even though female engineering graduates are less likely to go into full-time employment than male engineering graduates, they are still more likely to go into full-time employment than graduates of all subjects.

Table 12.0: Destinations of leavers of HE (all qualifications) in all subjects and engineering, by gender (2012/13) – UK domiciled

	Full-time work	Part-time work	Full-time study	Part-time study	Work and further study	Unemployed	Other
Total – all subject areas – male graduates	57.8%	10.7%	12.2%	1.2%	6.3%	7.9%	4.0%
Total – all subject areas – female graduates	57.6%	14.3%	10.0%	1.3%	7.3%	5.0%	4.5%
Engineering – male graduates	66.7%	5.3%	10.4%	1.0%	6.3%	7.4%	2.8%
Engineering – female graduates	63.6%	6.4%	12.5%	*[1101]	5.4%	6.2%	5.0%

Source: HESA/Destination of Leavers from Higher Education bespoke data request

1098 *The gap between the proportion of young graduates from professional backgrounds who go on to a "graduate job" 6 months after graduating and young graduates from non-professional backgrounds,* Department for Businesses, Innovation and Skills, January 2014, p3 1099 *Mapping the occupational destinations of new graduates,* Social Mobility and Child Poverty Commission, October 2013, p9 1100 *State of the nation 2013: social mobility and child poverty in Great Britain,* Social Mobility and Child Poverty Commission, October 2013, p146 1101 Data suppressed to due to HESA data rounding policy

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12.1.1 Destination of engineering graduates

Table 12.1 shows that over three quarters (85.6%) of those obtaining a doctorate went into full-time employment within six months of graduating, while nearly three quarters of postgraduates (71.4%) also went into full-time employment. One in ten (9.8%), however, were unemployed. For those obtaining a First Degree, two thirds (67.6%) went into full-time employment while 10.3% went into full-time further study and 8.1% were unemployed.

Perhaps unsurprisingly, those who obtained a Foundation Degree, or those on other undergraduate courses, were the least likely to go into full-time employment (53.3% and 53.1% respectively). However, further full-time study (19.3% and 15.2%) and work and further study (19.9% and 19.5%) were popular options.

Research by the Office for Fair Access and the Higher Education Funding Council for England has shown that in addition to improving employment outcomes at an undergraduate level, more could be done to better prepare postgraduates for employment.[1102] They also stated that relatively little was known about what employers want from postgraduates.

Table 12.1: Destinations of engineering graduates by level (2012/13) – UK domiciled

	Full-time work	Part-time work	Full-time study	Part-time study	Work and further study	Unemployed	Other
Doctorate	85.6%	2.8%	1.2%	0.2%	2.8%	3.9%	3.6%
Postgraduate	71.4%	4.7%	7.6%	0.6%	3.7%	9.8%	2.3%
First Degree	67.6%	6.4%	10.3%	0.6%	3.5%	8.1%	3.5%
Foundation Degree	53.3%	0.9%	19.3%	3.8%	19.9%	1.9%	0.9%
Other undergraduate	53.1%	3.9%	15.2%	2.7%	19.5%	3.6%	2.0%
Total – all engineering graduates	66.3%	5.5%	10.7%	1.0%	6.2%	7.3%	3.1%

Source: HESA/Destination of Leavers from Higher Education bespoke data request

1102 *National strategy for access and student success in Higher Education,* Office for Fair Access and Higher Education funding Council for England, April 2014, p90

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12.2 Destination of First Degree graduates

Table 12.2 shows that medicine and dentistry have the highest percentage of graduates going into full-time employment within six months of graduating, at 92.3%. This was then followed by veterinary science (85.1%), subjects allied to medicine (71.8%) and architecture, building and planning (71.0%). Engineering and technology had the fifth highest proportion of graduates going into full-time employment at 66.3%. It is also noteworthy that nearly two thirds (63.0%) of computer science graduates went into full-time employment, although computer science graduates were also the most likely to be unemployed (13.0%).

Law has the lowest proportion of graduates going into full-time employment (38.6%), but it also has the highest proportion going into full-time further study (25.2%). Other subjects where fewer than half of the graduates went into full-time employment were:

- historical and philosophical studies – 42.7%
- biological sciences – 44.6%
- combined subjects – 44.9%
- physical sciences – 45.0%
- languages – 45.3%
- mathematical sciences – 48.4%

It should be noted that out of the seven subjects to have fewer than half their graduates go into full-time employment, three were STEM subjects. This is a bit at odds with the fact that one in five (19%) STEM companies are currently experiencing a shortage of STEM graduates – a figure expected to rise to 28% in the coming years.[1103] It should also be noted that rising demand for STEM graduates is occurring throughout the European Union. According to Cedefop,[1104] demand for STEM professionals and associate professionals is expected to rise by around 8% between now and 2025, which is higher than the 3% growth forecast for all occupations.

Table 12.2: Destinations of all full-time First Degree graduates (2012/13) – UK domiciled

	Full-time work	Part-time work	Full-time study	Part-time study	Work and further study	Unemployed	Other
Medicine and dentistry	92.3%	0.7%	4.3%	0.1%	2.0%	0.2%	0.5%
Subjects allied to medicine	71.8%	11.7%	5.5%	0.5%	4.4%	3.9%	2.3%
Biological sciences	44.6%	17.0%	17.4%	1.3%	7.4%	7.3%	5.1%
Veterinary science	85.1%	4.4%	2.4%	0.0%	1.0%	5.2%	1.9%
Agriculture and related subjects	57.7%	14.2%	8.6%	0.8%	5.7%	7.1%	5.8%
Physical sciences	45.0%	10.8%	24.3%	1.0%	5.1%	8.5%	5.4%
Mathematical sciences	48.4%	7.9%	21.1%	1.1%	8.3%	8.5%	4.7%
Computer science	63.0%	10.9%	6.6%	0.9%	2.4%	13.0%	3.2%
Engineering and technology	66.3%	7.7%	10.0%	0.6%	3.5%	8.1%	3.6%
Architecture, building and planning	71.0%	7.4%	5.4%	0.7%	5.2%	6.1%	4.2%
Social studies	52.8%	14.4%	11.7%	0.9%	6.5%	8.4%	5.3%
Law	38.6%	11.1%	25.2%	2.4%	11.0%	6.5%	5.1%
Business and administrative studies	63.2%	12.1%	4.8%	0.7%	5.5%	8.7%	5.0%
Mass communications and documentation	54.7%	22.1%	4.4%	0.6%	2.8%	10.7%	4.7%
Languages	45.3%	14.6%	18.2%	1.2%	6.9%	7.3%	6.5%
Historical and philosophical studies	42.7%	13.9%	19.0%	1.7%	7.6%	7.9%	7.3%
Creative arts and design	50.0%	25.2%	6.5%	0.8%	4.0%	8.8%	4.8%
Education	65.3%	13.3%	9.7%	0.6%	4.8%	3.0%	3.3%
Combined subjects	44.9%	15.9%	6.4%	2.5%	11.1%	4.5%	14.8%
Total – all subjects	56.0%	14.0%	11.4%	0.9%	5.6%	7.3%	4.7%

Source: HESA/Destination of Leavers from Higher Education bespoke data request

1103 *Gateway to growth CBI/Pearson education and skills survey 2014*, Confederation of British Industry and Pearson Education, 2014, p7 **1104** Website accessed on the 18 July 2014 (http://www.cedefop.europa.eu/EN/articles/22503.aspx)

12.3 Proportion of graduates going into employment[1105]

Table 12.3 shows the proportion of graduates, in each subject area, going into any form of employment by the level of qualification obtained. The general pattern for STEM subjects is that those graduating with a doctorate have the highest employment rate while those graduating with a Foundation Degree have the lowest employment rate.

Looking in detail at engineering and technology shows that overall 77.5% of graduates go into some form of employment, with 91.2% of those obtaining a doctorate finding employment, compared with 69.9% of those with a Foundation Degree. Around three quarters of those obtaining other undergraduate qualifications (74.8%), First Degree (77.6%) and a Postgraduate Degree (79.8%) went into employment. Filtering the data to just engineering, 77.9% of graduates at all qualification levels went into employment.

For architecture, building and planning, 82.3% of graduates went into employment: doctorates (89.2%), postgraduates (87.5%) and First Degrees (83.6%) all had at least three quarters of their graduates in employment within six months. However, for Foundation Degrees (63.4%) and other undergraduate qualifications (69.7%), the employment rate was around two thirds.

Nearly three quarters (72.5%) of computer science graduates went into employment: over three quarters of those graduating with a Doctorate (89.4%), Postgraduate (77.9%) or First Degree (76.3%) found employment, compared with just 41.3% of those obtaining a Foundation Degree and 56.2% of those in the other undergraduate qualification category.

Overall, just under two thirds (64.3%) of graduates in physical sciences went into employment. Looking at the different qualifications obtained reveals that nearly 9 in 10 (89.1%) of those getting a Doctorate were in employment, compared with just under three quarters (72.3%) of Postgraduates. Employment rates for Foundation Degrees were just over half (51.0%), while for First Degrees (60.9%) and other undergraduate qualifications (64.4%), employment rates were just under two thirds.

Finally, looking at mathematical sciences shows graduate employment rates are nearly two thirds (65.2%). Other undergraduate (64.6%), First Degree (64.6%) and Postgraduate (64.5%) all had employment rates that were very close to the average, while for Doctorates the employment rate was 84.2%.

Table 12.3: Proportion of graduates going into employment by subject area and level (2012/13) – UK domiciled

	Other undergraduate – proportion in employment	Foundation Degree – proportion in employment	First Degree – proportion in employment	Postgraduate (including PGCE) – proportion in employment	Doctorate – proportion in employment	All graduates – proportion in employment
Medicine and dentistry	56.6%	**[1106]	95.0%	80.8%	92.0%	91.5%
Subjects allied to medicine	89.8%	80.3%	87.9%	88.6%	88.2%	88.2%
Biological sciences	59.7%	42.8%	69.0%	77.1%	90.8%	69.5%
Veterinary science	*[1107]	**	90.4%	70.6%	*	88.2%
Agriculture and related subjects	65.3%	51.7%	77.7%	83.4%	*	70.4%
Physical sciences	64.4%	51.0%	60.9%	72.3%	89.1%	64.3%
Mathematical sciences	64.6%	**	64.6%	64.5%	84.2%	65.2%
Computer science	56.2%	41.3%	76.3%	77.9%	89.4%	72.5%
Engineering and technology	74.8%	69.9%	77.6%	79.8%	91.2%	77.5%
Architecture, building and planning	69.7%	63.4%	83.6%	87.5%	89.2%	82.3%
Social studies	75.2%	67.9%	73.7%	83.2%	88.3%	75.4%
Law	57.9%	41.9%	60.8%	81.8%	89.0%	65.6%
Business and administrative studies	72.2%	55.8%	80.8%	88.0%	90.0%	80.0%
Mass communications and documentation	50.7%	27.7%	79.6%	87.5%	87.0%	78.1%
Languages	53.9%	*	66.8%	71.1%	85.5%	66.8%
Historical and philosophical studies	59.1%	67.2%	64.1%	67.5%	79.3%	65.0%
Creative arts and design	51.1%	35.4%	79.1%	81.3%	87.8%	75.4%
Education	89.4%	73.0%	83.4%	94.9%	90.5%	89.7%
Combined	56.7%	*	71.9%	*	**	69.5%
Total – all graduates	75.1%	58.9%	75.6%	86.4%	88.7%	77.3%

Source: HESA/Destination of Leavers from Higher Education bespoke data request

1105 Employment is classed as full-time or part-time employment plus working and studying 1106 No graduates qualified in this subject area at this level in 2012/13 1107 Data suppressed to due to HESA data rounding policy

12.4 Occupation of graduates[1108]

As well as providing details on destinations for graduates, the Destination of Leavers from Higher Education data also captures the occupation that graduates are employed in (if they are working) six months after graduation).[1109 1110] Overall, one in nine (11.2%) of employed graduates go into an engineering occupation (Table 12.4), with a proportion coming from every subject area. In three subject areas, at least half of all graduates went into an engineering occupation. These were:

- architecture, building and planning – 66.6%
- engineering and technology – 64.1%
- computer science – 52.1%

The subject area with the lowest proportion of graduates going into engineering employment was veterinary science, at 0.6%.

Looking specifically at engineering and technology graduates, nearly two thirds (64.1%) of those who went into employment were working as engineers. Around two thirds of those graduating with other undergraduate qualifications (67.1%), Foundation Degrees (66.5%), First Degrees (65.4%) and postgraduate qualifications (61.3%) were employed as engineers, compared with fewer than half (42.5%) of those getting a Doctorate. However, of the 361 who got a Doctorate but didn't go into an engineering occupation, 151 became university researchers (unspecified discipline). So it is likely that many of them are doing university research that is still related to engineering.

Key career choices for the engineering and technology graduates who didn't go into an engineering occupation included:

- photographers, audio-visual and broadcasting equipment operators
- officers in armed forces

Also, of those students who graduated in engineering and went into employment, 69.5%[1111] went into an engineering occupation.

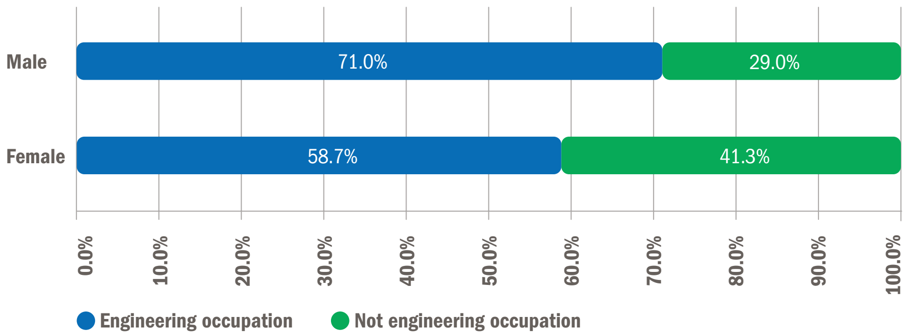
Two thirds (66.6%) of graduates in architecture, building and planning who went into employment go into an engineering-related job. For computer science, just over half (52.1%) of those going into employment went into an engineering occupation. Nearly one in five (18.2%) graduates in physical sciences who went into employment got an engineering job. For mathematical sciences, the figure was 14.5%, with limited variation by the different qualifications obtained. For biological sciences, 5.8% of employed graduates went into an engineering occupation, with again very little variation by qualification.

It is also worth noting that although only 1.8% of those graduating in medicine and dentistry who were employed went into an engineering occupation, 63.6% of those with an other undergraduate qualification did. All of these graduates got employment in engineering technician roles.

Finally, research by the UK Commission for Employment and Skills has shown that 4% of non-STEM graduates were working in core STEM jobs,[1112] which supports the findings in Table 12.4.

Nearly three quarters (71.0%) of male engineering graduates who were in employment went into an engineering occupation, compared with over half (58.7%) of female graduates (Figure 12.12).

Fig. 12.2: Proportion of employed engineering graduates, all qualifications, going into an engineering occupation by gender (2012/13) – UK domiciled[1113]



Source: HESA/Destination of Leavers from Higher Education bespoke data request

1108 For further details on what is an engineering occupation please see Table 17.4 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf 1109 By Standard Occupational Classification (SOC) code. For further details see Table 17.4 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf 1110 Data is not compatible with previous years, for this year's report we have worked with HESA to provide a more accurate measure of the occupation graduates are going into based on 4 digit SOC2010 codes, compared with 3 digit SOC2010 codes used last year. 1111 Manually calculated figure – does not appear in any tables 1112 *The Supply of and Demand for High-Level STEM Skills,* UKCES, December 2013, p56 1113 Proportions are based on all respondents who gave their occupation and where the occupation could be coded to SOC2010 at the four digit level. For further details see Table 17.4 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf

Table 12.4: Proportion of graduates in engineering occupations by subject area and level (2012/13) – UK domiciled[1114]

	Other undergraduate – proportion in engineering occupations	Foundation Degree – proportion in engineering occupations	First Degree – proportion in engineering occupations	Postgraduate (including PGCE) – proportion in engineering occupations	Doctorate – proportion in engineering occupations	All graduates – proportion in engineering occupations
Medicine and dentistry	63.6%	**[1115]	0.7%	2.4%	3.1%	1.8%
Subjects allied to medicine	1.4%	6.5%	2.3%	2.2%	4.3%	2.3%
Biological sciences	7.5%	2.2%	6.1%	5.1%	3.7%	5.8%
Veterinary science	*[1116]	**	0.4%	*	*	0.6%
Agriculture and related subjects	9.7%	9.3%	13.6%	21.6%	*	13.4%
Physical sciences	22.3%	3.5%	18.8%	18.2%	14.1%	18.2%
Mathematical sciences	20.0%	**	14.1%	14.2%	12.7%	14.5%
Computer science	35.1%	43.4%	53.8%	58.1%	36.1%	52.1%
Engineering and technology	67.1%	66.5%	65.4%	61.3%	42.5%	64.1%
Architecture, building and planning	66.8%	50.8%	69.3%	63.4%	21.1%	66.6%
Social studies	2.3%	1.2%	2.5%	2.8%	0.9%	2.5%
Law	6.0%	*	2.4%	5.5%	1.4%	3.6%
Business and administrative studies	10.1%	10.0%	4.6%	11.1%	4.1%	6.8%
Mass communications and documentation	5.5%	6.7%	3.8%	3.6%	*	3.8%
Languages	9.6%	*	2.3%	2.7%	2.0%	2.7%
Historical and philosophical studies	6.7%	5.8%	3.7%	4.1%	2.1%	3.9%
Creative arts and design	8.8%	10.1%	11.7%	8.0%	2.1%	11.1%
Education	2.5%	0.4%	0.9%	0.6%	1.8%	0.8%
Combined	11.9%	*	13.1%	*	**	13.0%
Total – all graduates	11.6%	12.2%	12.1%	8.4%	9.9%	11.2%

Source: HESA/Destination of Leavers from Higher Education bespoke data request

1114 Proportions are based on all respondents who gave their occupation, and where the occupation could be coded to SOC2010 at the four digit level 1115 No graduates qualified in this subject area at this level in 2012/13 1116 Data suppressed due to HESA data rounding policy

12.4.1 Occupations by selected engineering sub-disciplines

In Table 12.4, we showed that around two thirds (64.1%) of engineering and technology graduates went into an engineering occupation. Figure 12.3 shows the proportion of employed graduates who went into an engineering occupation by selected engineering sub-disciplines.

It shows that only aerospace engineering had a lower proportion of graduates in engineering occupations than the average for engineering and technology (63.3% compared with 64.1%). Over three quarters (76.1%) of employed mechanical engineering graduates were in engineering occupations, while civil engineering (73.5%) and chemical, process and energy engineering (71.8%) were close to three quarters. Around two thirds of employed graduates in general engineering (64.8%), electronic and electrical engineering (64.9%) and production and manufacturing engineering (66.8%) were in engineering occupations.

12.4.2 Occupation of graduates by ethnicity

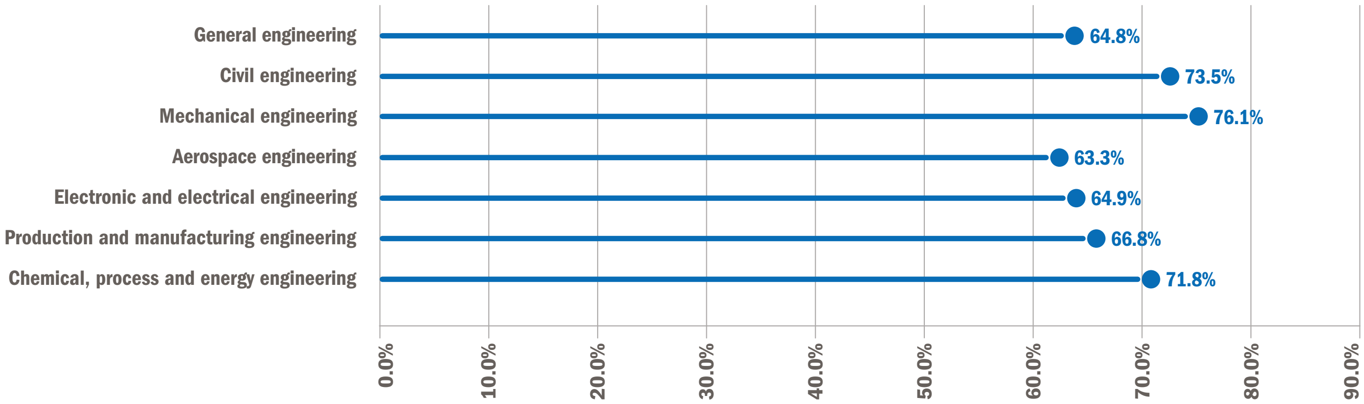
Table 12.5 shows that nearly three quarters (72.0%) of white employed graduates go into an engineering occupation. This is followed by Asian or Asian British (Indian, Pakistani and Bangladeshi) graduates, at 60.7%. The lowest proportion going into an engineering career was other Asian background, which was just over half (53.9%). The lower percentage of employed engineering graduates from minority ethnic groups who go into engineering occupations represents an under-utilised source of potential professional engineers.

Table 12.5: Proportion of employed engineering graduates, all qualifications, going into an engineering occupation, by ethnicity (2012/13) – UK domiciled[1118]

	Engineering	Not engineering
White	72.0%	28.0%
Black or black British (Caribbean, African and other)	56.7%	43.3%
Asian or Asian British (Indian, Pakistani and Bangladeshi)	60.7%	39.3%
Chinese	56.5%	43.5%
Other Asian background	53.9%	46.1%
Other (including mixed)	58.1%	41.9%

Source: HESA/Destination of Leavers from Higher Education bespoke data request

Fig. 12.3: Proportion of employed engineering graduates, by sub-discipline, going into an engineering occupation (2012/13) – UK domiciled[1117]



Source: HESA/Destination of Leavers from Higher Education bespoke data request

1117 Proportions are based on all respondents who gave their occupation and where the occupation could be coded to SOC2010 at the four digit level. For further details see Table 17.4 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf 1118 Proportions are based on all respondents who gave their occupation and where the occupation could be coded to SOC2010 at the four digit level. For further details see Table 17.4 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf

12.5 Types of industry

It is also possible to examine the destination of qualifiers by Standard Industrial Classification (SIC) codes.[1119] The SIC code denotes the primary occupation of the employer. However, it should be noted that the actual role of individuals within a company can be very different to the primary activity of the employer. The modern engineering sector cuts across a number of different industrial groups, within the SIC coding system. The analysis in this section has been done using the engineering SIC footprint developed by EngineeringUK.

Table 12.6 shows the proportion of employed graduates in each subject area who go to work for an engineering company by qualification type. Overall, 15.3% of all employed graduates from all subject areas go to work for an engineering employer. In two subject areas, nearly two thirds of graduates go on to work for an engineering company: engineering and technology (64.3%) and architecture, building and planning (60.6%). Two further subject areas supply over a third of graduates employed by the engineering sector: computer science (44.8%) and physical sciences (34.5%).

Looking specifically at engineering and technology, around two thirds of employed graduates who had other undergraduate qualifications (62.3%), Foundation Degrees (65.7%), First Degrees (65.5%) or a postgraduate qualification (65.7%) went to work for an engineering company. However, less than half (43.4%) of those with a Doctorate went to work for an engineering employer. Of the 355 students who graduated with an engineering and technology Doctorate and went to work for a non-engineering employer, 267 were working for a tertiary education employer and so many are likely to be involved in engineering teaching and research.

If the data is restricted to just engineering graduates, then overall 68.6% of engineering graduates who went into employment went to work for an engineering company.

For architecture, building and planning, nearly two thirds (60.6%) of graduates went to work for an engineering company. Nearly half (44.8%) of employed computer science graduates went to work for an engineering employer. A third (34.5%) of employed graduates in physical sciences went to work for an engineering company, along with a fifth of employed graduates in mathematical sciences (19.6%).

Table 12.6: Proportion of graduates going into employment who work for an engineering company, by subject area and level (2012/13) – UK domiciled[1120]

	Other undergraduate – proportion working for an engineering employer	Foundation Degree – proportion working for an engineering employer	First Degree – proportion working for an engineering employer	Postgraduate (including PGCE) – proportion working for an engineering employer	Doctorate – proportion working for an engineering employer	All graduates – proportion in engineering occupations
Medicine and dentistry	3.0%	**[1121]	0.3%	4.0%	5.7%	1.4%
Subjects allied to medicine	1.4%	1.8%	2.3%	3.1%	6.7%	2.2%
Biological sciences	10.9%	3.6%	9.4%	10.6%	11.8%	9.6%
Veterinary science	*[1122]	**	0.9%	*	*	1.9%
Agriculture and related subjects	9.2%	12.8%	16.6%	29.8%	*	17.1%
Physical sciences	27.4%	9.5%	33.2%	46.7%	33.7%	34.5%
Mathematical sciences	21.2%	**	19.4%	21.1%	18.7%	19.6%
Computer science	28.5%	41.8%	47.0%	45.0%	32.5%	44.8%
Engineering and technology	62.3%	65.7%	65.5%	65.7%	43.4%	64.3%
Architecture, building and planning	58.5%	44.4%	62.3%	60.2%	24.1%	60.6%
Social studies	4.1%	1.7%	8.0%	7.8%	3.6%	7.3%
Law	15.8%	*	8.3%	8.2%	2.8%	8.7%
Business and administrative studies	18.2%	13.3%	17.0%	24.7%	5.1%	18.6%
Mass communications and documentation	13.6%	9.6%	20.5%	27.1%	*	21.4%
Languages	13.3%	*	13.4%	12.3%	6.7%	13.1%
Historical and philosophical studies	11.1%	3.7%	11.6%	11.3%	8.2%	11.3%
Creative arts and design	10.9%	9.6%	14.8%	14.6%	5.7%	14.5%
Education	3.5%	0.5%	1.2%	0.9%	0.9%	1.1%
Combined	16.3%	*	15.4%	*	**	15.6%
Total – all graduates	12.8%	12.0%	16.7%	12.6%	16.2%	15.3%

Source: HESA/Destination of Leavers from Higher Education bespoke data request

1119 Industrial Classification (SIC) codes. For further details see Table 17.6 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf 1120 Only those graduates whose industry type could be identified at the 4 digit SIC code level in SIC2007 have been included in this analysis. For further details see Table 17.6 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf 1121 No graduates qualified in this subject area at this level in 2012/13 1122 Data suppressed to due to HESA data rounding policy

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Table 12.7 shows the proportion of graduates who work for an engineering company, either as an engineer or in another occupation, by each of the different subject areas. The table shows that nearly nine in 10 employed graduates in architecture, building and planning (87.8%) and engineering and technology (85.0%) went to work as an engineer for an engineering company. Three quarters (74.5%) of computer science graduates who were working in an engineering company were working as an engineer.

The table shows the importance of non-STEM subjects in providing non-engineering staff for engineering companies. For example, nine in 10 mass communication and documentation graduates (91.4%) and language graduates (90.2%) working for engineering employers had non-engineering roles, while eight in 10 graduates in medicine and dentistry (82.9%), social studies (84.7%), law (81.5%), business and administrative studies (79.4%) and historical and philosophical studies (83.9%) also worked in non-engineering roles.

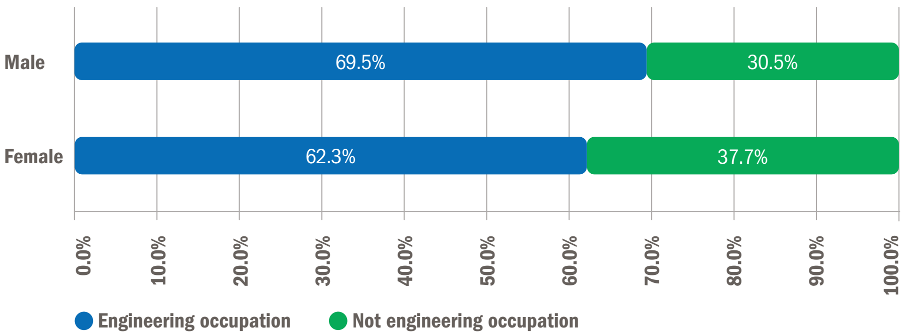
Figure 12.4 shows us that over two thirds (69.5%) of male engineering graduates went to work for an engineering employer, compared with 62.3% of female engineering graduates.

Table 12.7: Proportion of graduates who work for an engineering company, by subject area and whether they work as an engineer (2012/13) – UK domiciled[1123]

	Engineering occupation	Not engineering occupation
Medicine and dentistry	17.1%	82.9%
Subjects allied to medicine	31.0%	69.0%
Biological sciences	27.5%	72.5%
Veterinary science	*[1124]	*
Agriculture and related subjects	47.2%	52.8%
Physical sciences	37.3%	62.7%
Mathematical sciences	49.4%	50.6%
Computer science	74.5%	25.5%
Engineering and technology	85.0%	15.0%
Architecture, building and planning	87.8%	12.2%
Social studies	15.3%	84.7%
Law	18.5%	81.5%
Business and administrative studies	20.6%	79.4%
Mass communications and documentation	8.6%	91.4%
Languages	9.8%	90.2%
Historical and philosophical studies	16.1%	83.9%
Creative arts and design	28.9%	71.1%
Education	24.4%	75.6%
Combined	48.0%	52.0%
Total	48.9%	51.1%

Source: HESA/Destination of Leavers from Higher Education bespoke data request

Fig. 12.4: Proportion of employed engineering graduates, all qualifications, going to work for an engineering employer by gender (2012/13) – UK domiciled[1125]



Source: HESA/Destination of Leavers from Higher Education bespoke data request

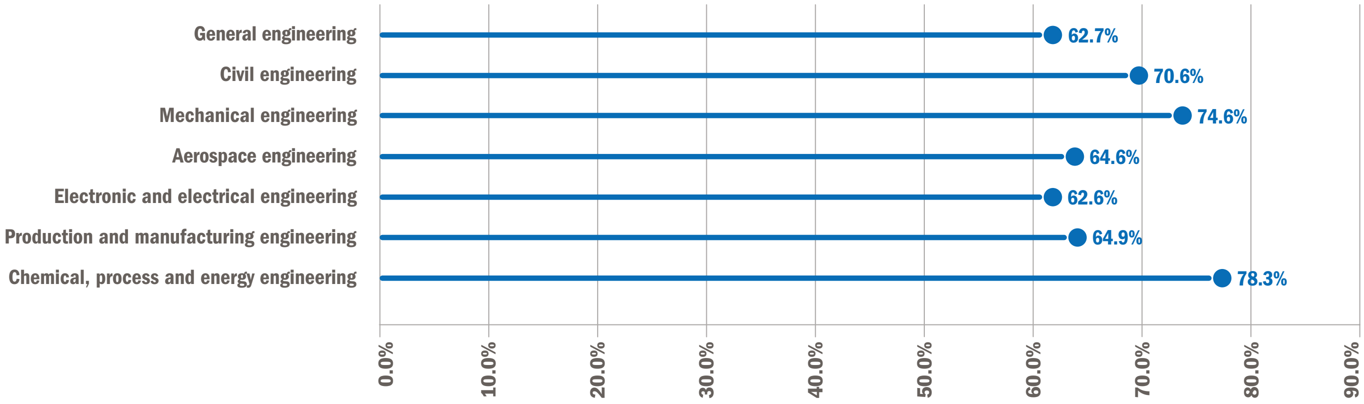
1123 For this table only those graduates whose employer could be identified at the four digit SIC level using SIC2007 and whose occupation could be identified at the four digit SOC level using SOC2010 were included in this analysis. For further details see Table 17.6 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf 1124 Data suppressed to due to HESA data rounding policy 1125 Only those graduates whose industry type could be identified at the 4 digit SIC code level in SIC2007 have been included in this analysis. For further details see Table 17.6 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf

12.5.1 Industry type by selected engineering sub-discipline

In Table 12.6 we showed that nearly two thirds (64.3%) of employed engineering and technology graduates went to work for an engineering company. However, only 62.6% of employed graduates in electronic and electrical engineering and 62.7% of employed graduates in general engineering went to work for an engineering employer.

By comparison, around three quarters of employed graduates in chemical, process and energy engineering (78.3%) and mechanical engineering (74.6%) went to work for an engineering employer.

Fig. 12.5: Proportion of employed graduates in engineering, by sub-discipline, going to work for an engineering employer (2012/13) – UK domiciled[1126]



Source: HESA/Destination of Leavers from Higher Education bespoke data request

1126 Only those graduates whose industry type could be identified at the 4 digit SIC code level in SIC2007 have been included in this analysis. For further details see Table 17.6 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf

Table 12.8 shows the top ten industry destinations for engineering graduates and the proportion of graduates from selected engineering sub-disciplines who go into each industry. It shows that overall a quarter (25.7%) of engineering graduates go into manufacturing. However, when you examine the seven selected engineering sub-disciplines, you see that production and manufacturing engineering has the highest proportion (43.4%), followed by mechanical engineering (39.8%) and aerospace engineering (36.9%). General engineering (27.7%), electronic and electrical engineering (22.5%) and chemical, process and energy engineering (23.8%) are all close to the average. However, of those graduating in civil engineering, only 4.6% who went into employment got a job in manufacturing.

A fifth (19.3%) of employed engineering graduates went to work in professional, scientific and technical activities. For most engineering sub-disciplines, between one in five (general engineering with 20.4%) and one in nine (electronic and electrical engineering with 11.8%) employed graduates went into professional, scientific and technical roles. However, a third (33.9%) of employed civil engineering graduates went into this sector.

Civil engineering accounted for most engineering graduates working in the construction industry. Overall, 7.8% of employed engineering graduates were working in construction, compared with a quarter (26.0%) of civil engineering graduates.

Only 5.9% of all employed engineering graduates were working in mining and quarrying. But for those graduating in chemical, process and energy engineering, the proportion rose to 22.9%.

12.5.2 Industry type by ethnicity

Table 12.9 shows that nearly three quarters (71.4%) of white employed engineering graduates are working for an engineering company. However, when you look at graduates from an ethnic minority background, the highest proportion going to work for an engineering company is other (including mixed) ethnicity, at 59.5%. Graduates from black or black British (Caribbean, African and other) ethnic backgrounds make up only half (51.8%) of those who go to work for an engineering company.

Table 12.8: Top ten employer destinations for engineering graduates by SIC2007 (2012/13) – UK domiciled[1127]

	General engineering	Civil engineering	Mechanical engineering	Aerospace engineering	Electronic and electrical engineering	Production and manufacturing engineering	Chemical, process and energy engineering	Average for all engineering subjects
Manufacturing	27.7%	4.6%	39.8%	36.9%	22.5%	43.4%	23.8%	25.7%
Professional, scientific and technical activities	20.4%	33.9%	17.3%	12.1%	11.8%	13.3%	17.5%	19.3%
Construction	4.6%	26.0%	2.6%	1.7%	3.4%	1.2%	3.0%	7.8%
Wholesale and retail trade; repair of motor vehicles and motorcycles	4.3%	4.3%	7.4%	8.2%	8.5%	9.7%	3.6%	6.4%
Public administration and defence; compulsory social security	6.1%	7.8%	3.3%	12.2%	5.0%	5.8%	1.5%	6.0%
Mining and quarrying	4.9%	4.6%	7.6%	1.2%	3.1%	1.8%	22.9%	5.9%
Information and communication	4.5%	1.3%	1.9%	2.3%	14.5%	4.3%	2.2%	5.1%
Education	5.9%	2.3%	4.0%	3.7%	6.0%	5.8%	4.7%	4.4%
Transport and storage	5.6%	3.7%	1.9%	9.5%	3.1%	1.2%	1.2%	3.6%
Electricity, gas, steam and air conditioning supply	2.5%	0.9%	3.3%	0.6%	6.0%	0.8%	5.3%	3.1%

Source: HESA/Destination of Leavers from Higher Education bespoke data request

1127 Only those graduates whose industry type could be identified at the 4 digit SIC code level in SIC2007 have been included in this analysis. For further details see Table 17.6 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf

Table 12.9: Proportion of employed engineering graduates, all qualifications, going to work for an engineering company, by ethnicity (2012/13) – UK domiciled[1128]

	Engineering	Not engineering
White	71.4%	28.6%
Black or black British (Caribbean, African and other)	51.8%	48.2%
Asian or Asian British (Indian, Pakistani and Bangladeshi)	56.6%	43.4%
Chinese	58.7%	41.3%
Other Asian background	52.3%	47.7%
Other (including mixed)	59.5%	40.5%

12.5.3 Engineering graduates going into finance[1129]

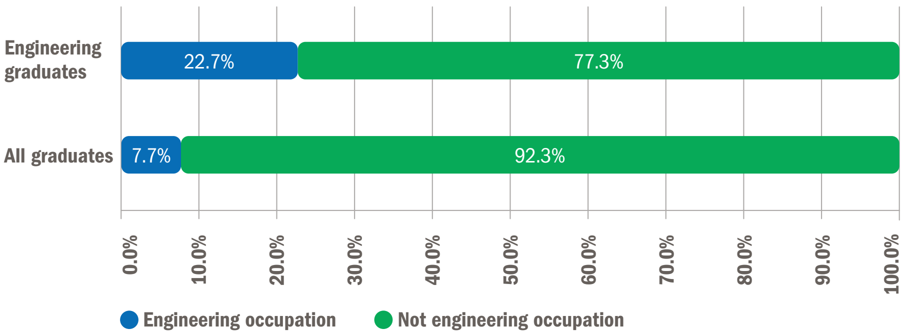
There is a common misconception that finance attracts a high percentage of analytically-trained engineering graduates, which diminishes the pool of potential engineers. Table 12.10 shows that the proportion of graduates who go to work in finance is 3.6% for all graduates but only 2.1% for engineering graduates. In addition, Figure 12.6 tells us that nearly a quarter (22.7%) of engineering graduates who go to work in finance work in engineering occupations, compared with only 7.7% of all graduates. This conclusively proves that a below-average percentage of engineering graduates do go to work in finance companies, and that nearly a quarter of those who do are working as engineers.

Table 12.10: Proportion of graduates who went to work in finance, by whether they graduated in engineering or not (2012/13) – UK domiciled[1130]

	Proportion of graduates going to work in finance
Engineering graduates	2.1%
All graduates	3.6%

Source: HESA/Destination of Leavers from Higher Education bespoke data request

Fig. 12.6: Graduates who went to work for financial service providers, by whether they worked in an engineering occupation and whether they graduated in engineering (2012/13) – UK domiciled[1131]



Source: HESA/Destination of Leavers from Higher Education bespoke data request

1128 Only those graduates whose industry type could be identified at the 4 digit SIC code level in SIC2007 have been included in this analysis. For further details see Table 17.6 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf **1129** Finance has been defined as working for an employer in the following industry groups: financial service activities, except insurance and pension funding; insurance, reinsurance and pension funding, except compulsory social security; and activities auxiliary to financial services and insurance activities **1130** Only those graduates whose industry type could be identified at the 4 digit SIC code level in SIC2007 have been included in this analysis. For further details see Table 17.6 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf **1131** Only those graduates whose industry type could be identified at the 4 digit SIC code level in SIC2007 have been included in this analysis. For further details see Table 17.6 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf

Part 3 – Engineering in Employment
13.0 Graduate recruitment and starting salaries[1132]

In 2012/13, graduates in engineering and technology had the second-highest mean salary within six months of graduating at £26,536, with only medicine and dentistry higher at £31,853. This was some 22% higher than that of all graduates at £21,725. The UK mean salary for all those in employment was £27,174. This means that graduates in engineering and technology start with an average salary that is almost the same as the UK national average salary.

Students graduating in general engineering (£31,901) and chemical, process and energy engineering (£29,703) had the highest mean salaries within engineering. The qualification obtained also had an impact on salaries, with engineering and technology graduates who gained a postgraduate degree earning the highest mean salary at £33,558, closely followed by those with a doctorate at £33,140.

Before looking in detail at graduate salaries six months after graduating, we will explore the long-term benefits on earnings of acquiring a degree. In its report on education and skills,[1133] the Confederation of British Industry and Pearson Education identified that by age 35, a graduate earns on average nearly double the salary of those whose highest qualification is GCSE A*-C.

Research by the Department for Business, Innovation and Skills has shown that the lifetime earnings of graduates, net of tax and loan repayments, are on average higher than those of non-graduates by £168,000 for men and £252,000 for women.[1134] However, there is a larger return for those obtaining a first or upper-second class degree with a further £76,000 uplift for men and £85,000 for women over their lifetimes compared to other graduates.[1135]

Figure 13.0 shows the average annual salary in 2013 for all workers who had a degree in each of the specified subject areas. Graduates in medicine had the highest mean salary at £45,604, followed by engineering at £42,016. The third-highest salary was £35,984 for graduates in physical and environmental subjects. At the other end of the scale, graduates in media and information studies earn £21,008, exactly half the salary of those graduating in engineering.

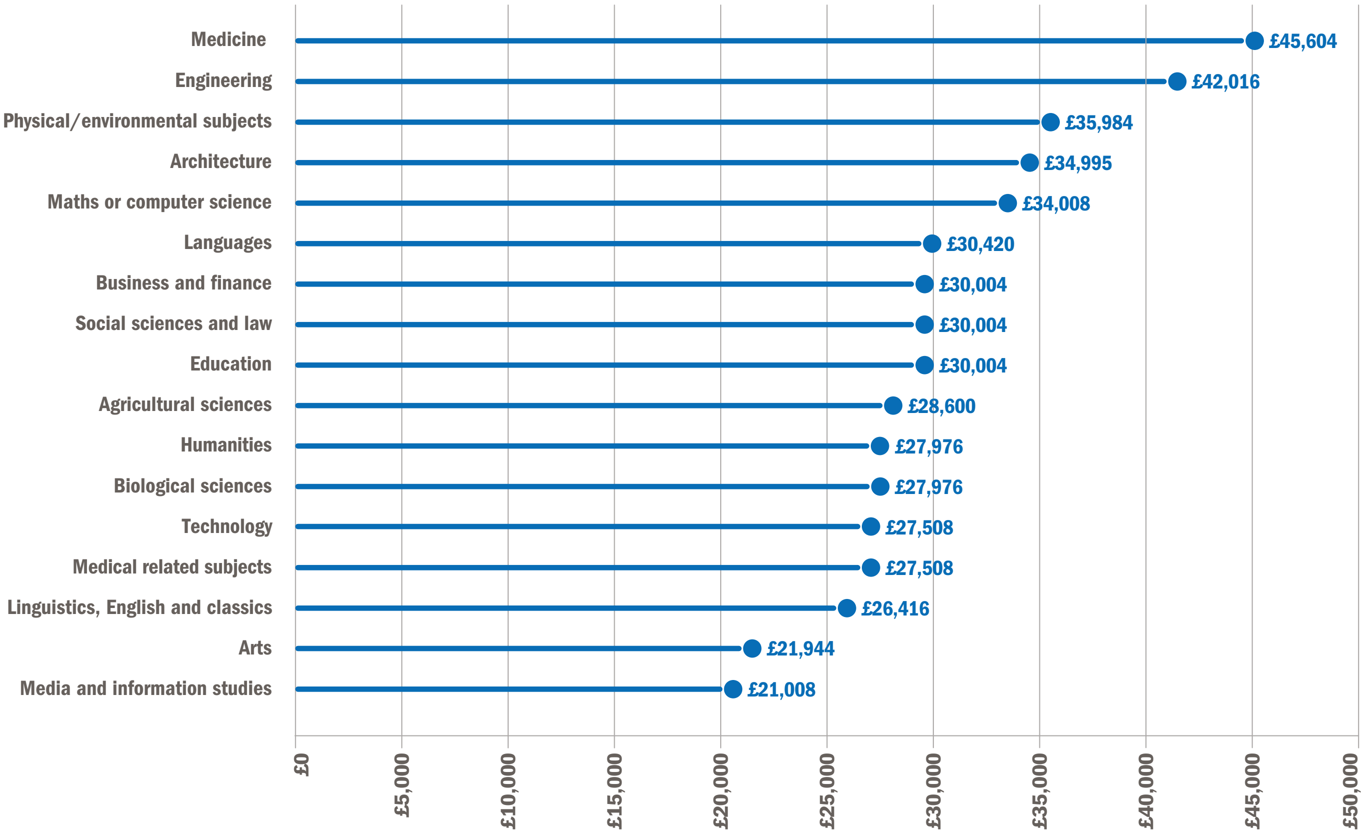
However, while looking at the financial benefits of having a degree it is also worth considering what impact there is if you start but don't finish a degree. The Department for Business, Innovation and Skills[1136] has identified that male dropouts earn approximately the same salary as those who never went to university but for women there is a small wage penalty. In other words, women would be financially better off if they never went to university rather than if they drop out of university.

Finally, it should be remembered that there is also a financial benefit to the Government from students obtaining a degree, of around £264,000 for men and £318,000 for women.[1137]

The Association of Graduate Recruiters polls its employers on how many applications they receive per vacancy (figure 13.1). Its analysis shows that on average there were 69.2 applications per place. Only one engineering-related sector had more applications per place than average – IT/communications (104.4). For engineering or industrial companies, applications per place were 56.8, while for energy, water or utility companies (51.4) and construction companies or consultancy, it was even lower (46.1).

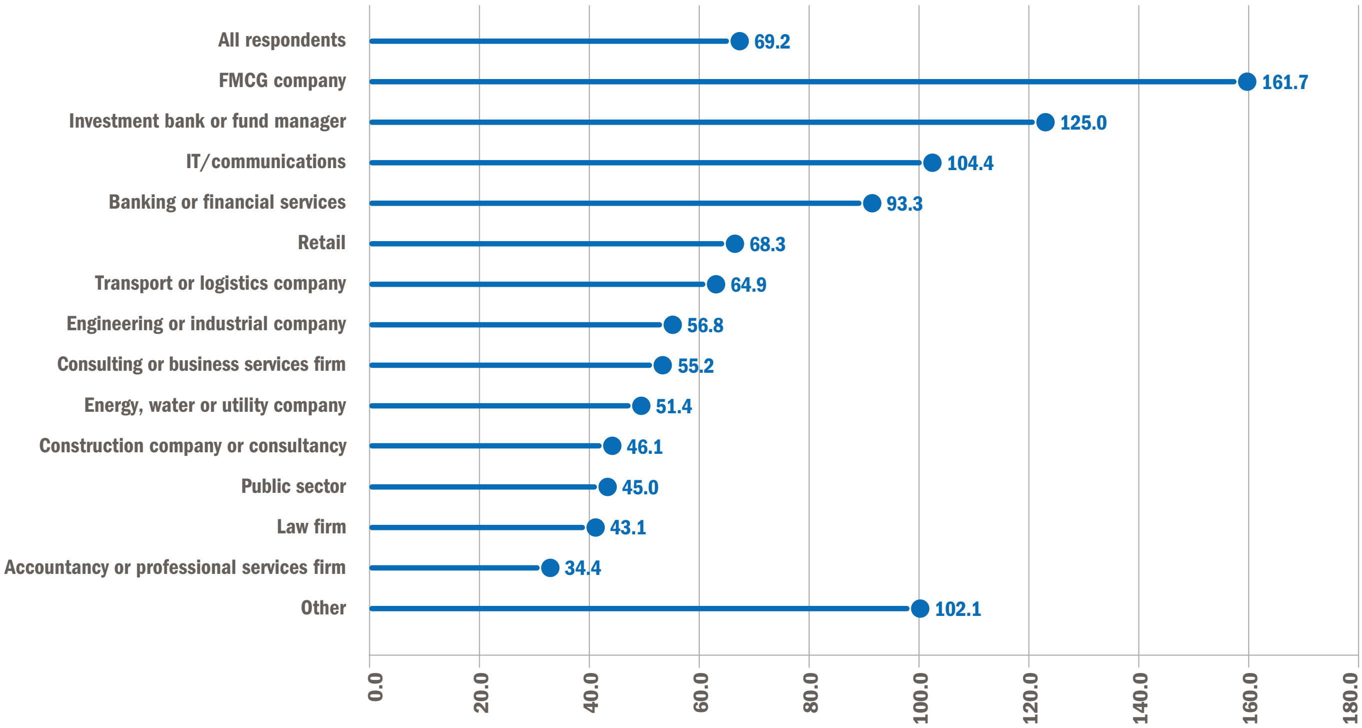
1132 Throughout this section, 50p has been removed from each median graduate salary which has been calculated using the HESA DLHE data **1133** *Gateway to growth CBI/Pearson education and skills survey 2014,* Confederation of British Industry and Pearson Education, 2014, p67 **1134** *The impact of university degrees on the lifecycle of earnings: some further analysis,* Department for Business, Innovation and skills, August 2013, p5 **1135** *The impact of university degrees on the lifecycle of earnings: some further analysis,* Department for Business, Innovation and skills, August 2013, p6 **1136** *The impact of university degrees on the lifecycle of earnings: some further analysis,* Department for Business, Innovation and skills, August 2013, p6 **1137** *The impact of university degrees on the lifecycle of earnings: some further analysis,* Department for Business, Innovation and skills, August 2013, p5

Fig. 13.0: Average annual salary for graduates by subject (2013)



Source: Confederation of British Industry[1138]

Fig. 13.1: Number of applications per vacancy for AGR employers by sector (2013/14)



Source: Association of Graduate Recruiters[1139]

1138 *Engineering our Future Stepping up the Urgency on STEM*, CBI, March 2014, p9 1139 *The AGR Graduate Recruitment Survey 2014 Summer Review,* Association of Graduate Recruiters, 2014, p29

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13.1 Graduate starting salaries[1140]

In its *Destination of Leavers from Higher Education* survey (DLHE), HESA asks graduates what their starting salary is.[1141] Using this data, it is possible to calculate the mean and median starting salaries for graduates in each subject area.[1142 1143 1144] Table 13.0 shows that the mean salary for all graduates was £21,725 in 2012/13. Medicine and dentistry had the highest mean salary at £31,853 while engineering and technology had the second-highest at £26,536.

In Section 12,[1145] we identified a number of non-engineering and technology subject areas from which a large proportion of graduates go into engineering occupations. Of these subject areas, business and administrative studies had the highest mean salary in 2012/13 at £25,230. However, employed graduates of physical sciences had a below-average mean salary of £21,073.

The lowest graduate mean salary was for creative arts and design at £14,363.

In the Annual Survey of Hours and Earnings,[1146] the Office for National Statistics calculated that the mean salary for everyone in employment was £27,174. This means that, on average, a graduate in engineering and technology has a starting salary nearly as high as a group including much more experienced workers.

Table 13.0: Average starting salary for graduates by subject area (2012/13) – UK domiciled[1147]

	Mean	Median
Medicine and dentistry	£31,853	£29,500
Engineering and technology	£26,536	£24,500
Business and administrative studies	£25,230	£20,500
Veterinary science	£24,620	£24,500
Architecture, building and planning	£23,499	£22,500
Subjects allied to medicine	£23,191	£21,500
Mathematical sciences	£22,975	£21,500
Computer science	£22,817	£21,500
Education	£22,471	£21,500
Combined subjects	£22,289	£19,500
Social studies	£21,482	£19,500
Physical sciences	£21,073	£19,500
Law	£19,999	£16,500
Agriculture and related subjects	£18,102	£17,500
Historical and philosophical studies	£17,945	£16,500
Biological sciences	£17,511	£15,500
Languages	£16,788	£15,500
Mass communications and documentation	£16,353	£15,500
Creative arts and design	£14,363	£13,500
Average for all graduates	£21,725	£20,500

Source: HESA/Destination of Leavers from Higher Education bespoke data request

13.1.1 Graduate starting salaries by gender

Table 13.1 shows the average starting salary by gender for selected engineering sub-disciplines in 2012/13. The highest mean salaries were for those graduating in general engineering (£31,901) and chemical, process and energy engineering (£29,703). Those graduating in civil engineering had the lowest mean starting salary at £25,053. In no sub-discipline did female graduates have a higher mean starting salary than their male counterparts.

Graduates in general engineering had the highest mean starting salary among male graduates at £32,689, while for female graduates it was those in chemical, process and energy engineering at £28,451.

1140 In this chapter engineering graduates has been defined as general engineering, civil engineering, mechanical engineering, aerospace engineering, naval engineering, electronic and electrical engineering, production and manufacturing engineering, chemical, process and energy engineering and others in engineering **1141** The salary is their actual salary six months after graduating which, for most, will be their starting salary. But it is acknowledged that some graduates will have received a pay rise during this six month period. **1142** Mean starting salary is not as accurate as median starting salary as the mean can be distorted by a few particularly high or low salary figures. **1143** In total 10,326 graduates in engineering and technology gave their starting salary. **1144** HESA DLHE data is provided in salary brackets: £0-£5,000 then rising by £1,000 increments until £69,000 and then all salaries £70,000 plus. In order to calculate the mean average salary. The midpoint was used in each salary bracket. For salaries £70,000 plus the salary midpoint used was £85,000. **1145** See Section 12.4 for further details of non-engineering and technology graduates who go into engineering occupations **1146** See http://www.ons.gov.uk/ons/rel/ashe/annual-survey-of-hours-and-earnings/index.html for further details on the Annual Survey of Hours and Earnings **1147** Not all graduates who completed the DLHE survey for 2010/11 provided salary information.

Table 13.1: Average starting salary for graduates in engineering, by selected sub-discipline and gender (2012/13) – UK domiciled

	All engineering graduates		Male engineering graduates		Female engineering graduates	
	Mean	Median	Mean	Median	Mean	Median
General engineering	£31,901	£28,500	£32,689	£28,500	£27,329	£26,500
Chemical, process and energy engineering	£29,703	£28,500	£30,113	£29,500	£28,451	£27,500
Mechanical engineering	£25,949	£25,500	£25,970	£25,500	£25,652	£25,500
Production and manufacturing engineering	£25,920	£24,500	£26,179	£24,500	£24,290	£24,500
Electronic and electrical engineering	£25,303	£24,500	£25,743	£24,500	£21,079	£21,500
Aerospace engineering	£25,106	£24,500	£25,206	£25,500	£24,171	£24,500
Civil engineering	£25,053	£23,500	£25,166	£23,500	£24,450	£23,500
All engineering graduates	£26,768	£25,500	£26,975	£25,500	£25,307	£24,500

Source: HESA/Destination of Leavers from Higher Education bespoke data request

13.1.2 Graduate starting salaries by ethnicity

Examining graduate starting salaries by ethnicity (Table 13.2) reveals that white graduates had the highest mean salary at £27,353, followed by other (including mixed) with £24,596. The lowest starting salary was for those of black or black British (Caribbean, African and other) ethnicity, who had a mean salary of £23,157.

13.1.3 Graduate starting salaries by university mission groups

Looking at mean salaries by university mission group (Table 13.3) shows very little variance. Surprisingly, those graduating from other (including non-aligned) had the highest mean salary at £27,982, with the Russell Group second at £26,520, while those graduating from Guild HE institutions had the lowest mean at £25,626, some £2,356 less than the highest average earners.

Table 13.2: Average starting salary for graduates in engineering, by ethnicity (2012/13) – UK domiciled

	Mean salary	Median salary
White	£27,353	£25,500
Black or black British (Caribbean, African and other)	£23,157	£22,500
Asian or Asian British (Indian, Pakistani and Bangladeshi)	£23,283	£23,500
Chinese	£23,280	£24,500
Other Asian background	£23,431	£23,500
Other (including mixed)	£24,596	£24,500

Source: HESA/Destination of Leavers from Higher Education bespoke data request

Table 13.3: Average starting salary for graduates in engineering, by university mission group (2012/13) – UK domiciled

	Mean salary	Median salary
Russell Group	£26,520	£25,500
Million Plus	£26,093	£24,500
Guild HE	£25,626	£25,500
University Alliance	£25,771	£24,500
Other (including non-aligned)	£27,982	£25,500

Source: HESA/Destination of Leavers from Higher Education bespoke data request

13.1.4 Graduate starting salaries by qualification obtained

Looking at mean salaries for engineering graduates, Table 13.4 shows that those obtaining a postgraduate degree had the highest starting salary at £33,558, while those who graduated with a doctorate earned slightly less at £33,140. Those qualifying with a First Degree had the lowest mean starting salary at £25,047 in 2012/13.

13.2 Graduate starting salaries by industry

The mean salary for someone employed by an engineering company in 2012/13 was £28,116 compared with £23,183 for those who did not work for an engineering company (Table 13.5).

In Section 12.5 we showed that females and graduates from an ethnic minority were less likely to work for an engineering company than white and male graduates. In this chapter, we have shown that females and ethnic minority graduates earn less than white and male graduates. The difference in salary for those working for an engineering or non-engineering company and the difference in the proportion of white and male graduates working in engineering companies, compared with females and those from an ethnic minority, may go some way to explain the differences observed in graduate starting salaries.

Table 13.4: Average starting salary for graduates in engineering, by qualification obtained (2012/13) – UK domiciled

	Mean salary	Median salary
Doctorate	£33,140	£30,500
Postgraduate	£33,558	£29,500
First Degree	£25,047	£24,500
Foundation Degree[1148]	£29,037	£29,500
Other undergraduate	£26,445	£24,500

Source: HESA/Destination of Leavers from Higher Education bespoke data request

Table 13.5: Average starting salary for graduates in engineering, by whether they work for an engineering company or not (2012/13) – UK domiciled

	Mean salary	Median salary
Engineering	£28,116	£25,500
Not engineering	£23,183	£22,500

Source: HESA/Destination of Leavers from Higher Education bespoke data request

1148 For Foundation Degrees nine out of 466 graduates who gave their salary information said they were earning over £70,000 per year

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 at £78,482 in 2012/13: more than medical practitioners at £70,648. Amongst STEM technician and craft careers, the highest salary for an engineering occupation was £32,528, achieved by engineering technicians. The chapter also shows that the mean salary for everyone in employment was £27,174, while the gender pay gap tends to occur for workers aged 40 or above.

Before we explore salaries in different STEM occupations, it is worth looking at low pay and factors that influence pay. The Social Market Foundation[1149] has shown that in September 2013, 22% of the UK workforce – nearly five million people – were on low pay. This is the second highest proportion of people in low pay amongst developed countries, with only America having a higher percentage.

Using its own definition of minimum wage jobs,[1150] the Low Pay Commission has shown a higher proportion of minimum wage amongst:[1151]

- part-time jobs
- temporary jobs
- jobs held for less than a year
- jobs in smaller firms

In addition, it determined that, although part-time jobs form just 30% of all jobs, they represent 60% of minimum wage jobs.[1152]

Citing research by the Resolution Foundation, the Social Market Foundation has shown that a large proportion of those in low paid occupations stay in low paid occupations.[1153] Additionally, 27% of those who were in low paid jobs in 2002 were in low paid jobs for each year over the next decade, and that 2.9 million workers who were in low paid jobs were still in low paid jobs 12 months later.[1154]

Research has shown that those with no qualifications are more likely to move in and out of work and be stuck on low pay.[1155] Of those on low pay, 30% don't have officially recognised qualifications and a further 20% are educated to GCSE level.[1156] This finding is supported by Figure 14.0, which shows that graduate salaries peak at a higher age than non-graduate salaries and that, apart from when graduates are just starting their careers, they earn a higher salary than those with other qualifications.

1149 *Making Progress Boosting the skills and wage prospects of the low paid,* Social Market Foundation, April 2014, p12 **1150** For details on the Low Pay Commissions definition of minimum wage jobs see National Minimum Wage Low Pay Commission Report 2014, Low Pay Commission, March 2014, p22 **1151** *National Minimum Wage Low Pay Commission Report 2014,* Low Pay Commission, March 2014, p22 **1152** *National Minimum Wage Low Pay Commission Report 2014,* Low Pay Commission, March 2014, p22 **1153** *Making Progress Boosting the skills and wage prospects of the low paid,* Social Market Foundation, April 2014, p15 **1154** *Making Progress Boosting the skills and wage prospects of the low paid,* Social Market Foundation, April 2014, p6 **1155** *Work in progress Low pay and progression in London and the UK,* Centre for Economic and Social Inclusion and Trust for London, October 2013, p42 **1156** *Making Progress Boosting the skills and wage prospects of the low paid,* Social Market Foundation, April 2014, p7

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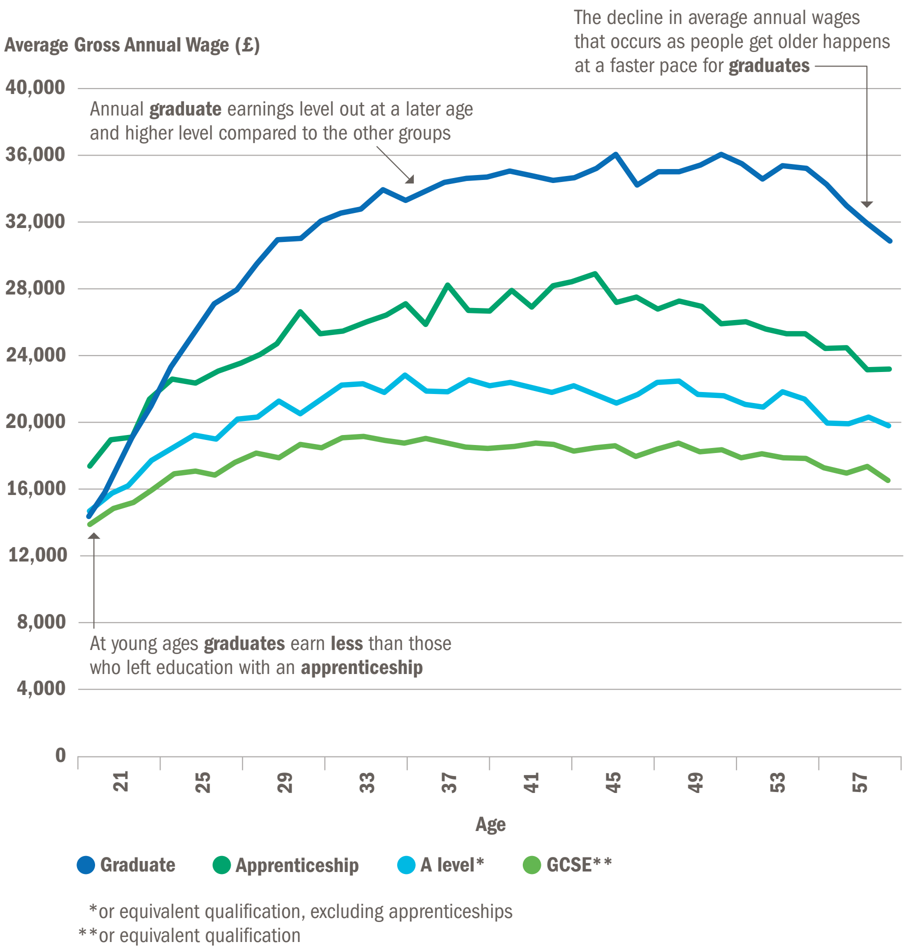
Fig. 14.0: Pay progression by highest qualification and age (2013)[1157]



Source: Office for National Statistics[1158]
Notes: *or equivalent qualifications, excluding apprenticeships **or equivalent qualifications

Finally, it should be noted that low paid work carries a significant cost to the State: State subsidies for working households are estimated at around £21 billion.[1159]

1157 Annual wages are calculated as an average wage for each year from 2003 to 2013 and then adjusted to 2013 earning levels 1158 *Full report – Graduates in the UK labour market 2013*, Office for National Statistics, 19 November 2013, p15 1159 *Making progress boosting the skills and wage prospects of the low paid*, Social Market Foundation, April 2014, p6

14.1 Earnings by gender

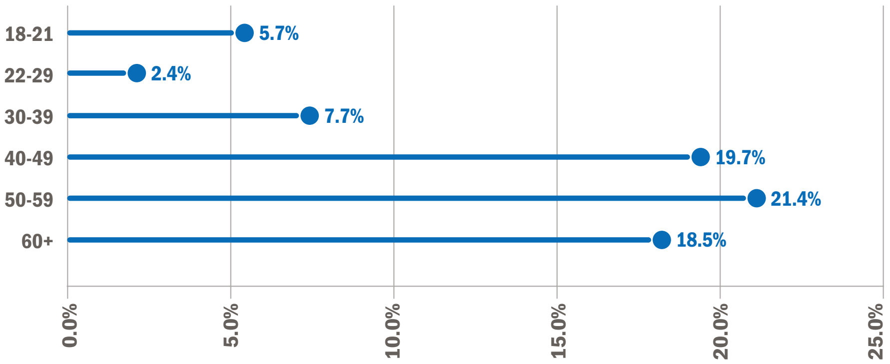
Figure 14.1 shows the gender pay gap for mean full-time hourly earnings by age. For those aged 18-39, the pay gap was at most 7.7%. However, for those aged 40-49 the pay gap rose to 19.7% and for those aged 50-59 it increased again to 21.4%.

The House of Commons Library[1160] has suggested that one possible reason that the pay gap affects older workers is the generational difference. It states that since 1997, there have been large decreases in the pay gap for workers aged 30-39 and for those aged 40-49. Therefore, as time progresses, the pay gap may naturally shrink. However, another potential explanation is that factors affecting female pay only become evident when women reach their 30s and 40s, and hence the pay gap may persist without further Government action.

It is also possible that the profile of careers followed by men and women could have an effect on the gender pay gap. For young people entering managerial, senior official and professional occupations, there is little difference by gender. However, there are long term gender divisions elsewhere in the labour market, with young men more likely to be employed in elementary and skilled trades occupations and young women more likely to be employed in sales and customer service or caring, leisure and other service occupations.[1161] If pay gaps persist between male and female workers in the occupations that men and women choose then inequality will be entrenched for the long term.

Finally, it should be noted that the gender pay gap varies considerably by occupation. The Department for Culture, Media and Sport[1162] has shown that the gender pay gap has been consistently high for those in skilled trades and for managers and directors. By comparison, the pay gap has been consistently lower for those in professional and associate professional occupations.

Fig. 14.1: Gender pay gap for mean full-time hourly earnings (excluding overtime), by age (April 2013)



Source: Office for National Statistics – Annual Survey of Hours of Earnings 2013

14.2 Annual mean[1163] and median gross pay for selected STEM professions

The Annual Survey of Hours and Earnings (ASHE) is regarded by the Office of National Statistics as the best source of information on individual earnings in the UK.[1164] The Centre for Economic and Social Inclusion and Trust for London[1165] shows that, as a result of the recession, earnings have fallen by 8.5% in real terms since 2009.

A report by the Royal Society shows that the scientific workforce[1166] is better paid than other occupations, but that there are few people in science who earn the very highest salaries.[1167] The National STEM Centre[1168] has cited research showing that STEM skills command a wage premium, and that the wage premium is higher in STEM jobs.

Table 14.0 shows the annual mean and median gross pay for selected STEM professionals in 2013. The mean salary for all workers was £27,174. Compare this with the highest mean salary for a STEM career, which was £78,482 for aircraft pilots and flight engineers. There was a substantial decline to the second-highest salary, which was £70,648 for medical practitioners. There was then another fairly sharp drop to the third highest salary, £64,879, for information technology and telecommunications directors. At the other end of the scale, the lowest mean salary was for conservation professionals at £28,956.

1160 *Debate on contribution of women to the economy: Library briefing note,* House of Commons Library, 4 March 2014, p7 **1161** *The Gender Jobs Split: how young men and women experience the labour market,* Touchstone Extras, 2013, p7 **1162** *Secondary Analysis of the Gender Pay Gap: changes in the gender pay gap over time,* Department for Culture, Media and Sport, March 2014, p5 **1163** Mean salaries can be distorted by a few very large or small salaries in a specific career **1164** *National Minimum Wage Low Pay Commission Report 2014,* Low Pay Commission, March 2014, p22 **1165** *Work in progress: low pay and progression in London and the UK,* Centre for Economic and Social Inclusion and Trust for London, October 2013, p5 **1166** The Royal Society definition of science occupations is very broad and includes many engineering occupations. For further details see *A picture of the UK scientific workforce: diversity data analysis for the Royal Society Summary report,* Royal Society, February 2014, p10 **1167** *A picture of the UK scientific workforce: diversity data analysis for the Royal Society Summary report,* Royal Society, February 2014, p5 **1168** *School organisation and STEM career-related learning,* National STEM Centre, August 2013, p2

Table 14.0: Annual mean and median gross pay for selected STEM professions (2013) – UK[1169]

Occupation	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Aircraft pilots and flight engineers	9,000	£78,482	-0.1%	£78,356	-0.4%
Medical practitioners	172,000	£70,648	1.3%	£63,677	4.4%
Information technology and telecommunications directors	25,000	£64,879	-9.7%	£55,426	-11.5%
Production managers and directors in manufacturing	424,000	£51,498	-2.6%	£40,564	0.1%
Research and development managers	37,000	£49,590	4.3%	£43,618	2.0%
Health services and public health managers and directors	41,000	£49,015	-5.3%	£43,443	-0.2%
IT specialist managers	136,000	£48,384	-0.1%	£43,423	0.8%
Production managers and directors in construction	88,000	£47,452	4.9%	£39,505	4.0%
Electrical engineers	19,000	£44,439	3.7%	£42,609	-
Mechanical engineers	37,000	£44,176	4.9%	£40,477	2.2%
Architects	28,000	£44,024	3.3%	£35,000	-0.6%
IT business analysts, architects and systems designers	87,000	£43,848	-1.2%	£40,398	2.5%
Quality assurance and regulatory professionals	56,000	£42,898	-3.8%	£36,767	-0.3%
Waste disposal and environmental services managers	6,000	£42,452	-7.6%	£37,212	-3.1%
Construction project managers and related professionals	17,000	£42,066	8.3%	£35,242	0.1%
Engineering professionals n.e.c.	120,000	£41,421	2.6%	£38,929	4.4%
Managers and directors in transport and distribution	61,000	£40,856	5.4%	£35,400	2.6%
Information technology and telecommunications professionals n.e.c.	76,000	£40,222	0.4%	£36,948	2.5%
Programmers and software development professionals	142,000	£40,165	-0.2%	£38,486	1.1%
Design and development engineers	63,000	£39,890	0.5%	£37,877	2.1%
Production and process engineers	33,000	£38,475	3.5%	£36,526	6.1%
Civil engineers	38,000	£38,236	-2.7%	£36,060	2.3%
Chartered and certified accountants	76,000	£37,850	-0.2%	£34,745	-2.3%
Biological scientists and biochemists	53,000	£37,627	-1.7%	£34,182	-3.1%
Pharmacists	29,000	£36,739	-1.4%	£35,262	-5.5%
Natural and social science professionals n.e.c.	45,000	£36,574	1.0%	£34,191	1.0%
Managers and proprietors in other services n.e.c.	70,000	£36,405	-0.5%	£28,271	-1.9%
Business, research and administrative professionals n.e.c.	62,000	£36,012	0.8%	£32,806	0.6%
Chemical scientists	14,000	£35,492	-1.0%	£32,469	-3.4%
Chartered surveyors	50,000	£35,480	-3.7%	£32,800	-1.6%
Quality control and planning engineers	28,000	£34,868	1.7%	£33,909	5.9%
Environment professionals	30,000	£33,220	0.5%	£31,057	2.6%
Medical radiographers	30,000	£31,505	-3.8%	£30,387	-3.3%
Ophthalmic opticians	7,000	£30,959	-0.8%	£32,304	-5.3%
Web design and development professionals	31,000	£29,870	5.5%	£29,204	2.7%
Conservation professionals	9,000	£28,956	6.4%	£30,010	6.3%
All employees	21,488,000	£27,174	1.6%	£21,905	1.9%

Source: Office for National Statistics – Annual Survey of Hours and Earnings 2013. Note - means data suppressed by ONS.

1169 Employees on adult rates who have been in the same job for more than a year

14.2.1 Annual mean and median pay for selected full-time STEM professions by gender

Table 14.1 shows the mean and median salaries for different full-time STEM professionals by gender. Overall, aircraft pilots and flight engineers had the highest mean salary, at £81,179. The second highest mean salary was £79,494 for medical practitioners, with male workers earning £88,570, compared with £63,772 for female workers. There is then a very steep decline to the third highest mean salary, which was £69,249 for information technology and telecommunications directors.

The only full-time STEM occupations where female mean salaries were higher than those of their male counterparts were ophthalmic opticians (£33,967 and £39,677), managers and directors in transport and distribution (£41,391 and £44,056) and quality control and planning engineers (£35,338 and £36,026)

Interestingly, given their reputation for high pay, the full-time mean salary for chartered and certified accountants was £41,454.

Table 14.1: Annual mean and median pay for selected full-time STEM professions by gender (2013) – UK[1170]

	All full-time workers		Male		Female	
	Mean	Median	Mean	Median	Mean	Median
Aircraft pilots and flight engineers	£81,179	£78,659	£81,179	£78,659	-	-
Medical practitioners	£79,494	£75,342	£88,570	£86,860	£63,772	£53,822
Information technology and telecommunications directors	£69,249	£57,375	£69,741	£57,136	£66,647	-
Actuaries, economists and statisticians	£62,783	£44,219	£67,377	£46,576	-	£39,789
Dental practitioners	£60,782	-	£73,060	£70,764	£47,220	-
Production managers and directors in manufacturing	£55,076	£42,984	£57,093	£44,471	£44,361	£36,590
Physical scientists	£54,089	£42,889	£56,903	£44,711	£40,473	£37,526
Research and development managers	£52,000	£45,000	£55,700	£47,050	£42,370	£37,260
Health services and public health managers and directors	£51,099	£45,847	£54,242	£48,468	£48,683	£42,495
IT project and programme managers	£50,295	£48,597	£51,773	£49,090	£46,270	£47,285
Production managers and directors in construction	£49,648	£40,238	£49,680	£40,447	£49,255	£39,455
IT specialist managers	£49,302	£44,314	£50,260	£45,072	£43,947	£38,732
Architects	£46,398	£37,410	£48,740	£39,328	£33,655	£30,236
Mechanical engineers	£45,551	£41,003	£46,015	£41,733	£41,257	£36,169
Electrical engineers	£45,222	£42,905	£45,448	£43,039	£40,933	£32,716
IT business analysts, architects and systems designers	£44,893	£40,896	£45,326	£41,634	£41,631	£36,076
Quality assurance and regulatory professionals	£44,439	£37,867	£47,804	£40,301	£38,757	£34,173
Waste disposal and environmental services managers	£43,349	£37,294	£43,739	-	£41,641	-
Construction project managers and related professionals	£42,759	£35,397	£44,087	£36,258	£31,288	-
Information technology and telecommunications professionals n.e.c.	£42,170	£38,666	£42,963	£39,374	-	-
Engineering professionals n.e.c.	£42,070	£39,434	£42,998	£39,977	£35,497	£32,139
Pharmacists	£41,818	£40,275	£45,630	£43,721	£39,428	£37,943
Managers and directors in transport and distribution	£41,688	£35,679	£41,391	£35,796	£44,056	£35,031
Chartered and certified accountants	£41,454	£37,535	£44,862	£39,839	£37,029	£33,948

1170 Employees on adult rates who have been in the same job for more than a year

Table 14.1: Annual mean and median pay for selected full-time STEM professions by gender (2013) – UK – continued

	All full-time workers		Male		Female	
	Mean	Median	Mean	Median	Mean	Median
Design and development engineers	£41,178	£38,736	£41,448	£38,805	£37,267	£36,158
Programmers and software development professionals	£41,005	£39,037	£41,158	£39,298	£39,627	£35,999
Biological scientists and biochemists	£40,705	£37,636	£42,218	£39,321	£39,001	£36,967
Electronics engineers	£39,542	£38,424	£39,591	£38,576	£39,123	£38,260
Civil engineers	£39,002	£36,285	£39,557	£36,412	£32,101	£32,647
Veterinarians	£38,844	£37,415	£41,167	£38,267	£37,237	£36,385
Managers and proprietors in other services n.e.c.	£38,812	£30,000	£42,557	£30,855	£32,426	£26,806
Production and process engineers	£38,725	£36,873	£39,320	£36,983	-	-
Natural and social science professionals n.e.c.	£37,997	£35,139	£38,983	£36,178	£36,441	£33,272
Business, research and administrative professionals n.e.c.	£37,829	£33,467	£39,103	£34,681	£35,603	£32,132
Ophthalmic opticians	£37,317	£36,712	£33,967	£34,733	£39,677	£36,350
Chartered surveyors	£37,282	£34,451	£38,151	£34,899	£29,722	£29,621
Chemical scientists	£37,205	£33,589	£39,551	£35,035	£30,425	-
Medical radiographers	£35,967	£34,705	£36,736	£34,812	£35,565	£34,653
Quality control and planning engineers	£35,434	£34,057	£35,338	£34,104	£36,026	£33,740
Environment professionals	£34,342	£31,456	£34,953	£32,311	£31,989	£28,668
Conservation professionals	£32,596	£31,288	£34,323	£35,078	£29,473	£30,003
Web design and development professionals	£30,902	£30,000	£31,516	£30,475	£27,600	£25,515
Social and humanities scientists	£29,901	£27,813	£30,871	£27,996	£24,623	£21,359
Chartered architectural technologists	£28,791	£24,949	£28,681	£24,615	-	-
All employees	£33,288	£27,017	£36,825	£29,251	£27,720	£23,589

Source: Office for National Statistics – Annual Survey of Hours and Earnings 2013. Note - means data suppressed by ONS.

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14.2.2 Annual mean and median pay for selected part-time STEM professions by gender

Table 14.2 shows the mean and median pay for selected part-time STEM professions by gender.

The part-time STEM profession with the highest mean salary was IT specialist managers (£26,682). The lowest mean salary was for production managers and directors in manufacturing (£17,597). This compares to the mean salary for all employees, which was £11,352 in 2013.

Table 14.2: Annual mean and median pay for selected part-time STEM professions by gender (2013) – UK[1171]

	All part-time workers		Male		Female	
	Mean	Median	Mean	Median	Mean	Median
IT specialist managers	£26,682	£23,285	£29,256	-	£25,736	£21,314
Business, research and administrative professionals n.e.c.	£24,887	£20,877	-	-	£23,098	£21,178
Research and development managers	£24,195	£23,089	-	-	£26,056	£23,996
Chemical scientists	£22,485	£19,799	-	-	£23,513	£20,464
Managers and proprietors in other services n.e.c.	£19,245	£14,483	£19,776	-	£19,028	£14,110
Biological scientists and biochemists	£19,206	£19,607	£17,529	-	£19,822	£20,099
Production managers and directors in manufacturing	£17,597	£11,078	£17,283	£9,463	£18,089	£12,765
All employees	£11,352	£8,901	£12,234	£8,480	£11,095	£9,004

Source: Office for National Statistics – Annual Survey of Hours and Earnings 2013. Note - means data suppressed by ONS.

1171 Employees on adult rates who have been in the same job for more than a year

14.3 Annual mean and median gross pay for selected STEM technician and craft careers

Table 14.3 shows the mean and median gross pay for selected STEM technician and craft careers in 2013. The highest mean salary was for financial and accounting technicians at £44,038, followed by pipe fitters, who earned £36,637 per annum. Engineering technicians had the fifth-highest mean salary at £32,528.

The lowest mean salary was for industrial cleaning and process occupations at £15,241.

Table 14.3: Annual mean and median gross pay for selected STEM technician and craft careers (2013) – UK[1172]

	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Financial and accounting technicians	29,000	£44,038	2.2%	£37,143	-3.1%
Pipe fitters	7,000	£36,637	-2.9%	£37,195	9.4%
Skilled metal, electrical and electronic trades supervisors	53,000	£35,316	1.4%	£32,658	0.7%
Aircraft maintenance and related trades	9,000	£34,511	2.1%	£34,643	6.8%
Engineering technicians	79,000	£32,528	-0.3%	£31,711	0.1%
Telecommunications engineers	35,000	£32,253	5.3%	£31,224	7.8%
Electrical and electronic trades n.e.c.	102,000	£30,696	4.0%	£29,572	3.5%
Electricians and electrical fitters	107,000	£30,055	1.4%	£29,371	2.4%
Assemblers (vehicles and metal goods)	53,000	£29,845	1.9%	£28,355	1.6%
IT operations technicians	94,000	£29,815	2.1%	£27,209	1.2%
Planning, process and production technicians	32,000	£29,789	0.1%	£26,977	-0.4%
Draughtspersons	29,000	£29,702	4.7%	£27,599	5.2%
Metal plate workers, and riveters	9,000	£29,458	-4.6%	£28,491	-
IT user support technicians	106,000	£29,457	0.8%	£27,132	-0.2%
Precision instrument makers and repairers	10,000	£29,334	1.4%	£28,453	-0.1%
Product, clothing and related designers	23,000	£29,301	2.6%	£27,640	4.0%
Metal working production and maintenance fitters	291,000	£29,173	2.0%	£27,699	1.8%
Water and sewerage plant operatives	9,000	£29,085	1.0%	£29,243	-0.1%
Electrical and electronics technicians	11,000	£28,893	-5.9%	£30,351	-0.1%
Architectural and town planning technicians	12,000	£27,866	1.8%	£26,836	3.3%
Plumbers and heating and ventilating engineers	55,000	£27,832	-1.2%	£27,449	-0.4%
Quality assurance technicians	24,000	£27,303	4.6%	£25,899	6.0%
Metal machining setters and setter-operators	60,000	£27,223	2.0%	£25,102	0.5%
IT engineers	13,000	£27,064	-2.4%	£25,789	1.2%
Medical and dental technicians	26,000	£26,922	6.1%	£25,729	8.3%
Printers	21,000	£26,833	2.7%	£25,782	1.8%
Welding trades	41,000	£26,735	-1.6%	£24,814	-1.1%
Science, engineering and production technicians n.e.c.	122,000	£26,710	4.9%	£24,934	3.9%
Energy plant operatives	6,000	£26,413	8.9%	£26,182	8.3%
Tool makers, tool fitters and markers-out	11,000	£26,389	-1.3%	£26,217	-
TV, video and audio engineers	9,000	£26,164	14.5%	£26,510	24.6%

1172 Employees on adult rates who have been in the same job for more than a year

Table 14.3: Annual mean and median gross pay for selected STEM technician and craft careers (2013) – UK – continued

	Number of jobs	Mean	Annual percentage change	Median	Annual percentage change
Sheet metal workers	11,000	£26,087	3.8%	£24,161	4.8%
Vehicle paint technicians	7,000	£25,591	2.8%	£25,183	0.9%
Chemical and related process operatives	26,000	£25,307	0.9%	£23,188	2.9%
Vehicle technicians, mechanics and electricians	102,000	£25,238	-0.7%	£23,961	-0.4%
Metal making and treating process operatives	11,000	£24,941	-2.3%	£24,155	-0.5%
Rubber process operatives	5,000	£24,867	6.4%	£25,021	5.4%
Routine inspectors and testers	39,000	£24,787	3.8%	£22,974	4.0%
Process operatives n.e.c.	11,000	£24,629	-2.7%	£23,914	-2.3%
Plant and machine operatives n.e.c.	16,000	£24,278	-1.5%	£22,281	0.8%
Vehicle body builders and repairers	19,000	£23,620	-1.0%	£23,348	1.1%
Metal working machine operatives	22,000	£22,044	-1.0%	£20,932	-4.2%
Electroplaters	5,000	£21,758	-5.4%	£21,391	-1.9%
Laboratory technicians	63,000	£21,168	0.2%	£19,005	-1.7%
Printing machine assistants	18,000	£21,002	3.3%	£19,248	-1.6%
Elementary construction occupations	47,000	£20,910	-0.1%	£20,609	2.7%
Pharmaceutical technicians	14,000	£20,815	2.4%	£19,506	0.9%
Paper and wood machine operatives	23,000	£20,557	1.1%	£19,116	2.8%
Glass and ceramics process operatives	5,000	£20,382	3.0%	£18,021	1.4%
Textile process operatives	11,000	£19,946	-3.8%	£18,981	-0.9%
Assemblers (electrical and electronic products)	14,000	£19,590	5.4%	£19,169	6.7%
Elementary process plant occupations n.e.c.	86,000	£19,409	2.7%	£18,653	2.5%
Tyre, exhaust and windscreen fitters	14,000	£18,888	-4.2%	£17,410	-11.0%
Food, drink and tobacco process operatives	131,000	£18,133	1.9%	£17,056	1.5%
Industrial cleaning process occupations	14,000	£15,241	-8.0%	£15,360	-3.4%
All employees	21,488,000	£27,174	1.6%	£21,905	1.9%

Source: Office for National Statistics – Annual Survey of Hours and Earnings 2013. Note - means data suppressed by ONS.

14.3.1 Annual mean and median gross pay for selected full-time STEM technician and craft careers by gender

Table 14.4 shows the median and mean salary for selected full-time STEM technician and craft careers by gender. Financial and accounting technicians had the highest mean salary in 2013 at £49,583. They were followed by rail and rolling stock builders and repairers at £39,602. The mean salary for engineering technicians was £33,687.

The full-time STEM technician and craft career with the lowest mean salary was weighers, graders and sorters, who earned on average £18,170.

Table 14.4: Annual mean and median pay for selected full-time STEM technician and craft careers by gender (2013) – UK[1173]

	All full-time workers		Male		Female	
	Mean	Median	Mean	Median	Mean	Median
Financial and accounting technicians	£49,583	£40,903	£55,758	£48,188	£40,789	£31,597
Rail and rolling stock builders and repairers	£39,602	£40,664	£39,203	£40,196	-	-
Pipe fitters	£37,616	£37,590	£37,616	£37,590	-	-
Skilled metal, electrical and electronic trades supervisors	£35,538	£32,664	£35,391	£32,724	-	-
Aircraft maintenance and related trades	£35,015	£34,795	£35,835	£35,491	£21,286	£19,371
Engineering technicians	£33,687	£32,608	£33,927	£32,796	£31,720	£28,821
Telecommunications engineers	£32,773	£31,694	£33,227	£32,272	£23,897	£23,352
IT operations technicians	£31,946	£28,438	£33,219	£29,449	£28,421	£26,456
Building and civil engineering technicians	£31,825	£29,049	£32,268	£29,242	-	-
Electrical and electronic trades n.e.c.	£31,009	£29,671	£31,084	£29,648	£29,560	£29,535
Product, clothing and related designers	£30,852	£29,093	£32,882	£29,967	£28,128	£25,503
Coal mine operatives	£30,771	£25,585	£30,771	£25,585	-	-
Draughtspersons	£30,595	£27,985	£31,203	£28,309	£25,459	£23,616
IT user support technicians	£30,572	£27,837	£32,029	£28,924	£26,344	£25,051
Electricians and electrical fitters	£30,407	£29,538	£30,449	£29,574	£26,591	-
Planning, process and production technicians	£30,301	£27,373	£31,816	£28,998	£25,156	£22,729
Medical and dental technicians	£30,167	£27,574	£31,847	£29,731	£28,007	£25,155
Assemblers (vehicles and metal goods)	£30,091	£28,498	£30,537	£28,983	£22,524	-
Electrical and electronics technicians	£29,928	£30,900	£30,413	£31,105	£22,820	£21,037
Precision instrument makers and repairers	£29,870	£28,633	£29,856	£28,488	£30,110	-
Metal working production and maintenance fitters	£29,634	£28,110	£29,774	£28,276	£24,522	-
Boat and ship builders and repairers	£29,583	£29,506	£29,583	£29,506	-	-
Air-conditioning and refrigeration engineers	£29,534	£30,269	£29,534	£30,269	-	-
Water and sewerage plant operatives	£29,374	£29,581	£29,457	£29,618	£28,161	-
Metal plate workers, and riveters	£29,364	£28,452	£29,364	£28,452	-	-
IT engineers	£28,890	£27,011	£28,281	£26,995	£35,155	-
Architectural and town planning technicians	£28,700	£27,358	£29,161	£27,322	£27,157	£26,542
Plumbers and heating and ventilating engineers	£28,351	£27,606	£28,369	£27,606	£27,184	-
Science, engineering and production technicians n.e.c.	£28,185	£25,719	£29,003	£26,632	£21,886	£19,292

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Table 14.4: Annual mean and median pay for selected full-time STEM technician and craft careers by gender (2013) – UK – continued

	All full-time workers		Male		Female	
	Mean	Median	Mean	Median	Mean	Median
Energy plant operatives	£28,165	£27,119	£29,464	£27,474	£16,842	-
Quality assurance technicians	£28,141	£26,650	£29,580	£27,356	£25,417	£24,160
Printers	£27,723	£26,313	£27,745	£26,322	-	-
Tool makers, tool fitters and markers-out	£27,722	£26,544	£28,082	£26,760	-	-
Metal machining setters and setter-operators	£27,675	£25,602	£27,953	£26,009	£19,557	-
Welding trades	£27,181	£25,165	£27,257	£25,246	-	-
TV, video and audio engineers	£26,714	£26,694	£26,714	£26,694	-	-
Sheet metal workers	£26,663	£24,207	£27,047	£24,751	-	-
Chemical and related process operatives	£26,299	£24,805	£27,590	£25,900	£17,394	£17,259
Routine inspectors and testers	£25,869	£24,021	£27,348	£25,137	£20,668	£18,649
Vehicle technicians, mechanics and electricians	£25,778	£24,214	£25,882	£24,381	£18,334	£16,197
Vehicle paint technicians	£25,754	£25,279	£25,680	£25,180	-	-
Metal making and treating process operatives	£25,670	£25,487	£25,623	£25,479	-	-
Rubber process operatives	£25,138	£25,714	£25,724	£27,061	-	-
Process operatives n.e.c.	£24,815	£23,914	£25,613	£25,003	£15,710	£15,290
Plant and machine operatives n.e.c.	£24,556	£22,755	£25,377	£23,314	£17,808	£14,468
Pre-press technicians	£24,362	£22,028	£24,862	£22,670	£21,645	£18,559
Vehicle body builders and repairers	£24,237	£23,479	£24,237	£23,479	-	-
Laboratory technicians	£24,167	£21,503	£26,433	£23,774	£21,212	£18,667
Pharmaceutical technicians	£22,887	£21,390	£23,929	£21,107	£22,597	£21,330
Metal working machine operatives	£22,549	£21,762	£23,356	£22,659	£17,195	£15,300
Elementary construction occupations	£22,104	£21,285	£22,162	£21,323	£19,189	£18,193
Textile process operatives	£22,059	£20,574	£23,233	£22,220	£18,379	£18,580
Electroplaters	£22,043	£21,550	£22,300	£21,637	-	-
Printing machine assistants	£21,960	£20,457	£22,863	-	£18,319	£16,043
Plastics process operatives	£21,543	-	£21,897	-	£18,096	£17,517
Paper and wood machine operatives	£21,398	£19,445	£21,631	£19,728	£18,243	-
Glass and ceramics process operatives	£21,308	£18,237	£22,241	£18,769	£14,710	£13,209
Moulders, core makers and die casters	£20,894	£20,171	£20,894	£20,171	-	-
Assemblers (electrical and electronic products)	£20,294	£19,401	£21,861	£21,179	£17,201	£16,979
Elementary process plant occupations n.e.c.	£20,256	£19,207	£21,076	£20,105	£16,542	£15,504
Tyre, exhaust and windscreen fitters	£20,079	£18,955	£20,066	£18,908	-	-
Industrial cleaning process occupations	£19,398	£18,480	£19,946	£18,972	£17,289	£18,137
Food, drink and tobacco process operatives	£19,151	£17,662	£20,086	£18,713	£16,661	£16,034
Weighers, graders and sorters	£18,170	£17,583	£20,139	£18,967	£14,821	£12,841
All employees	£33,288	£27,017	£36,825	£29,251	£27,720	£23,589

Source: Office for National Statistics – Annual Survey of Hours and Earnings 2013. Note - means data suppressed by ONS.

14.3.2 Annual mean and median gross pay for selected part-time STEM technician and craft careers by gender

Table 14.5 shows the mean pay for selected part-time STEM technician and craft careers by gender. Boat and ship builders and repairers had the highest mean salary in 2013 at £21,248. They were followed by electrical and electronic trades n.e.c.[1174] who earned £20,131.

The lowest mean for a STEM technician or craft occupation salary was £6,852 for industrial cleaning process occupations, which was below the mean for all part-time workers at £11,352.

Table 14.5: Annual mean and median pay for selected part-time STEM technician and craft careers by gender (2013) – UK[1175]

	All part-time workers		Male		Female	
	Mean	Median	Mean	Median	Mean	Median
Boat and ship builders and repairers	£21,248	£21,339	£21,248	£21,339	-	-
Electrical and electronic trades n.e.c.	£20,131	-	£20,913	-	£17,823	-
Quality assurance technicians	£18,438	£16,679	-	-	£18,206	-
Draughtspersons	£17,279	£15,837	£19,515	-	£14,235	£14,283
Metal machining setters and setter-operators	£16,858	-	£20,132	-	£10,988	-
Medical and dental technicians	£16,443	-	£19,004	-	£16,047	-
IT operations technicians	£15,210	-	£13,480	-	£16,102	-
Pharmaceutical technicians	£14,256	£13,382	-	-	£14,256	£13,382
Chemical and related process operatives	£14,224	£12,448	£16,807	£17,633	£12,631	-
Planning, process and production technicians	£13,694	£12,125	-	-	£13,694	£12,125
IT user support technicians	£13,677	£11,774	-	-	£13,803	£11,956
Routine inspectors and testers	£13,611	£12,344	£15,863	-	£12,215	£11,450
Science, engineering and production technicians n.e.c.	£12,072	£11,369	£11,809	-	£12,221	£10,624
Assemblers (electrical and electronic products)	£11,489	-	£15,391	-	£9,316	-
Food, drink and tobacco process operatives	£11,083	£9,937	£12,430	£11,537	£10,122	£9,229
Textile process operatives	£10,969	-	£13,050	-	£8,941	£8,539
Laboratory technicians	£10,939	£9,996	£7,809	-	£11,481	£10,294
Elementary construction occupations	£10,747	£8,283	£10,987	£8,614	-	-
Paper and wood machine operatives	£10,681	-	£11,187	-	£9,087	£8,362
Industrial cleaning process occupations	£6,852	-	£6,813	-	£6,894	-
All employees	£11,352	£8,901	£12,234	£8,480	£11,095	£9,004

Source: Office for National Statistics – Annual Survey of Hours and Earnings 2013. Note - means data suppressed by ONS.

1174 n.e.c. stands for not elsewhere classified **1175** Employees on adult rates who have been in the same job for more than a year

14.4 Engineering salaries in the regions of the UK

Table 14.6 shows the variation in mean salaries for different engineering occupations across the regions of the UK. The highest mean salary for all workers was in London at £41,143 while the lowest was £22,463 in Northern Ireland. It also shows that aircraft pilots and flight engineers had the highest mean salary in 2013 at £78,482, while TV, video and audio engineers had the lowest at £26,164.

Table 14.6: Annual mean salaries for engineering occupations by region (2013) – UK[1176]

	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	£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	-	£38,096	£39,972	£40,980	-	£40,043	£48,131	£46,851	£42,177	£48,635	£49,837	-	£44,176
Electrical engineers	-	£47,938	£36,187	£51,765	£36,987	£48,268	£43,156	£45,838	£33,018	-	-	-	£44,439
Electronics engineers	-	-	-	-	-	£29,935	£32,189	£50,410	£39,807	-	-	-	£36,751
Design and development engineers	£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	-	£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.	£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	£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	£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	-	£33,553	£29,382	-	-	-	-	£30,168	£28,344	£21,961	-	-	£30,300
Science, engineering and production technicians n.e.c.	£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	-	-	-	£66,765	-	£78,973	£103,225	-	£60,413	-	£53,470	-	£78,482
Air-conditioning and refrigeration engineers	-	£26,490	£31,073	£27,676	£26,275	£26,645	-	£38,872	-	-	-	-	£28,770
Telecommunications engineers	£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	-	-	-	-	-	£23,839	-	£22,136	-	-	£27,937	-	£26,164
IT engineers	-	-	£21,465	-	£21,855	£31,012	£31,306	£29,458	£27,945	-	£27,323	-	£27,064
Plumbers and heating and ventilating engineers	£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	£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 2013. Note - means data suppressed by ONS.

1176 Employees on adult rates who have been in the same job for more than a year

14.5 Engineering vacancy and salary trends 2013/2014

Authored by Keith Gallagher, Managing Director, Roevin

Engineering opportunities

The last 12 months can best be described by a well-used football euphemism: a game of two halves.

The second half of 2013 was filled with much promise and optimism but vacancy growth only appeared in July and October **as real confidence in long term project security galvanised employers to start taking on staff in earnest to meet the growing demand** (Figures 14.2 and 14.3).

The start of 2014 heralded the usual New Year jump in vacancies and since then it has remained high.

With business confidence at a 22-year high, according to Lloyds Bank, we are seeing hiring managers investing in their workforce, especially permanent staff. As John Longworth, Director General of the British Chambers of Commerce noted, recent growth figures, "Confirm what we've been hearing for some time."

With more than 200 infrastructure projects due to begin during the second half of 2014, there are likely to be plenty of opportunities for candidates. These projects are part of £36 billion worth of planned infrastructure investments that the Government predicts will support **in excess** of 150,000 **jobs**.

Overall, we are seeing a third more engineering vacancies in June 2014 than we saw in June 2013, and that is excellent news. Senior roles, those that combine technical and managerial skill sets, have grown particularly strongly (up by 160%). Automotive, skilled trades and project management have also excelled, all seeing at least 70% more vacancies than a year ago.

Salary review

Within the context of weak pay growth throughout the economy – 0.3% according to the Office for National Statistics – the engineering sector is faring pretty well.

Overall, we have seen starting salaries rise by 3%. But that certainly does not tell the whole story. Some sectors have seen advertised salaries grow by much more and some have actually seen them shrink. On one hand, there is the demand from businesses for often very scarce resources. On the other hand, the recovery is only just getting going and companies still have to be careful over their costs (Table 14.7).

Jobs with the largest increases are:

- surveyor
- design engineer
- control systems

While those that saw drops in advertised rates included:

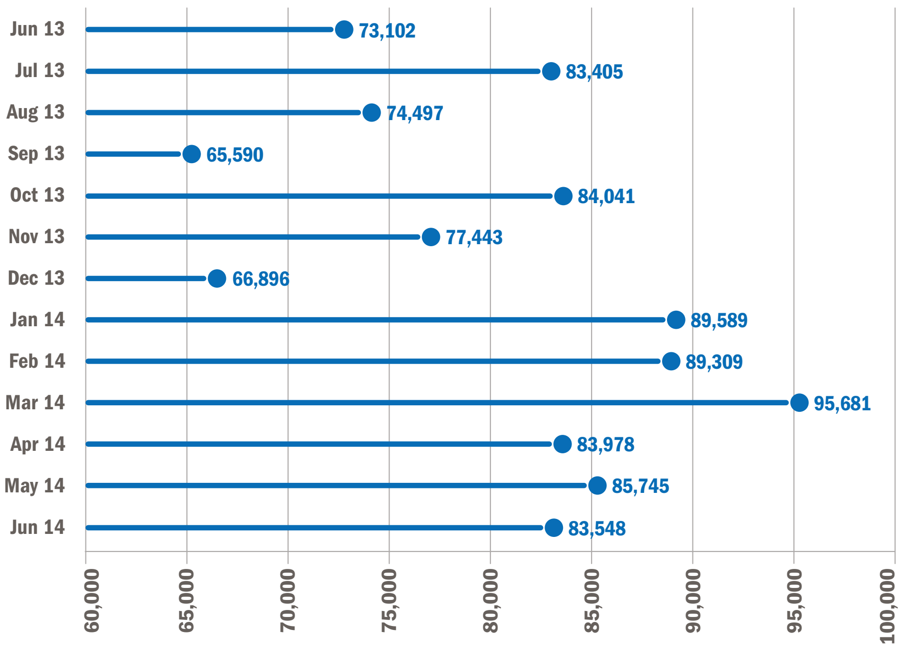
- civil engineer
- architect (mostly in the permanent market)
- quality control

With unemployment now at a six-year low, we expect real growth in remuneration to return to all sectors within the next 12 months. Additionally, candidates are likely to be able to negotiate salary packages above the advertised value increase.

Popular vacancies

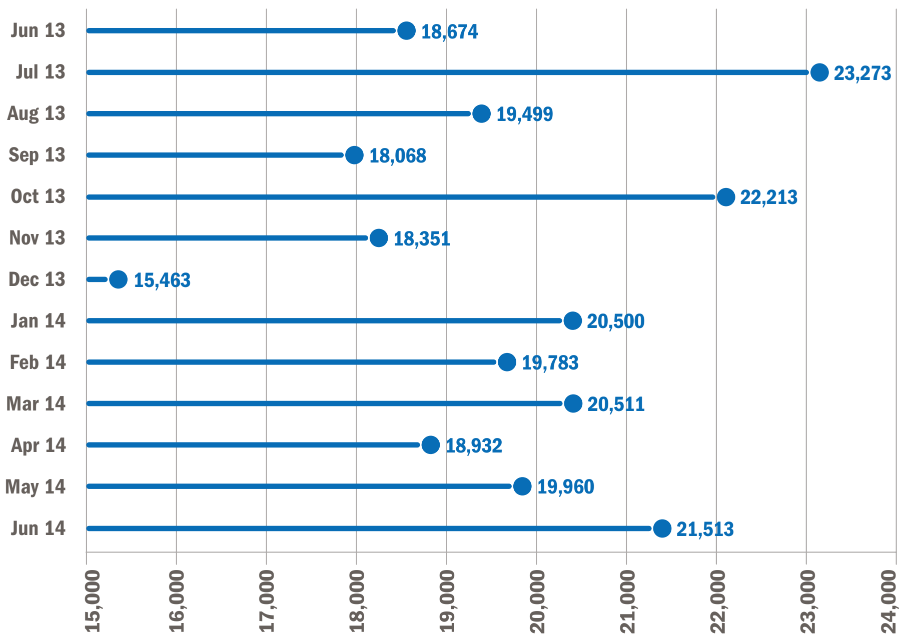
Highly skilled and qualified engineers continue to remain in high demand. Design, Quality and Project Engineers are among the most sought after roles for both permanent and contract markets (Table 14.8).

Fig. 14.2: Vacancies for permanent roles (rolling 12 months)



Source: Roevin

Fig. 14.3: Vacancies for contract roles (rolling 12 months)



Source: Roevin

Table 14.7: Engineering pay (2013/14)

	Permanent				Contract			
	Salary (Average)		% Monthly change	% Yearly change	Daily rate (average)		% Monthly change	% Yearly change
Job Title	Jun-14	Jun-13	May 14-Jun 14	Jun 13-Jun 14	Jun-14	Jun-13	May 14-Jun 14	Jun 13-Jun 14
Aerospace engineer	£31,121.00	£33,286.00	-5%	-7%	£248.00	£228.00	26%	9%
Architect	£55,855.00	£63,863.00	-7%	-13%	£254.25	£423.27	12%	7%
Automotive engineer	£35,235.00	£36,373.00	2%	-3%	£184.53	£197.74	-27%	-7%
Building surveyor	£35,684.00	£37,342.00	-1%	-4%	£172.58	£147.34	-5%	17%
CAD technician	£26,996.00	£25,649.00	-4%	5%	£157.60	£153.07	3%	3%
Chemical engineer	£41,444.00	£41,114.00	18%	1%	£340.00	£230.15	N/A	48%
Civil engineer	£39,363.00	£30,519.00	15%	29%	£237.05	£255.07	21%	-7%
Electrical engineer	£37,068.00	£33,787.00	11%	10%	£226.45	£238.76	15%	-5%
Mechanical engineer	£34,562.00	£34,731.00	-3%	0%	£215.40	£227.80	-10%	-5%
Quantity surveyor	£42,192.00	£40,298.00	2%	5%	£271.11	£248.06	10%	-9%
Site facilities manager	£38,310.00	£31,125.00	10%	23%	N/A	N/A	N/A	N/A
Structural engineer	£36,064.00	£35,134.00	-16%	3%	£235.87	£311.43	-3%	-23%
Town planner	£27,679.00	£33,595.00	-4%	-18%	£158.55	£161.33	7%	-2%

Source: Roevin

Table 14.8: Jobs in demand (2013/14)

Jobs in demand (ranked by most in demand first)	
Permanent	Contract
Maintenance engineer	Engineer
Mechanical design engineer	Contracts engineer
Field services engineer	Project engineer
Engineer	Mechanical design engineer
Project engineer	Mechanical fitter
Quality engineer	Design engineer
Service engineer	Quality engineer
Design engineer	Welder fabricator
Multi skilled maintenance engineer	Setting out engineer
Engineering manager	Mechanical engineer
Production engineer	Planning engineer
Maintenance electrical engineer	Maintenance engineer
Mechanical engineer	Development engineer
Quality manager	Electrical engineer
Electrical engineer	Operator
Maintenance technician	Process engineer
Vehicle technician	Manufacturing engineer
Manufacturing engineer	Welder
Production engineer	Systems engineer
Electrical design engineer	Solidworks design engineer

Source: Roevin

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14.6 2013 Survey of professionally registered engineers and technicians

Salaries of professionally registered engineers and technicians

Table 14.9 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.

Direct comparisons with the 2010 survey of professionally registered engineers and technicians shows that the mean and median salaries have increased for individuals in all sections of the register. (Please note that comparisons were not made for ICT Technicians as this register was newly established, so not surveyed in 2010).

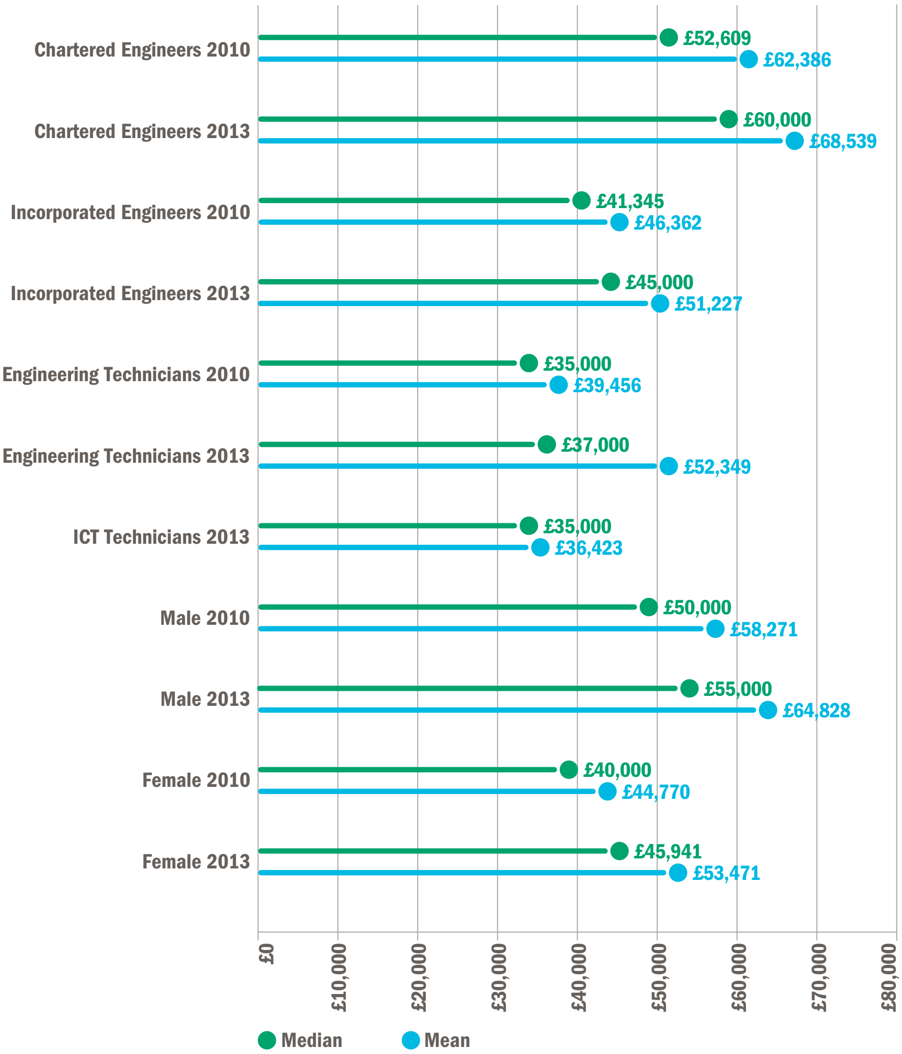
Figure 14.4 illustrates the median and mean salaries for Chartered Engineers, Incorporated Engineers, Engineering Technicians and ICT Technicians in 2010 and 2013. The median basic annual income for Chartered Engineers has increased by 14% to £60,000, Incorporated Engineers' salaries increased 9% to £45,000 and the salary for Engineering Technicians rose by 5% to £37,000. For ICT Technicians, the median salary was £35,000 and the mean salary was £36,423 in the 2013 survey.

Table 14.9: Mean and median basic salaries for Chartered Engineers, Incorporated Engineers, Engineering Technicians and ICT Technicians

	Mean salary	**Median salary**
	Mean	Median
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

Fig. 14.4: Median and mean salaries for Chartered Engineers, Incorporated Engineers, Engineering Technicians and ICT Technicians (2010 and 2013)



Source: Engineering Council 2013 Survey of Professionally Registered Engineers and Technicians

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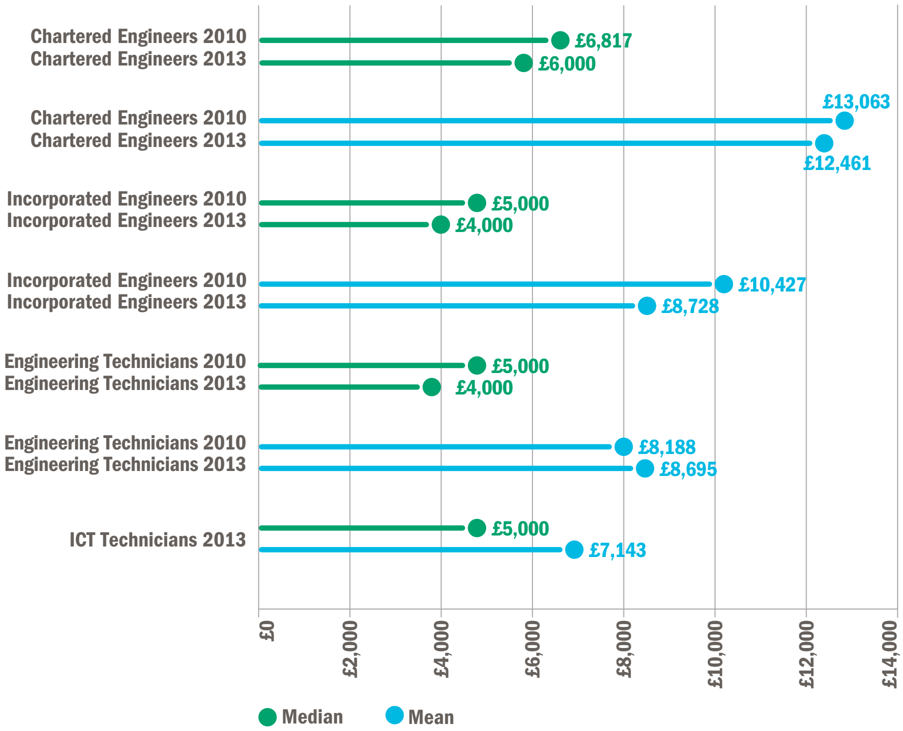
Comparisons with the 2010 survey revealed that the median and mean bonuses decreased for Chartered Engineers, Incorporated Engineers and Engineering Technicians. Figure 14.5 shows the comparison of median and mean bonuses in 2010 and 2013. Chartered Engineers have seen a 14% reduction in their median bonus to £6,000, the median bonus for Incorporated Engineers decreased by 20% to £4,000 and there was a 20% reduction to a £4,000 median bonus for Engineering Technicians. The 2013 survey showed that ICT Technicians received a median bonus of £5,000 and a mean bonus of £7,143.

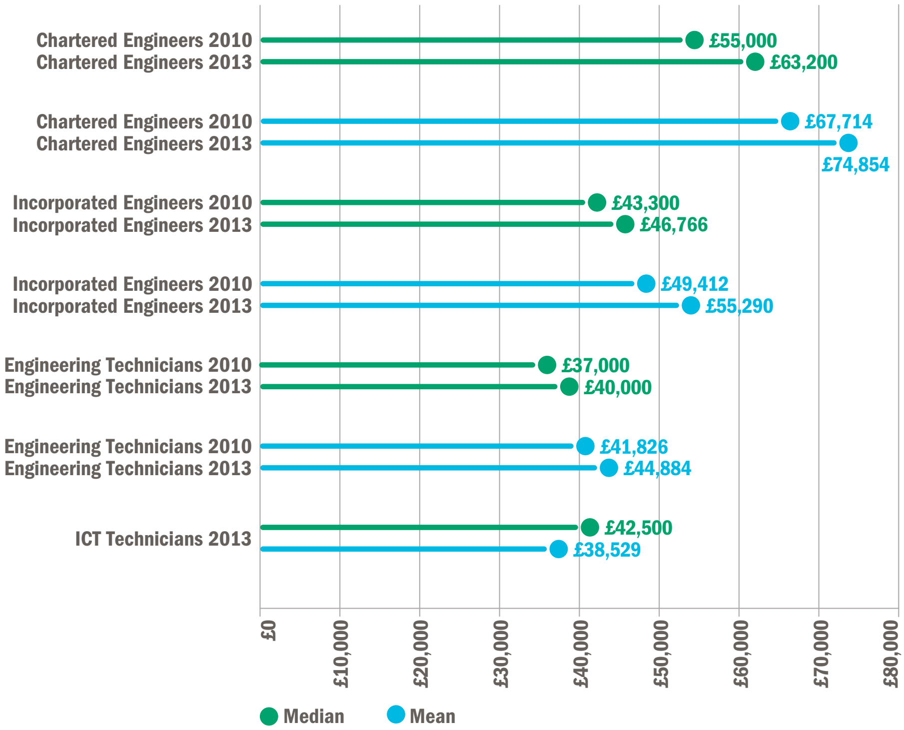
The current rate of annual earnings was calculated by combining the gross basic annual income from employment and all overtime, bonus and commission payments. Engineers and Technicians in all three sections of registration saw an increase in their median annual earnings, as shown in Figure 14.6. The combined income increased by 15% for Chartered Engineers, 8% for Incorporated Engineers and 8% for Engineering Technicians. The median annual earnings was £45,500 for ICT Technicians in the 2013 survey.

Fig. 14.5: Median and mean bonuses for Chartered Engineers, Incorporated Engineers, Engineering Technicians and ICT Technicians (2010 and 2013)



Source: Engineering Council 2013 Survey of Professionally Registered Engineers and Technicians

Fig. 14.6: Median and mean annual earnings for Chartered Engineers, Incorporated Engineers, Engineering Technicians and ICT Technicians (2010 and 2013)



Source: Engineering Council 2013 Survey of Professionally Registered Engineers and Technicians

The proportion of employers who pay the subscription for institution membership increased significantly. Table 14.10 shows the percentage of Chartered Engineers, Incorporated Engineers, Engineering Technicians and ICT Technicians who had their subscription paid for by their employer in 2010 and 2013.

In 2013, 59% of Chartered Engineers had their employer pay their registration fee, whilst 54% of Incorporated Engineers, 46% of Engineering Technicians and 39% of ICT Technicians had their registration fee paid.

The willingness of employers to offer support for professional development continues to advance, with 76% of registrants receiving help. Table 14.11 shows how employers offer support for registrants' professional development.

There has been a continuous significant increase in employers supporting registrants in all sections of registration.

Table 14.10: Percentage of Chartered Engineers, Incorporated Engineers, Engineering Technicians and ICT Technicians who had their institution membership paid for by their employer (2010 and 2013)

	2013 percent	2010 percent
Chartered Engineers	68	61
Incorporated Engineers	57	51
Engineering Technicians	50	43
ICT Technicians	29	

Source: Engineering Council 2013 Survey of Professionally Registered Engineers and Technicians

Table 14.11: Ways in which employers offer support for professional development

How does your employer offer support for your professional development?	Percentage of registered engineers and technicians agreeing to the statement
On-the-job training	61
A good range of training courses at place of work	58
Financial support for external training	50
Opportunities to broaden experience at workplace	48

Source: Engineering Council 2013 Survey of Professionally Registered Engineers and Technicians

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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 engineering skills is approximately 107,000 per year at level 4+ and approximately 56,000 per year at level 3. However, our analysis of the supply data shows that the supply is only 82,000 at level 4+ (a shortfall of 25,000 per year) and 26,000 at level 3 (a shortfall of 30,000 per year). Alongside this, our analysis of the UK Commission Employer Skills Survey shows that engineering enterprises are more likely than average to have Hard-to-Fill Vacancies for professionals (31.7% compared with 17.6%) and skilled trades occupations (24.8% compared with 12.6%). Furthermore, nearly half (48.3%) of engineering enterprises said that Hard-to-Fill Vacancies meant they had delays developing new products or services: 44.8% said they experienced increased operating costs, showing the tangible effect of skills shortages.

To further compound the population issue, if we assume that currently people start work at 18 and stay in employment until 65 then the average number of years of employment the average person in the UK has is 24 years; from this we can calculate that over the next 24 years half of the current working population will retire.

According to the Office for National Statistics,[1177] 31 million people in the UK were not enrolled on any education courses in the second quarter of 2013. Looking at the highest qualification of these people shows that 12.0 million (38%) were graduates, 6.7 million (21%) were educated to A level, 6.6 million (21%) were educated to GCSE A*-C, 3.1 million (10%) had other qualifications not categorised in the UK and 2.9 million (9%) had no qualifications. Research[1178] has shown that higher skills are associated with improved labour market outcomes and that for local areas there is a clear link between economic growth and skills.

Table 15.0 shows the activity rates for people with different levels of qualifications in 2010 and projected to 2020. By 2020, nine in 10 (90.5%) of those qualified to level 4+ will be economically active, an increase of 2.9 percentage points on 2010. It should also be noted that the active population qualified to level 4+ is projected to rise from 11,230,000 in 2010 to 15,759,000 in 2020. For those with level 3 qualifications, the 2020 activity rate is projected at 83.6% – an increase of 3.4 percentage points on 2010. However, the number who are economically active will decline from 5,999,000 in 2010 to 5,667,000 in 2020. Although people with qualifications below level 2 are projected to have the largest increase in activity rate – rising by 5.0 percentage points – their active population is only set to reach 69.9% in 2020. It should also be noted that their total active population is forecast to decline from 6,649,000 in 2010 to 5,528,000 in 2020. The UK Commission for Employment and Skills (UKCES) has also identified that the UK is 19th out of 33 for having the largest proportion of the working age population classed as low qualified (below upper secondary).[1179] People with no qualifications are more likely to move in and out of work or be trapped in low paid jobs.[1180]

1177 *Full report – Graduates in the UK labour market 2013*, Office for National Statistics, 19 November 2013, p2 1178 *Evidence Review Employment Training*, What Works Centre for Local Economic Growth, April 2014, p9 1179 *UK Skill Levels and International Competitiveness*, 2013, UK Commission for Employment and Skills, August 2014, p10 1180 *Work in progress Low pay and progression in London and the UK*, Centre for Economic and Social Inclusion and Trust for London, October 2013, p42

Table 15.0: Overall activity rates by qualification level (2010 and 2020)

	2010			2020			
	Population (thousands)	Active population (thousands)	Activity rate	Population (thousands)	Active population (thousands)	Activity rate	Change in activity rate 2020-2010
Level 4+	12,814	11,230	87.6	17,410	15,759	90.5	2.9
Level 3	7,480	5,999	80.2	6,782	5,667	83.6	3.4
Level 2	7,471	6,009	80.4	7,347	6,160	83.8	3.4
Below level 2 (including no qualifications)	10,245	6,649	64.9	7,906	5,528	69.9	5.0

Source: UK Commission for Employment and Skills[1181]

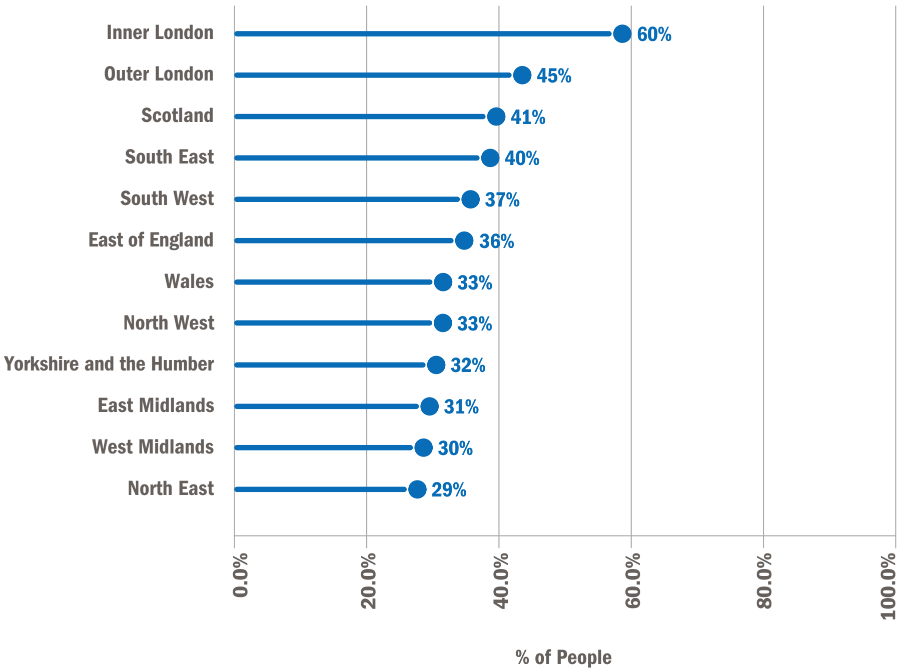
Finally, Figure 15.0 shows that graduates are not evenly distributed across the UK, implying that the growth in those qualified to level 4+ will also not be evenly distributed. It shows that 60% of people in inner London are graduates compared with 29% in the North East.

Looking at different sectors of the economy it is possible to see the breakdown of employees working in higher occupational roles,[1183] ie the roles that are most likely to require level 4+ skills (Table 15.1). Of the different industry sectors, information and communication has the highest proportion of employees in senior occupations (81.4%), followed by professional, scientific, and technical activities (74.9%).

Within the industry sectors where at least some elements fall within the engineering footprint,[1184] the proportion of employees in senior occupations is as follows:

- agriculture, forestry and fishing – 14.8%
- mining and quarrying – 51.0%
- manufacturing – 38.5%
- electricity, gas, air conditioning supply – 47.9%
- water supply, sewerage, waste – 33.0%
- construction – 26.4%
- wholesale, retail repair of vehicles – 26.4%
- transport and storage – 17.6%
- information and communication – 81.4%
- professional, scientific, technical activities – 74.9%
- administrative and support services – 28.7%
- public administration and defence – 62.4%
- other service activities – 33.2%

Fig. 15.0: Graduates across areas of Great Britain (2012)



Source: Office for National Statistics[1182]

1181 *UK Skill levels and international competitiveness,* UK Commission for Employment and Skills, November 2012, p12 1182 *Full report – Graduates in the UK labour market 2013,* Office for National Statistics, 19th November 2013, p27 1183 These are managers, directors, senior officials, professional occupations and associate professional 1184 For further details on the engineering footprint see Table 17.5 in the Annex http://www.engineeringuk.com/_resources/documents/EngineeringUK_Report_2015_Annex.pdf

Table 15.1 also shows that overall 42.9% of people working in senior occupations are female.

UKCES has determined that nearly three quarters (59%) of all jobs in 2012 were full-time, while 28% were part-time and 13% were self-employed.[1186]

Table 15.1: Workforce in industry sectors by gender (spring 2013)

Industry sector	Total employees in sector	Percentage male	Percentage female	Total employed in senior occupations	Percentage male	Percentage female	Percentage of all employees who are in senior occupations
Wholesale, retail, repair of vehicles	4,011,980	51.9%	48.1%	1,057,658	63.0%	37.0%	26.4%
Health and social work	3,958,918	20.9%	79.1%	1,972,309	25.2%	74.8%	49.8%
Education	3,090,965	28.0%	72.0%	1,904,059	36.4%	63.6%	61.6%
Manufacturing	2,911,815	76.4%	23.6%	1,121,797	79.7%	20.3%	38.5%
Construction	2,100,132	88.5%	11.5%	553,785	86.1%	13.9%	26.4%
Professional, scientific, technical activities	1,992,525	59.2%	40.8%	1,491,607	65.5%	34.5%	74.9%
Public administration and defence	1,841,733	51.9%	48.1%	1,148,415	60.1%	39.9%	62.4%
Accommodation and food services	1,492,423	46.4%	53.6%	262,879	55.8%	44.2%	17.6%
Transport and storage	1,478,678	80.9%	19.1%	260,719	83.1%	16.9%	17.6%
Administrative and support services	1,346,352	55.3%	44.7%	386,977	58.9%	41.1%	28.7%
Information and communication	1,152,955	71.7%	28.3%	938,877	76.4%	23.6%	81.4%
Financial and insurance activities	1,149,752	55.8%	44.2%	730,560	67.4%	32.6%	63.5%
Other service activities	795,048	38.4%	61.6%	263,922	57.6%	42.4%	33.2%
Arts, entertainment and recreation	721,763	53.2%	46.8%	384,064	58.5%	41.5%	53.2%
Real estate activities	341,573	49.4%	50.6%	218,561	53.7%	46.3%	64.0%
Agriculture, forestry and fishing	302,785	72.3%	27.7%	44,959	67.5%	32.5%	14.8%
Water supply, sewerage, waste	220,988	77.0%	23.0%	73,007	71.7%	28.3%	33.0%
Electricity, gas, air conditioning supply	181,069	75.7%	24.3%	86,643	82.0%	18.0%	47.9%
Mining and quarrying	133,080	82.7%	17.3%	67,925	83.8%	16.2%	51.0%
Households as employers	58,627	26.3%	73.7%	1,833	35.1%	64.9%	3.1%
Extraterritorial organisations	38,930	64.2%	35.8%	25,927	69.5%	30.5%	66.6%
Total	29,322,091	55.3%	46.7%	12,996,483	57.1%	42.9%	44.3%

Source: CFE Research[1185]

1185 *Industry graduate skills needs Summary report for the National Centre for Universities and Business,* CFE Research, 2013, p29 1186 *Working Futures 2012-2022,* UK Commission for Employment and Skills, March 2014, p21

15.1 Increasing capacity in the UK workforce

There are a number of ways in which the UK can increase the capacity of its workforce. The World Economic Forum has stated that educating and utilising the female talent is critical to a nation's competiveness,[1187] while the Government[1188] has shown that in the UK there are over 2.4 million women who want to work but who are not in employment and that a further 1.3 million women who are in employment but want to work more hours. Similarly, the Institute of Public Policy Research[1189] has shown that one in ten people say they would like to work longer hours.

In addition to people who want to work longer hours, another way of increasing capacity is to better harness the skills of people in work. Research has shown that 4.3 million workers (16% of the workforce) have underused skills.[1190] Using the skills that exist in the workforce better could generate considerable benefits for the UK economy and individual employers. The UK has one of the highest levels of under-utilised skills of the advanced economies,[1191] with a very high level of skilled workers employed in low skilled jobs.

Another way to increase capacity is for employers to invest in the training of their staff. In the period 2011-2013, total employer investment in training has fallen from £45.3 billion to £42.9 billion, a fall of around 5%. And while there was a significant increase in the number of people receiving training, the number of days training each employee had decreased from 7.8 days in 2011 to 6.7 days in 2013. As a result, although more staff are receiving training, the total number of days allocated to training has decreased from 115 million to 113 million. However, at the same time 1.4 million employees (5.2% of the UK workforce) are regarded as not being fully proficient in their job roles.[1192] UKCES has also shown that the distribution of training is not even and that women, full-time workers and higher skilled workers are more likely to participate in training than men, part-time or lower skilled workers.[1193]

In addition, UKCES has cited research by the Department for Business, Innovation and Skills (BIS) which shows that the quality of maths and science education is a competitive weakness in the UK workforce.[1194] National Numeracy has shown that the cost of poor numeracy skills is £20.2 billion per year.[1195]

Finally, as highlighted in Section 6, in Q1 2014 there were still 728,000 18- to 24-year-olds classified as Not in Education, Employment or Training (NEETs). The cost to the state alone is around £22 billion, in addition to the waste of potential.[1196]

15.2 Skills shortages

As Sir Roy Anderson stated "the skills of individuals within a nation are vital for the economic success of that nation."[1197] However, he also pointed out that England was not producing enough people with the right skills for a labour market that was rapidly changing and that many businesses, particularly those in high growth sectors, were unable to recruit the highly skilled workers they needed. In this section we look at skills shortages and the impact they have on businesses in the UK.

Since the last Employer Skills Survey in 2011, there has been a rise in the volume of vacancies of 12%. However Skills Shortage Vacancies[1198] have increased at five times that rate (up 60% on 2011)[1199] and now account for just under a quarter of all vacancies. In addition, nearly three in 10 vacancies are classed by the employer as Hard-to-Fill.[1200 1201] While skills shortages and Hard-to-Fill Vacancies are not universal, those employers who are affected by them can be hit hard.[1202 1203]

Table 15.2 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 classed as a Skills Shortage Vacancy is similar across all enterprises and all engineering enterprises. However, for professional occupations, one in five (19.7%) vacancies was classed as a Skills Shortage Vacancy, compared with 14.3% for engineering enterprises, while Skills Shortage Vacancies in skilled trades occupations were almost double for engineering enterprises (23.9%) compared with all enterprises (13.6%).

Table 15.2: Profile of Skills Shortage Vacancies, by occupation, for all enterprises and engineering enterprises (2013) – UK

	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 unweighted base size is too small to be reliable.
** Figures are indicative only due to small base size.

1187 *The Global Gender Gap Report 2013,* World Economic Forum, 2013, p31 **1188** *Women and the Economy Government Action Plan,* Government Equalities Office, November 2013, p5 **1189** *European Jobs And Skills A comprehensive review 2014,* Institute of Public Policy Research, April 2014, p2 **1190** *UK Commission's Employer Skills Survey 2013: UK Results Evidence Report 81,* UK Commission for Employment and Skills, January 2014, p55 **1191** *Climbing the ladder: skills for sustainable recovery,* UK Commission for Employment and Skills, July 2014, p16 **1192** *UK Commission's Employer Skills Survey 2013: UK Results Evidence Report 81,* UK Commission for Employment and Skills, January 2014, p110 **1193** *The Labour Market Story: The State of UK Skills,* UK Commission for Employment and Skills, July 2014, p15 **1194** *The Labour Market Story: The UK Following Recession,* UK Commission for Employment and Skills, July 2014, p9 **1195** *Manifesto for a numerate UK,* National Numeracy, 2014, page 5 **1196** See Section 6.1 for further details **1197** *Making Education Work,* Independent Advisory Group chaired by Professor Sir Roy Anderson, January 2014, p39 **1198** A Skills Shortage Vacancy is a type of vacancy caused by a shortage of skills, qualifications or experience the employer looks for **1199** *Climbing the ladder: skills for sustainable recovery,* UK Commission for Employment and Skills, July 2014, p17 **1200** Vacancies which are proving difficult to fill, as defined by the establishment **1201** *UK Commission's Employer Skills Survey 2013: UK Results Evidence Report 81,* UK Commission for Employment and Skills, January 2014, p23 **1202** *Climbing the ladder: skills for sustainable recovery,* UK Commission for Employment and Skills, July 2014, p17 **1203** *UK Commission's Employer Skills Survey 2013: UK Results Evidence Report 81,* UK Commission for Employment and Skills, January 2014

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It has been reported that as the construction sector comes back into growth there is already a risk of skills shortages holding back the construction of new houses.[1204] In addition, new technologies in construction[1205] and manufacturing[1206] are impacting on the way people work and can create potential gaps in workforce skills.

Table 15.3 shows the profile of Hard-to-Fill Vacancies by occupation for all enterprises and for all engineering enterprises. Engineering enterprises were less likely than average to have Skills Shortage Vacancies for professional occupations (Table 15.2). However, engineering enterprises have nearly double the proportion of Hard-to-Fill Vacancies amongst professionals (31.7% compared with 17.6%).

For 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%).

The Adonis Review[1207] showed that skills shortages are most likely to be cited by companies that have a higher than average proportion of technical occupations requiring STEM skills. The Edge Foundation[1208] has also shown that, for the foreseeable future, demand for STEM skills will exceed the supply of STEM skills.

Thinking specifically about technician level roles,[1209] the Institute for Public Policy Research[1210] has shown that by 2020 the UK is predicted to have a shortage of 3.4 million workers at technician level, across all industries, including non-STEM sectors. Meanwhile, the Confederation of British Industry and Pearson Education have shown that there is currently a shortage of STEM qualified technicians.[1211]

Finally, the Government has recognised the need to improve the supply of engineering skills and has launched a £30 million fund to encourage more women into the sector and to address skills shortages in smaller companies.[1212]

Table 15.3: Profile of Hard-to-Fill Vacancies, by occupation, for all enterprises and engineering enterprises (up to six vacancies) (2013) – UK

	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.
* Data suppressed as unweighted base size is too small to be reliable.
** Figures are indicative only due to small base size.

1204 *No more lost generations Creating construction jobs for young people,* A cross-party parliamentarians' inquiry, February 2014, p6 **1205** *No more lost generations Creating construction jobs for young people,* A cross-party parliamentarians' inquiry, February 2014, p6 **1206** *Making Education Work,* Independent Advisory Group chaired by Professor Sir Roy Anderson, January 2014, p34 **1207** *Mending The Fractured Economy Smarter State, better jobs,* Adonis Review, July 2014, p28 **1208** *The Skills Mismatch,* Lord Baker of Dorking CH Chair, the Edge Foundation, March 2014, p2 **1209** Technician roles are roles that require level 3 skills **1210** *Winning the Global Race? Jobs, Skills and the Importance of Vocational Education,* Institute for Public Policy Research, June 2014, p5 **1211** *Gateway to growth CBI/Pearson education and skills survey 2014,* Confederation of British Industry and Pearson Education, 2014, p7 **1212** Website accessed on the 30 July 2014 (http://www.freshbusinessthinking.com/news.php?CID=0&NID=22676&PGID=1#.U7Uz0fldXwp)

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Table 15.4 shows that, for engineering enterprises, the main implications of Hard-to-Fill Vacancies were increased workload for other staff (87.0%) and difficulties meeting customer services objectives (56.1%).

However, in addition to looking at the main implications for all enterprises, it is interesting to look at the likely implications for engineering enterprises specifically. Engineering enterprises were more likely to suffer from:

- difficulties meeting customer services objectives (56.1% compared with 47.0% for all enterprises)
- delay developing new products or services (48.3% compared with 41.0%)
- lost business or orders going to competitors (45.4% compared with 40.4%)
- the need to outsource work (35.2% compared with 27.5%)
- difficulties introducing technological change (25.8% compared with 19.9%)

The Confederation of British Industry has also highlighted barriers to recruiting STEM-skilled staff (Figure 15.1). Specific skill-based issues included quality of STEM graduates (35%), content of qualification(s) (30%) and lack of practical experience/lab skills (27%), along with a shortage of STEM graduates (30%) and a lack of applications (28%).

In addition, it needs noting that skills shortages are a European problem as well as a UK problem. Roughly 40% of establishments in Europe are having difficulty finding workers with the skills they require.[1213] Unfortunately, the Manpower Group's *Global Talent Shortage Survey 2014* shows that the top three shortages globally are skilled trades, engineers (second place for the third year running) and then technicians.[1214] Therefore, it is unlikely that migrants from the UK will help fill the UK skills gaps.

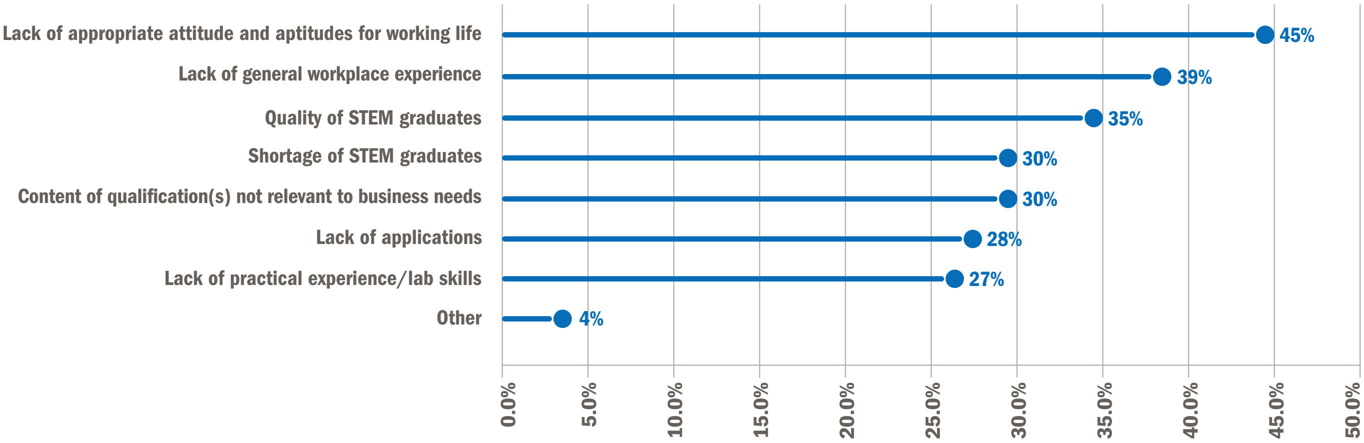
Table 15.4: Implications of Hard-to-Fill Vacancies for all enterprises and engineering enterprises (2013) – UK

	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.
* Data suppressed as unweighted base size is too small to be reliable.

1213 *Matching Skills and Labour Market Needs Building Social Partnerships for Better Skills and Better Jobs,* World Economic forum, January 2014, p9 1214 See Section 1.1.2 for further details regarding the Global Talent Shortage Survey 2014

Fig. 15.1: Barriers to recruiting STEM skills staff



Source: Confederation of British Industry[1215]

15.3 Labour force projections

In Working Futures 2012-2022, it is projected that over the 10-year period there will be 14.356 million job openings. This is made up of 12.501 million jobs created by those who leave the labour market,[1216] along with 1.855 million new job openings created over the period. Replacement demand – that is, 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. However, in Section 4 we show that between 2012 and 2022, the number of 21-year-olds entering the workforce will be 8,983,084. This raises questions about how the UK will fill 14.356 million job openings over the same period.

The *Working Futures* report also predicts there will be 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 market.[1217] This is caused by the aging population and changes in statutory pension ages. The report also highlights that the manufacturing sector will have a small decline in its total share of employment, down one percentage point to 7%, but that it will maintain its share of output at about 10%.

Table 15.5 shows that eight occupations are projected to grow by at least 15% over the 10-year period:

- 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%:

- 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 in full-time jobs, especially for men.[1218]

The table also shows that the following engineering-related occupations will need to recruit around half their current workforce over 10 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%

1215 *Engineering our Future Stepping up the Urgency on STEM,* Confederation of British Industry, March 2014, p16 **1216** *Working Futures 2012-2022,* UK Commission for Employment and Skills, March 2014, pxii **1217** *Working Futures 2012-2022,* UK Commission for Employment and Skills, March 2014, px **1218** *Working Futures 2012-2022,* UK Commission for Employment and Skills, March 2014, p77

Table 15.5: Expansion and replacement demand by occupation (2012-2022) – all UK industries[1219] [1220]

Results in thousands	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%

1219 Numbers may not sum due to rounding errors 1220 Occupational and geographical mobility are assumed to be zero in these estimates

Table 15.5: Expansion and replacement demand by occupation (2012-2022) – all UK industries – continued

Results in thousands	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
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[1221]

15.3.1 Labour force projections for engineering enterprises

For this section, we have worked with Warwick Institute for Employment Research to create an extension of the *Working Futures 2012-2022*[1222] for engineering enterprises.[1223 1224] 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 currently working in engineering enterprises (5.4 million). Of these 2.56 million jobs, 2.3 million will replace workers who are leaving the workforce, while the remaining 257,000 will be new jobs. These projected new vacancies will generate an additional £27 billion per year to the UK economy in 2022 (Section 1.0).

Not everyone working in an engineering company is an engineer. Table 15.6 provides a breakdown of demand for jobs across the major occupation groups identified in SOC2010, and by those selected sub-groups that we regard as the most likely to require engineering skills. This shows that by 2022 engineering companies will need to recruit 1.817 million workers who are most likely to need engineering skills: pro rata, that is 1.27 million over the next seven years (2014-2022).

1221 *Working Futures 2012-2022,* UK Commission for Employment and Skills, March 2014, p85 **1222** For further information on Working Futures 2012-2022 please see https://www.gov.uk/government/publications/working-futures-2012-to-2022 **1223** The engineering footprint is defined in SIC 2007. For further details see Table 17.5 **1224** Data was purchased from the Institute for Employment Research, using the engineering footprint.

Table 15.6: Changing composition of employment in the engineering sector, by occupation (2012-2022) – UK[1225]

Major group	Selected sub-group (jobs likely to require engineering skills)	Expansion by 2022 (in thousands)	Replacement demand by 2022 (in thousands)	Total requirement by 2022 (in thousands
1. Managers and senior officials		138.9	299	437.9
	11 Corporate managers and directors	130	240.9	370.9
	12 Other managers and proprietors	8.9	58.1	67
2. Professional occupations		248	458.6	706.6
	21 Science, research, engineering and technology professionals	169.7	270.5	440.2
3. Associate professional and technical occupations		102.6	311.5	414.1
	31 Science, engineering and technology associate professionals	22.9	72.7	95.6
	35 Business and public service associate professionals	67	167	234
4. Administrative, clerical and secretarial occupations		-38.9	245.1	206.2
5. Skilled trades occupations		-91.5	535.3	443.9
	52 Skilled metal, electrical and electronic trades	-74.3	253.7	179.5
	53 Skilled construction and building trades	40	217.4	257.4
	54 Textiles, printing and other skilled trades	-59.4	37.4	-22
6. Personal service occupations		23.9	30.5	54.4
7. Sales and customer service occupations		21.3	82.7	104
8. Transport and machine operatives		-130	218.5	88.5
	81 Process, plant and machine operatives	-142.9	140.8	-2.1
	82 Transport and mobile machine drivers and operatives	12.9	77.7	90.6
9. Elementary occupations		-17.2	122.7	105.5
	91 Elementary trades and related occupations	-11.4	57.5	46.1
	92 Elementary administration and service occupations	-5.8	65.2	59.4
Total major group		257.1	2,303.90	2,561.00
Total selected sub-group		158	1,659	1,817

Source: Working Futures 2012-2022 engineering extension

1225 The occupation categories come from SOC2010

While occupational groups do not map directly to qualifications, if we assume that those people working in sub-groups 11, 12 and 21, plus a proportion of those working in sub-groups 31 and 35,[1226] relate to engineering occupations that require level 4+ qualifications (Higher Apprenticeships, HNC/D, Foundation Degree, undergraduate or postgraduate and equivalent), then Table 15.7 infers that demand in engineering enterprises over 10 years for people with level 4+ qualifications is 1,066,500 people. This gives us an average demand of approximately 107,000 per year. However, looking at the supply of those qualified at level 4+[1227] gives us a total supply of 82,000 in 2012/13 – a shortfall of 25,000. In *Engineering UK 2014*,[1228] we showed that Higher Education engineering departments would need at least three to five years to double their capacity to teach engineering students.

Similarly, if we assume that those in sub-groups 52, 53 and 54, plus a proportion of those in sub-groups 31 and 35,[1229] require level 3 skills, then we can expect a demand over ten years of 556,100. This gives an average demand per year of around 56,000. However, the supply of level 3 apprentices was 26,000[1230] in 2012/13 – a shortfall of 30,000.

Table 15.8 shows that, of the 2.56 million job openings that will occur in engineering companies between 2012 and 2022, nearly a third (32.0%) are likely to be filled by women. Looking at just expansion demand (creation of new jobs) shows that half (51.9%) of these job openings are likely to be filled by women.

In Table 15.9 we show the breakdown of the total requirement for engineering companies and the number of jobs most likely to require engineering skills, broken down by nations and regions. Both nationally and regionally, it shows very little variation in the percentages for all requirement and requirement for jobs most likely to need engineering skills.

Nationally, 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 for jobs most likely to require engineering skills is the North East (3.7%).

Table 15.7: Summary table – changing composition of employment, by occupation in the engineering sector (2012-2022) – UK

	Expansion by 2022 (in thousands)	Replacement demand by 2022 (in thousands)	Total requirement by 2022 (in thousands
Selected jobs likely to require engineering skills	158	1,659	1,817
Jobs likely to require engineering qualifications at level 4+ (sub codes: 11, 12, 21, and parts of 31 and 35)	360.2	706.4	1,066.5
Jobs likely to require engineering qualifications at level 3 (sub codes: 52, 53, 54 and parts of 31 and 35)	-55.3	611.3	556.1

Source: Working Futures 2012-2022 engineering extension

Table 15.8: Total requirement for new workers in engineering companies, by gender (2012-2022) – UK

	Expansion by 2022 (in thousands)	Replacement demand by 2022 (in thousands)	Total requirement by 2022 (in thousands
Male and female	257.1	2,303.9	2,561.0
Male	123.8	1,617.9	1,741.8
Female	133.3	685.9	819.3
Proportion female	51.9%	29.8%	32.0%

Source: Working Futures 2012-2022 engineering extension

Table 15.9: Recruitment requirement in engineering companies by home nation and English region (2012-2022) – UK

	Total requirement in engineering companies 2012-2022 (thousands)	Percentage of total requirement	Total requirement, for jobs most likely to require engineering skills, in engineering companies 2012-2022 (thousands)	Percentage of total requirement for jobs most likely to require engineering skills
North East	95.2	3.7%	66.9	3.7%
North West	274.1	10.7%	192.9	10.6%
Yorkshire and The Humber	185.2	7.2%	130.3	7.2%
East Midlands	192.5	7.5%	138.0	7.6%
West Midlands	211.4	8.3%	149.7	8.2%
East	247.2	9.7%	177.7	9.8%
London	352.0	13.7%	242.9	13.4%
South East	402.2	15.7%	291.9	16.1%
South West	223.6	8.7%	161.4	8.9%
England	2,183.5	85.3%	1,551.8	85.4%
Wales	97.0	3.8%	71.4	3.9%
Scotland	215.3	8.4%	147.3	8.1%
Northern Ireland	65.2	2.5%	46.2	2.5%
UK total	2,561.0		1,816.8	

Source: Working Futures 2012-2022 engineering extension

1226 For sub-groups 31 and 35 the proportion of people in 2012 working in these occupations (for all engineering companies) who had a level 4+ qualification was calculated and this proportion was then applied to the net change, replacement demand and total requirement figures for these two sub-groups 1227 The supply of graduates consists of three categories, primary, secondary and tertiary supply and Higher Apprenticeships. For the primary supply, the number of engineering and technology qualifiers (all domiciles) was multiplied by the percentage going into employment (the percentage used was for UK students only). For the secondary supply – architecture, building and planning, computer science, mathematical sciences and physical sciences – the number of students qualifiers (all domiciles) was multiplied by the percentage going into employment (the percentage used was for UK students only) and then the percentage going into an engineering occupation at the 4 digit SIC code level. For the tertiary supply – all other subject areas – the number of qualifiers (all domiciles) was multiplied by the percentage going into employment (the percentage used was for UK students only), the percentage going into an engineering occupation (at the 4 digit SIC code level) and then the percentage going into graduate jobs (defined as those going into occupation codes 11, 12, 21, 31 and 35). The number of level 4+ apprenticeship achievements in engineering related subjects for England and Scotland. 1228 *Engineering UK Report The state of engineering*, EngineeringUK, December 2013, p13 1229 A similar calculation to level 4+ qualifications in sub-groups 31 and 35 was done for level 3 qualifications 1230 The exact supply figure for level 3 apprentices is 25,978, which is made up of those achieving an engineering related apprenticeship in England, Scotland and Wales. No achievement data is available for Northern Ireland.

The expansion and replacement demand plus the total number of job openings for engineering companies within the main industry groups is shown in Table 15.10. It shows that the largest proportion of job openings will occur in engineering enterprises within construction and the information and communications sectors (27.3% each). By comparison, a quarter (25.0%) of job openings will occur in engineering companies in the manufacturing sector. However, whilst this sector of the workforce will contract by 225,000, there will be a replacement demand of 864,000. This means that 640,000 job openings will be created, which counters the contraction which is being driven by automation.[1231]

According to the *Working Futures* report,[1232] construction is predicted to have particularly strong employment growth during the period 2017-2022. The Confederation of British Industry and Pearson Education[1233] 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 both for technician and graduate level roles.

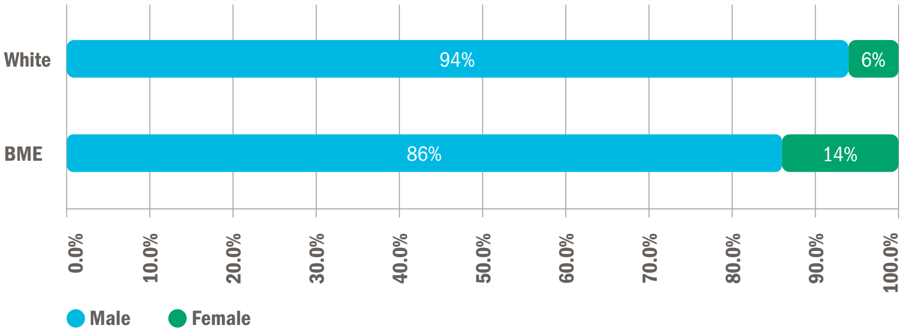
One way to address the demand for workers with engineering skills would be to better utilise the potential of females and those from ethnic minority backgrounds. In Section 12[1234] we showed that engineering and technology graduates who are female or from ethnic minority backgrounds are less likely than male and white graduates to go into an engineering occupation. Figure 15.2 shows that the proportion of female engineering professionals varies by ethnicity. Only 6% of white engineering professionals are female, compared with 14% of those from BME backgrounds.

Table 15.10: Recruitment requirements for engineering companies within the main industry groups (2012-2022) – UK

	Expansion by 2022 (in thousands)	Replacement demand by 2022 (in thousands)	Total requirement by 2022 (in thousands	Percentage of total requirement by 2022
Manufacturing	-225	864	640	25.0%
Construction	203	496	699	27.3%
Information and communication	244	454	699	27.3%
Professional, scientific and technical activities	17	239	256	10.0%
All engineering industries	257.2	2,303.9	2,561.0	

Source: Working Futures 2012-2022 engineering extension

Fig. 15.2: Percentage of engineering professionals by gender varies by ethnicity



Source: Campaign for Science and Engineering[1235]

1231 *Working Futures 2012-2022,* UK Commission for Employment and Skills, March 2014, p35 1232 *Working Futures 2012-2022,* UK Commission for Employment and Skills, March 2014, p15 1233 *Gateway to growth CBI/Pearson education and skills survey 2014,* Confederation of British Industry and Pearson Education, 2014, p7 1234 For further details see Sections 12.4 and 12.4.2 1235 *Improving Diversity in STEM,* Campaign for Science and Engineering, May 2014, p43

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15.4 Project MERCATOR – mapping the UK's engineering workforce

Authored by Tammy Simmons, Senior Marketing Executive, 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 and thoroughly assessed.

The Engineering Council has therefore undertaken a research project that maps the UK's engineering workforce in order to gain a better understanding of its constituency. An information tool has been produced to enable the organisation to provide reliable data on the numbers of working age[1236] engineers and technicians in the UK, the industries in which they work, the occupations they hold and the location of their workplace. Using statistics from the 2012/13 Annual Population Survey, *Project MERCATOR – mapping the engineering workforce* is currently being shared with the professional engineering institutions[1237] to assist in their strategy development. Examples of information generated by Project MERCATOR are shown in this section and, where relevant, have been compared with the Engineering Council's own professional registration statistics.[1238]

15.4.1 The UK's engineering workforce

As at 30 June 2014, the National Register of Professional Engineers and Technicians, held by the Engineering Council, showed that there were approximately 12,500 Engineering Technicians (EngTechs), 20,600 Incorporated Engineers (IEngs) and 95,550 Chartered Engineers (CEngs) living or working[1239] in the UK.[1240] Project MERCATOR identified the number of self-declared[1241] engineers and technicians[1242] working in the UK who are eligible for professional registration[1243] as being significantly higher that, providing an indication of the work required to be undertaken by the engineering institutions. As Table 15.11 shows,[1244] there are over 1.2m eligible for EngTech, 378,000 eligible for IEng and 316,200 eligible for CEng, across all occupational levels.[1245]

Table 15.11: Number of UK self-declared engineers and technicians eligible for registration

Occupational level	EngTech eligible	IEng eligible	CEng eligible	Total
Managers, directors and senior officials	134,100	85,950	102,550	322,600
Professionals	142,200	136,550	147,350	426,100
Associate professionals	86,900	48,000	18,900	153,800
Skilled trades	743,700	90,700	38,300	872,700
Unskilled trades and operatives	130,500	16,850	9,100	156,500
Total	1,237,400	378,000	316,200	1,931,600

Source: Engineering Council

15.4.2 Regions

The data has been cross-tabulated to show where in the UK engineers and technicians work,[1246] showing that the South East has the highest employment rate in England, followed by the North West.[1247] Taking the CEng statistics as an example, Table 15.12 presents the number of existing CEngs compared with those deemed to be eligible for registration as CEng in the UK, by region. This shows that London currently has the highest percentage of unregistered CEng eligible engineers.

Table 15.12: Registered Chartered Engineers vs eligible Chartered Engineers by region in UK

	Chartered Engineer		
Region	Existing	Eligible	Not yet registered
North East	3,200	8,800	63.6%
North West	9,700	31,200	68.9%
Yorkshire and The Humber	5,550	22,950	75.8%
East Midlands	7,050	25,100	71.9%
West Midlands	7,000	21,950	68.1%
East	7,900	27,050	70.8%
London	9,050	44,500	79.7%
South East	18,800	53,100	64.6%
South West	10,850	26,650	59.3%
England	79,150	261,250	69.7%
Wales	3,350	11,100	69.8%
Scotland	10,400	32,500	68.0%
Northern Ireland	2,650	8,250	67.9%
UK Total	95,550	313,100	69.5%

Source: Engineering Council

1236 20-64 years 1237 Having been successfully piloted with the Institution of Civil Engineers during 2014 1238 The full 'Project MERCATOR, mapping the UK's engineering workforce' report together with future plans for the project can be found at http://www.engc.org.uk/about-us/publications 1239 Registrants' address details are provided by the professional engineering institutions and may be work or home addresses 1240 Final stage registrants aged 20 – 64 years only 1241 Respondents to Annual Population Survey who have said they are working in occupations that are core engineering 1242 Across all industry sectors 1243 Eligibility criteria dependent on age/level of academic/vocational qualification ie anybody aged 40 or over with a level 4 in engineering and technology OR below 40 years with a Bachelors degree is deemed to be eligible for registration as an Incorporated Engineer. Similarly, anybody aged 40 or over with a Bachelors degree OR below 40 years with a Masters degree might be eligible for Chartered Engineer status 1244 All statistics taken from the Annual Population Survey have been rounded to the nearest 50 1245 The figures are shown by level of occupation using the Standard Occupational Classifications 1246 To local authority level 1247 All registration statistics have been rounded to the nearest 50 and are correct as at 30 June 2014

15.4.3 Industry sectors by occupational level

The number of engineers and technicians eligible for professional registration differs somewhat across industries. The examples in Table 15.13-15.16[1248] show the occupational levels of individuals in four sectors[1249] (extraction of crude petroleum and natural gas; manufacture of electrical equipment; water collection, treatment and supply; civil engineering). Of these sectors, civil engineering has the largest population, with the majority of individuals working at professional level, whereas water collection, treatment and supply has more than half of its engineering population working in skilled and unskilled trades.

Table 15.13: (06) Extraction of crude petroleum and natural gas

Occupational Level	EngTech Eligible	IEng Eligible	CEng Eligible	Total
Managers, directors and senior officials	-	750	-	1,400
Professionals	750	950	900	2,600
Associate professionals	750	-	-	1,150
Skilled trades	1,400	-	-	1,950
Unskilled trades and operatives	950	-	-	1,050
Total	4,250	1,950	1,950	8,150

Source: Engineering Council

Table 15.14: (27) Manufacture of electrical equipment

Occupational Level	EngTech Eligible	IEng Eligible	CEng Eligible	Total
Managers, directors and senior officials	2,350	1,150	1,750	5,250
Professionals	2,800	1,600	900	2,300
Associate professionals	1,350	850	-	2,250
Skilled trades	4,950	1,150	-	6,500
Unskilled trades and operatives	1,450	-	-	1,600
Total	12,900	4,800	3,200	20,900

Source: Engineering Council

Table 15.15: (36) Water collection, treatment and supply

Occupational Level	EngTech Eligible	IEng Eligible	CEng Eligible	Total
Managers, directors and senior officials	-	-	-	1,000
Professionals	1,250	750	850	2,850
Associate professionals	1,250	-	-	1,900
Skilled trades	2,700	600	-	3,750
Unskilled trades and operatives	2,950	600	1,000	4,500
Total	8,600	2,750	3,200	14,050

Source: Engineering Council

Table 15.16: (42) Civil engineering

Occupational Level	EngTech Eligible	IEng Eligible	CEng Eligible	Total
Managers, directors and senior officials	5,600	6,300	6,550	18,400
Professionals	9,150	15,050	16,250	40,450
Associate professionals	3,900	2,250	1,550	7,650
Skilled trades	13,550	1,250	1,050	15,850
Unskilled trades and operatives	3,400	-	-	3,700
Total	35,600	25,000	25,550	86,150

Source: Engineering Council

1248 Cells with a * represent numbers less than 500 **1249** 2 digit division Standard Industrial Classification

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15.4.4 Occupations in engineering

Drilling down further into the levels of occupation, Table 15.17 sets out the number and percentage of those eligible for EngTech, IEng and CEng in each occupation title.[1250] A high proportion of eligible EngTechs[1251] are working at 'managers, directors and senior officials' level: in particular, 'production managers and directors in construction' (49.27% compared with 25.49% of IEngs and 25.24% of CEngs). Just over 40,000 of these are aged 40 and over, suggesting they had progressed through their career by gaining the relevant experience and not through undertaking further academic qualifications.

Table 15.17: Eligible Engineering Technicians, Incorporated Engineers and Chartered Engineers in each occupation

		EngTech eligible		IEng eligible		CEng eligible		
Occupational level	**SOC 2010 full name**		**Percentage of total**		**Percentage of total**		**Percentage of total**	**Total**
Managers, directors and senior officials	1121 Production managers and directors in manufacturing	73,350	37.7%	52,900	27.2%	68,450	35.2%	194,700
	1122 Production managers and directors in construction	56,950	49.3%	29,450	25.5%	29,150	25.2%	115,550
	1123 Production managers and directors in mining and energy	3,800	31.0%	3,600	29.1%	4,900	39.8%	12,300
Professionals	2121 Civil engineers	9,500	16.1%	19,750	33.5%	29,700	50.4%	58,950
	2122 Mechanical engineers	27,000	40.3%	17,500	26.1%	22,600	33.7%	67,050
	2123 Electrical engineers	14,750	45.5%	9,950	30.8%	7,650	23.7%	32,350
	2124 Electronics engineers	10,000	32.5%	7,950	25.9%	12,850	41.6%	30,800
	2126 Design and development engineers	13,450	23.0%	24,450	41.8%	20,550	35.1%	58,450
	2127 Production and process engineers	12,200	30.6%	12,600	31.5%	15,150	37.9%	39,900
	2129 Engineering professionals n.e.c.	27,150	38.7%	21,300	30.4%	21,750	31.0%	70,250
	2436 Construction project managers and related professionals	19,050	39.8%	15,650	32.7%	13,200	27.6%	47,850
	2461 Quality control and planning engineers	9,100	44.5%	7,350	36.1%	3,950	19.4%	20,450
Associate professionals	3112 Electrical and electronics technicians	14,000	67.2%	5,050	24.3%	1,800	8.6%	20,850
	3113 Engineering technicians	42,700	63.3%	17,450	25.8%	7,350	10.9%	67,450
	3114 Building and civil engineering technicians	6,150	41.0%	5,100	34.1%	3,750	25.0%	15,000
	3116 Planning, process and production technicians	10,550	53.6%	7,700	39.0%	1,450	7.4%	19,700
	3122 Draughtspersons	13,500	43.9%	12,700	41.3%	4,550	14.8%	30,750
		363,200	40.3%	270,450	30.0%	268,800	29.8%	902,450

Source: Engineering Council

1250 Level 4 Standard Occupational Classification 1251 Holding a level 3 qualification and working in a core engineering occupation

15.4.5 Diversity

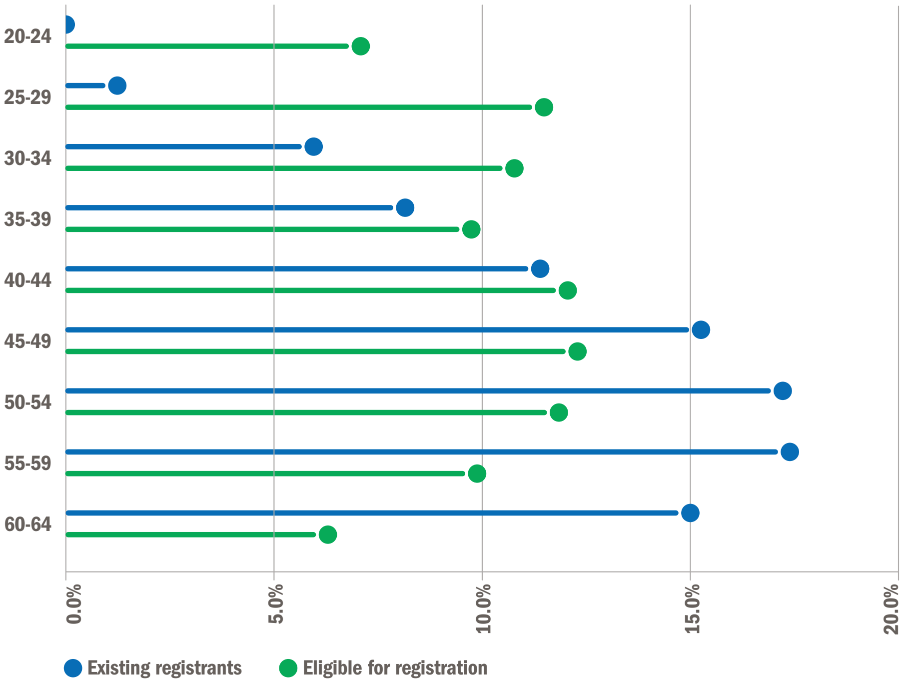
15.4.5.1 Age

Figure 15.3 shows the percentage comparison between the age profiles of existing Engineering Council registrants and those identified as being eligible for registration by Project MERCATOR. With 69.0% of existing registrants being aged 45 and over, compared with 44.3% of those eligible, there is a strong need to concentrate on engaging with young people entering the profession. Ensuring a healthy pipeline of professionals to fill the gaps that will inevitably be created by the retirement of current registrants is essential to ensure that the standards of engineering in the UK remain consistent and robust.

15.4.5.2 Gender

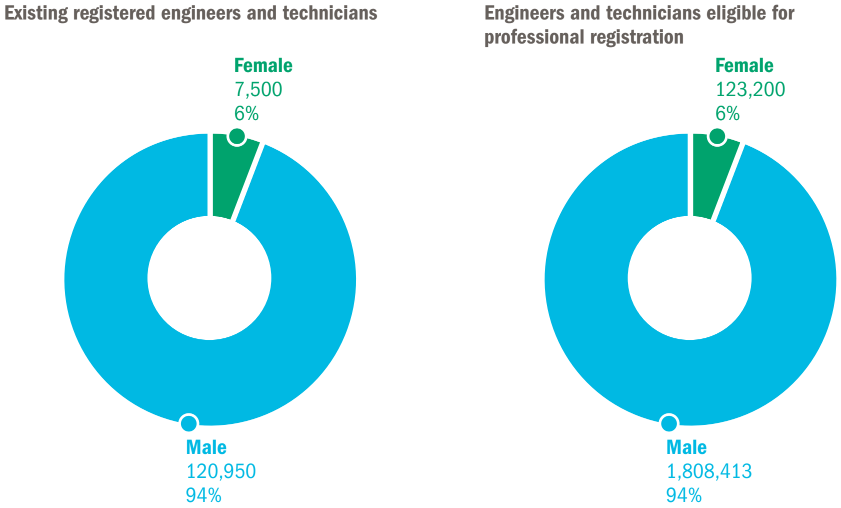
In terms of gender comparison between existing registrants and the UK engineering workforce, Project MERCATOR has shown that the Engineering Council's register is representative, albeit the actual numbers are somewhat different. Females represent 6% of both the national register[1252] (7,500) and the engineering workforce (123,200), as shown in Figure 15.4.

Fig. 15.3: Age profile – existing registrants vs eligible – percentage comparison



Source: Engineering Council

Fig. 15.4: Gender – existing registrants vs eligible for registration in UK



Source: Engineering Council

1252 Across all categories of registration

15.4.5.3 Ethnicity

Over half (53.64%) of all Chinese engineers working in the UK are eligible for registration as CEng (see Table 15.18), whereas for white British engineers, only 15.4% are eligible for CEng but 65.5% are eligible for EngTech. Indian engineers and technicians are the second largest ethnic group working in the UK at 34,350, behind white British at 1.8 million.

Table 15.18: Ethnicity – Percentage of eligible registrants by ethnic group

	EngTech		IEng		CEng		
Occupational level	**Eligible**	**Percentage of total**	**Eligible**	**Percentage of total**	**Eligible**	**Percentage of total**	**Total**
Any other Asian background	3,750	33.5%	2,750	24.6%	4,750	42.4%	11,200
Bangladeshi	800	61.5%	-	-	-	-	1,300
Black/African/Caribbean/ black British	12,350	48.1%	6,250	24.3%	7,100	27.6%	25,700
Chinese	-	-	2,200	40.0%	2,950	53.6%	5,500
Indian	15,600	45.4%	9,550	27.8%	9,150	26.6%	34,350
Mixed/multiple ethnic groups	6,100	62.6%	1,950	20.0%	1,700	17.4%	9,750
No answer	600	40.0%	-	-	650	43.3%	1,500
Other ethnic group	4,600	28.7%	4,700	29.3%	6,750	42.1%	16,050
Pakistani	5,200	42.8%	4,200	34.6%	2,750	22.6%	12,150
White	1,188,100	65.5%	346,050	19.1%	279,950	15.4%	1,814,050
Total	1,237,400	64.1%	378,000	19.6%	316,200	16.4%	1,931,600

Source: Engineering Council

Part 3 – Engineering in Employment
16.0 Concerted employer action

To reap a return in ten years, plant trees. To reap a return in 100, cultivate the people.

Ho Chí Minh

Through externally-provided case studies and cameos, this section highlights the ways that employers and employer bodies are taking responsibility for delivering sustainable UK growth.

16.1 STEM skills in short supply

Authored by Grace Breen, Policy Advisor, CBI

Science, technology, engineering and maths (STEM) skills underpin innovation and the UK's ability to compete successfully in high-value, high-growth sectors. Demand for these skills is rising strongly as economic recovery takes hold.

The CBI/Pearson *Education and Skills Survey 2014*[1253] highlighted that this is already leading to a rise in the proportion of businesses reporting difficulties in recruiting technicians and experienced staff with STEM skills. And this shortage is expected to intensify in the coming years. There is an urgent need to improve the supply of STEM-skilled people if economic growth is not to be held back.

Employers' views and priorities around STEM are clearly shown from our survey results:

- people with STEM skills are becoming harder to recruit and businesses expect the difficulties to intensify
- shortage of STEM skills is impacting some of our key growth sectors hardest
- STEM progress needs action by businesses and education, but also by Government

People with STEM skills are becoming harder to recruit...

STEM skills are vital to the UK's ability to sustain and develop high value-added industries – they underpin the UK's future economic growth.

Among those businesses that recruit employees with STEM skills and knowledge, well over a third (39%) report current difficulties recruiting STEM-skilled staff at some level (Table 16.0). So despite STEM shortages being high on the agenda for both business and Government, the supply of STEM skills is still inadequate and has worsened markedly at key levels as the recovery has gained traction.

1253 *Gateway to Growth – CBI/Pearson Education and Skills Survey 2014*, CBI, July 2014

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Table 16.0: Current difficulties in recruiting individuals with STEM skills and knowledge

	2014	2013	2012
People to train as apprentices	22	12	13
Technician	28	14	17
Graduate	19	12	17
Postgraduate	18	7	15
Experienced	26	22	23
At some level	39	39	42

Source: CBI

More than one in four employers report difficulties in meeting their need for technicians (28%) and experienced staff with STEM expertise (26%). In both cases, these figures are higher than in 2013. Finding suitable graduate recruits has also become more of a problem, with nearly one in five (19%) reporting difficulties in 2014 compared with 12% in 2013. There has been a jump too in the proportion of employers reporting difficulties in recruiting people with STEM skills to train as apprentices (from 12% to 22%).

...and businesses expect the difficulties to intensify

Businesses needing STEM-skilled staff believe the recruitment market will become much more difficult in the years ahead as the economic recovery gathers momentum. The proportion anticipating difficulties over the next three years has climbed from two in five (41%) in 2013 to more than half (53%) in 2014 (Table 16.1).

More than a third of firms recruiting STEM staff expect difficulties in finding suitable technicians (35%) and experienced STEM staff (36%) in the next three years. For both groups, the proportions of businesses in 2014 anticipating problems are much higher than last year (20% and 17% respectively in 2013). The supply of STEM graduates too is expected to be inadequate, with the proportion of employers anticipating problems in the next three years rising to 28% from 10% last year. At postgraduate level, the percentage of firms expecting recruitment problems has doubled (from 12% in 2013 to 25% in 2014).

Table 16.1: Expected difficulties in next three years recruiting individuals with STEM skills and knowledge

	2014	2013	2012
People to train as apprentices	32	11	12
Technician	35	20	19
Graduate	28	10	18
Postgraduate	25	12	14
Experienced	36	17	23
At some level	53	41	45

Source: CBI

Shortage of STEM skills is impacting some of our key growth sectors hardest

The mounting difficulties in recruiting STEM-skilled people currently and in the future (Table 16.2) are intense in sectors that should be driving future economic growth. The Government's industrial strategy sectors – aerospace, agri-tech, automotive, construction, education, information economy, life sciences, nuclear, oil and gas, off-shore wind, and professional and business services – are amongst those most in need of increases in amount and quality of skills.[1254]

In manufacturing, nearly one in four firms (24%) reports current difficulties in recruiting technicians, while more than a third (36%) expect problems in the coming three years. In the construction sector too, one in four (24%) reports current problems in recruiting technicians, and nearly half (48%) of construction firms anticipate problems over the next three years as the sector expands rapidly. In engineering, well over a quarter (29%) of businesses report difficulties in finding suitable technicians and the same proportion expect those problems to continue.

More difficulties are also expected in recruiting suitable people to train as apprentices in the coming years as the economy strengthens, with over a third of firms in all these sectors foreseeing problems. These findings highlight the need for balanced, effective careers advice to help young people understand the range of opportunities open to them in these and related sectors.

Table 16.2: Difficulty recruiting individuals with STEM skills and knowledge by sector

	People to train as apprentices	Technician	Graduate
Manufacturing – currently	26	24	19
– next three years	35	36	25
Construction – currently	18	24	11
– next three years	36	48	37
Engineering – currently	26	29	31
– next three years	35	29	38

Source: CBI

1254 *Raising the bar: business priorities for industrial strategy one year on*, CBI, September 2013

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The calibre of STEM graduates also needs attention

When asked about the barriers they encounter in filling jobs that require STEM-linked skills and qualifications, employers point to a range of concerns (Table 16.3).

Heading the list is the troubling finding that nearly half of those respondents (48%) experiencing problems have concerns about the quality of STEM graduates. This ranks just ahead of the problem of a shortage of STEM graduates (at 46%). Compounding this problem is that the content of qualifications at all levels is too often not relevant to business needs (33%). These finding highlight the need for firms and education and training providers to work together to ensure programmes of study properly reflect workplace developments and technological advances in manufacturing and science-based industries.

A lack of general workplace experience among applicants (39%) and weaknesses in the attitudes and aptitudes for working life among candidates (30%) are also identified as common problems. These findings highlight the need for young people to develop their understanding and gain some experience of the day-to-day demands of the workplace.

STEM progress needs action by businesses and education...

There is a clear need for action to promote the study of STEM subjects and so increase the future supply of STEM-skilled employees. When asked how best to achieve this, respondents see essential roles for businesses, educational bodies and Government (Table 16.4).

Three priorities for action are identified by more than half of respondent businesses. Firstly, businesses need to engage with schools to enthuse pupils about STEM study (57%). They can inject an invaluable 'real world' perspective, opening young people's eyes to the practical value and exciting creative scope of STEM subjects. Equally important is the creation of more STEM-related apprenticeships (57%). A majority of respondents (54%) also point to the need to tackle the low business relevance of some STEM qualifications. This requires employers and universities to work together more closely to develop STEM courses with built-in business relevance.

Firing young people's interest in STEM careers through schemes such as the STEM ambassadors' programme[1255] is widely recognised as important. This is reflected in the view of more than a third of respondents (38%).

Table 16.3: Barriers to recruiting STEM-skilled staff

Quality of STEM graduates	48
Shortage of STEM graduates	46
Lack of general workplace experience	39
Content of qualification(s) not relevant to business needs	33
Lack of appropriate attitude and aptitudes for working life	30
Lack of practical experience/lab skills	19
Lack of applications	16
Other	9

Source: CBI

Table 16.4: Priority action to promote STEM study

Streamlining of Government and stakeholder initiatives	31%
Government should recruit and retain more specialist teachers	50%
Business should provide more high quality work placements	36%
More STEM apprenticeships	57%
Businesses should engage with schools to enthuse pupils about STEM study	57%
Businesses should provide financial incentives (eg sponsorship/sign-on bonuses for graduate recruits)	14%
Closer working between business and universities to develop business-relevant STEM courses	54%
Employees should be encouraged to become STEM ambassadors	38%
Government should tilt Higher Education in favour of STEM subjects	40%

Source: CBI

And there is the added challenge of encouraging more young women to see STEM careers as open to them and an attractive option.

...but also by Government

Government too has an essential role in fostering development of STEM-skilled young people. Firstly, there can be no let-up in the push to recruit and retain more specialist STEM teachers in schools, with half of businesses (50%) pointing to the need for action.

There is a pressing need for high-quality teaching by specialists to foster enthusiasm and interest among young people in maths and science. The announcement of the Maths and Physics Chairs programme from September 2014 to increase the supply of maths and physics teachers with high-level subject expertise in non-selective state schools is therefore a welcome development.[1256]

In Higher Education, the Government is already taking steps to weight funding support towards STEM as high-cost subjects.[1257] This type of support is essential, with two in five businesses (40%) highlighting the importance of the Government tilting Higher Education in favour of STEM subjects. There is also a case for better streamlining of the varied initiatives to promote STEM study (seen as a priority by 31% of respondents). While a variety of programmes and campaigns can mean different audiences are reached, there is a risk of confusion and duplication of effort. There could be a role for Government in encouraging some streamlining and better co-ordination.

1255 http://www.stemnet.org.uk/content/ambassadors 1256 http://www.researchersinschools.org/researchers/maths-and-physics-uplift/ 1257 Funding for Higher Education in England for 2014-15: HEFCE grant letter from BIS, February 2014

16.2 The Big Three benefits of increasing industry engagement with universities

Authored by Verity O'Keefe, Employment and Skills Policy Adviser – EEF, the manufacturers' organisation

There are numerous benefits to increasing engagement with universities – too many to list all of them here. Having conducted research on Higher Education recently, we have highlighted what we consider to be the Big Three.

1. Employer engagement can enhance the employability of graduates – offering internships and placements gives students the industry experience employers demand.

One of the common features manufacturers are looking for when recruiting a graduate is experience in industry. Yet half of manufacturers say they are experiencing recruitment problems as candidates are lacking relevant experience. With apprentices, experience typically occurs throughout the apprenticeship training, as the apprentice is placed within a business and gains on-the-job training. Graduates cannot be guaranteed to have such experience.

However, there are ways in which vital experience can be gained, and graduates can find themselves ahead of the game when seeking employment. This includes undertaking an industrial placement or internship. It's widely acknowledged that a placement year improves a graduates' employability, but the number of placements on offer is in decline. Such offerings are, however, reasonably common practice amongst manufacturers, with four in 10 currently offering industrial placements (up from three in 10 in 2012), a few in the process of doing so, and one in five wanting to do so. A similar trend can be seen for internships (Figure 16.0).

Size matters when it comes to firms' ability to offer such opportunities to Higher Education learners. Larger companies are more likely to offer placements (69%) than medium and small firms (36% and 25% respectively). This reflects the barriers companies face in offering such opportunities, with employers most likely to cite time (37%) and cost (34%). Both of these can be overcome with appropriate action.

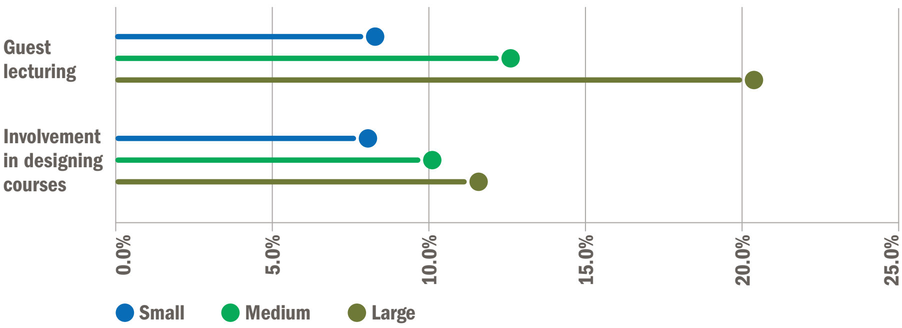
2. Businesses can influence Higher Education provision through engagement activities, sharing resources and facilities, guest lecturing and involvement in course design.

Some 66% of manufacturers plan to recruit an engineering graduate in the next three years. Nonetheless, when speaking to employers, some express concerns that graduates often lack the fundamental knowledge of the subjects they have a degree in – including technical disciplines such as engineering. This can often be due to the fact that the institutions delivering such courses are not providing the modules most relevant to what is an increasingly fast-moving industry.

However, employers needed to be proactive and get more involved in Higher Education. Some of this is already happening with manufacturers guest lecturing in universities, becoming involved in designing courses and building relationships with university employees such as Heads of Engineering Departments. However, such action is limited and tends to be undertaken by larger firms (Figure 16.1).

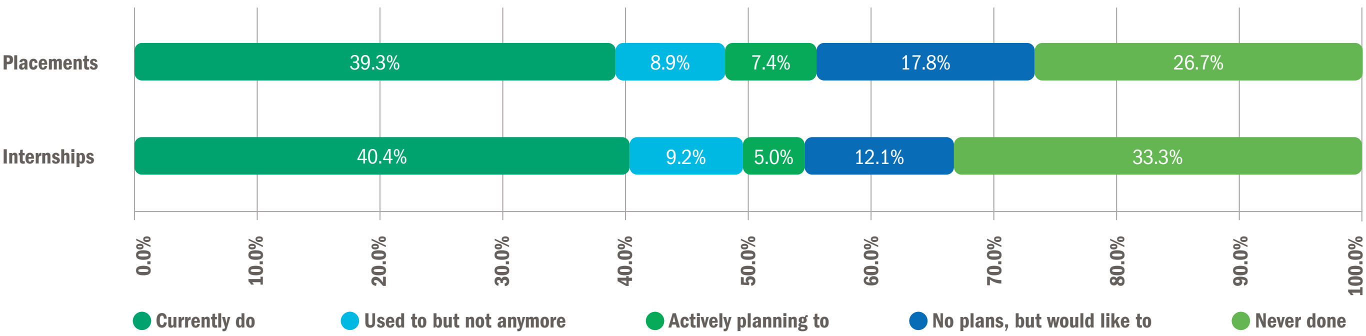
One of the challenges companies face is knowing how to get involved in these activities. When asking manufacturers how best they could influence the design and development of Higher Education courses, they indicated through the future creation of Industrial Partnerships (Figure 16.2). This, we suggest, would be sectoral, employer-led bodies taking end-to-end responsibility of the skills system. Others saw Sector Skills Councils and Trade Associations playing a role, and a limited number of businesses stating that businesses should simply be doing it themselves.

Fig. 16.1: Large firms are more likely to engage in activities that influence Higher Education provision



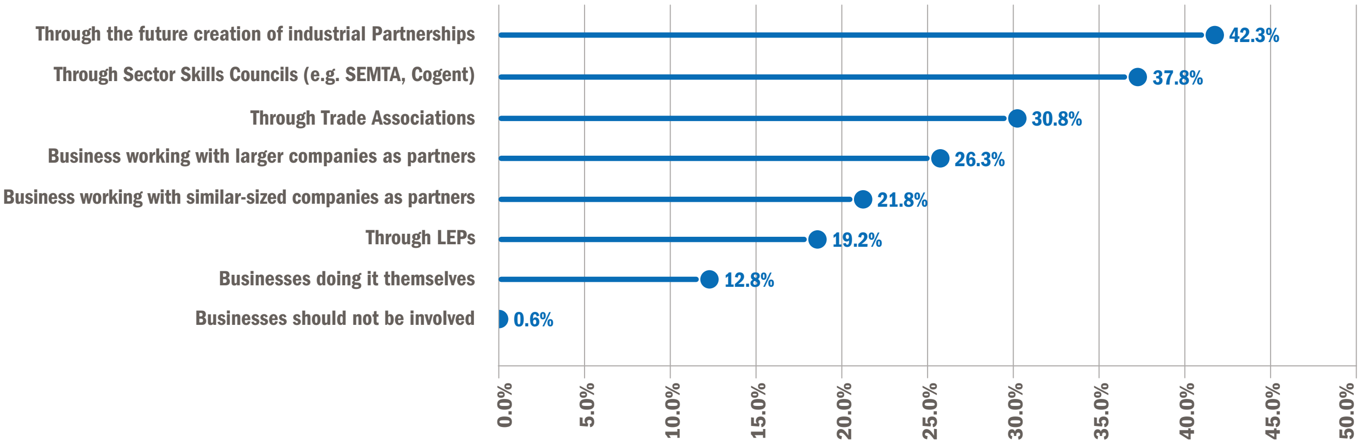
Source: EEF Higher Education Survey 2013/14

Fig. 16.0: Manufacturers offer internships and placements to give students industry experience



Source: EEF Higher Education Survey 2013/14

Fig. 16.2: Manufacturers see a number of channels through which they could influence Higher Education provision



Source: EEF Higher Education Survey 2013/14

For employers to engage with any of these activities, they need to have access to the right information. When employers have a question on apprenticeships, they can go to the National Apprenticeship Service (NAS) and generally find the answer they are looking for – they can even advertise their apprenticeship vacancies. There is, however, no such opportunity for those wanting to engage in Higher Education.

3. Partnerships with businesses can enable universities to secure finance for department and support learners financially.

One in 10 manufacturers say they fund specific university faculties and one in five share resources and facilities. This form of engagement is beneficial to ensuring that universities have the equipment and resources necessary to deliver high-quality STEM courses demanded by employers. A criticism that has reoccurred recently has been that the cost of delivering an engineering degree is greater than the total of the fee paid by the learner and the additional premium for courses such as engineering. Universities, therefore, do not always have the capacity or capability to recruit additional engineering graduates. Fortunately, some of this is provided through partnerships with business such as that between Unipart Group and Coventry University.

Unipart Group and Coventry University – A faculty on the factory floor

Unipart Group recently joined forces with Coventry University to develop a new Engineering and Manufacturing Institute on Unipart's manufacturing site in Coventry. The £32 million project will see the creation of an international centre of engineering and manufacturing excellence, which will be the base for a sustained programme of innovative teaching and learning, product development and research activity.

Unipart itself is contributing £17.9 million towards the new facility, with an additional £5.6 million towards student scholarships and product R&D, and for new undergraduate and postgraduate programmes in manufacturing.

The facility will create a 'faculty on the factory floor', allowing students the opportunity to be connected directly to the latest technology on the manufacturing front line. This will develop the next generation of highly skilled, specialist engineers and operational leaders needed for the industry. Students will have direct access to Unipart's operations, allowing them to work on live issues in a real world manufacturing production environment.

Partnerships can also be developed between industry and undergraduates through universities, including sponsorship. Currently, a quarter of EEF members say they sponsor students through university. However, there is once again a significant disparity between the ability of larger firms and smaller firms (43% and 15% respectively).

Whilst some companies consider the cost of sponsoring students through university a barrier, manufacturers must consider the return on investment of doing so. Many manufacturing and engineering companies tell us the average cost of offering an engineering apprenticeship is around £80,000, of which they can draw down approximately £17,000 of public funding. Yet, not all companies are as willing to make such investment in graduates.

This may be due to fears that graduates are often seen as more mobile and therefore susceptible to leave the organisation. Three-quarters of EEF members say they retain all their apprentices after training, but anecdotal evidence from our memberships suggests the same is not always true for graduates. Some suggest that graduates see them as a 'stepping stone' to another opportunity. However, companies must challenge this mind-set and realise the potential returns on investment in investing in undergraduates in this way.

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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 within the UK, 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 that it should do so. The UK generally prefers professions to be self-regulating. There is generally no statutory requirement for engineers or technicians to be registered in the UK, although there are some isolated areas of practice where public registers are maintained including work on reservoirs, aircraft maintenance, and gas appliance installation and maintenance.

The Government does, however, recognise the need for self-regulation and accordingly awards Royal Charters to appropriate professional bodies to deliver this public benefit, thereby encouraging the attainment of professional standards and the adherence to codes of conduct. In the case of engineering, this means that society can have confidence in the knowledge, experience and commitment of professionally-registered engineers and technicians.

Professional registration

The Engineering Council is the chartered body that sets the collective standards[1258] for registration of competent engineers and engineering technicians on behalf of the professional engineering community. It maintains the national Register of all those who meet or exceed these standards and keeps the standards under review to ensure that they meet the needs of both business and society at large.

The UK Standard for Professional Competence (UK-SPEC) is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. It was most recently reviewed in 2013 and the third edition was published in January 2014.

The process of individual assessment for professional registration is managed by professional engineering institutions and societies licensed for that purpose by the Engineering Council. There are currently 36 of these.[1259] The Engineering Council regularly reviews these licences and also works within international protocols to ensure that registered engineers and technicians meet internationally-agreed standards for 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[1260]
- 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 Masters (MEng) degree or equivalent

In addition, the Engineering Council operates the register for those that meet the ICT Technician (ICT*Tech*) standard,[1261] which is broadly equivalent to that of Engineering Technician.

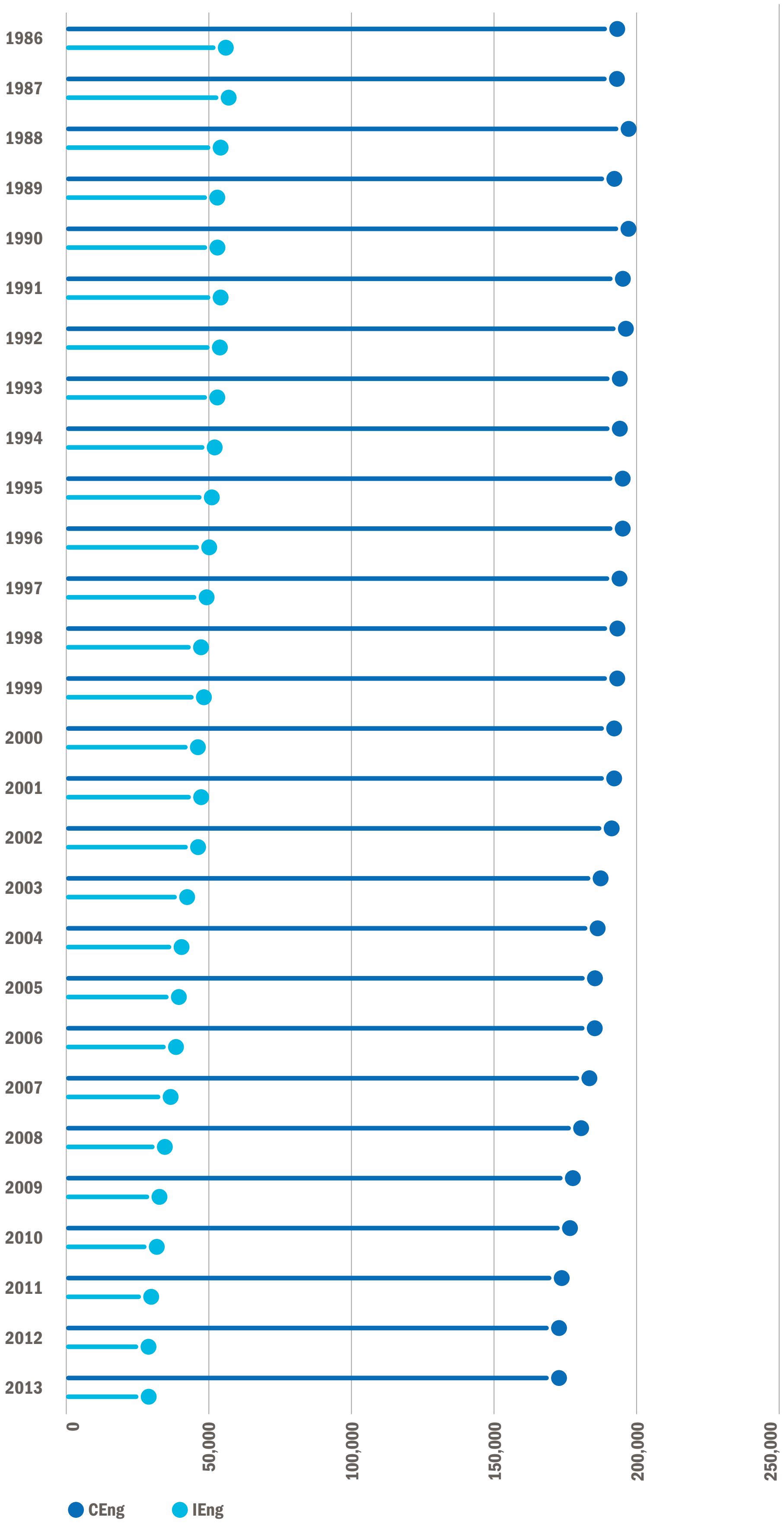
Candidates for all four registers must, in addition to demonstrating their competence to practice in accordance with the relevant standard, also demonstrate that they are committed to maintaining their competence and to acting in a professional and socially-responsible manner.

The number of professionally registered engineers

Approximately 180,000 individuals are currently registered with the Engineering Council as Chartered Engineers and 33,500 as Incorporated Engineers. The trend for the overall number of professionally-registered engineers has shown a decline since its peak in the 1980s (Figure 16.3). However, over the last couple of years there has been a levelling out and in 2013, for the first time since 2001, a small increase in final stage registrants was observed.

1258 UK Standards for Professional Engineering Competence (UK-SPEC) www.engc.org.uk/ukspec **1259** www.engc.org.uk/institutions **1260** The equivalent academic standards in the Scottish Credit and Curriculum Framework are 11, 9 and 6 respectively. **1261** www.engc.org.uk/icttech

Fig.16.3: Total number of registered Incorporated Engineers and Chartered Engineers (1986-2013)

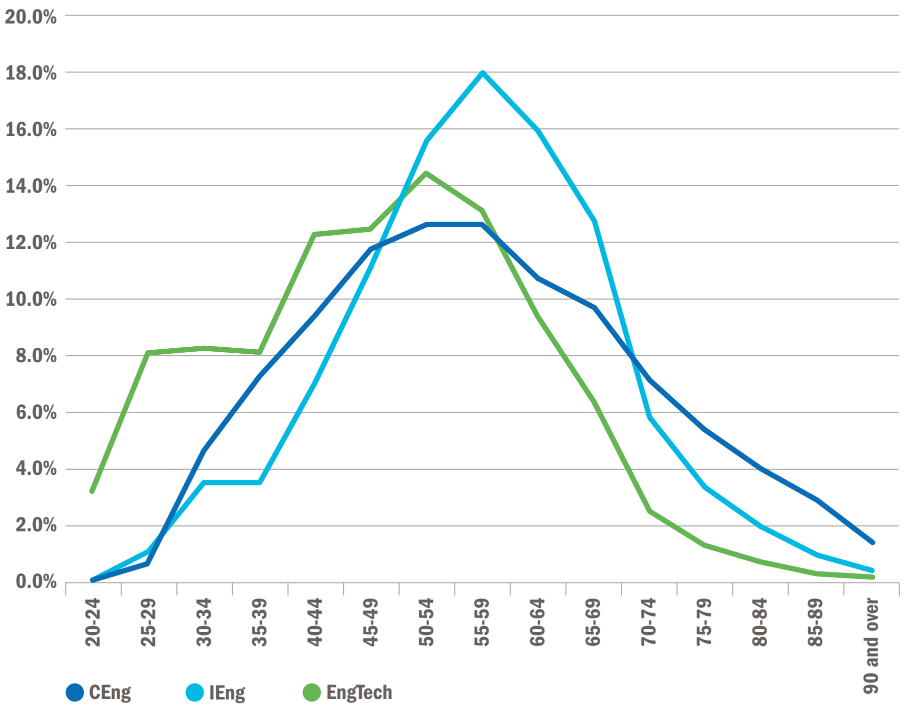


Source: Engineering Council Annual Registration Statistics 2013

When looking at the registrants' age profile and making allowances for age of retirement, the downward trend in the number of professionally-registered engineers is not a surprise (Figure 16.4).

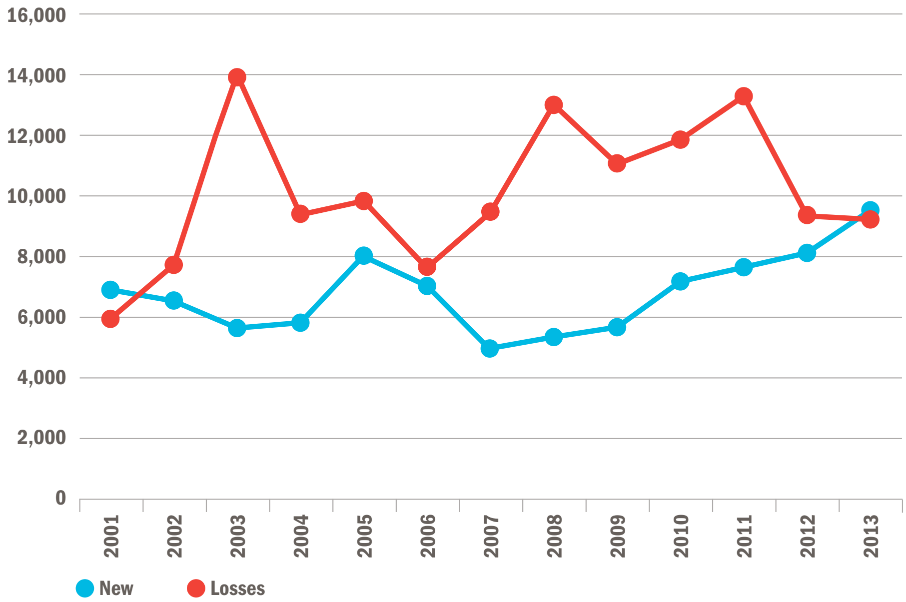
However, the rate of new registrations has steadily increased over the last few years (Figure 16.5), indicating that more graduates are electing to join professional bodies and being encouraged to become professionally-registered than was previously the case.

Fig.16.4: Age distribution of Engineering Technicians, Incorporated Engineers and Chartered Engineers



Source: Engineering Council Annual Registration Statistics 2013

Fig.16.5: New registrants versus losses from the register (2001-2013)



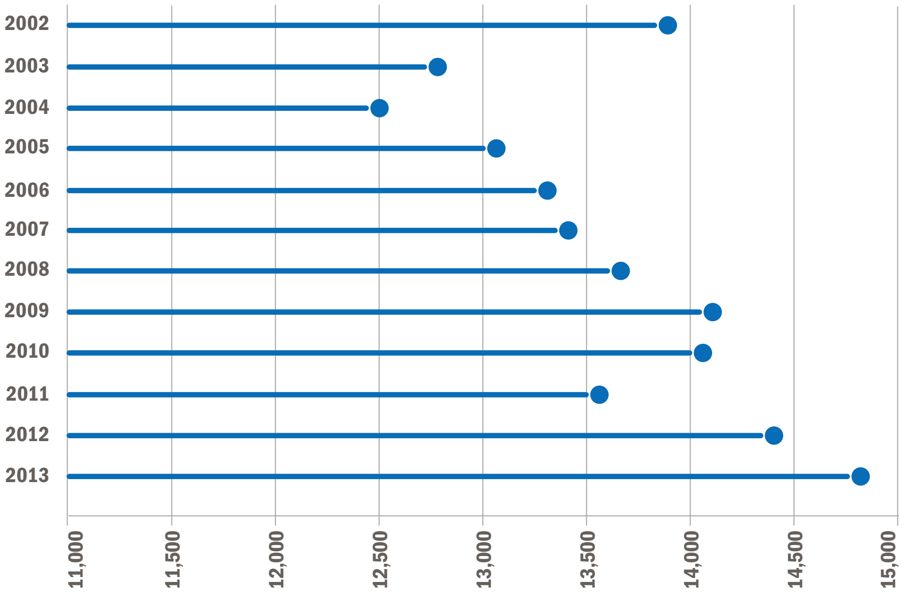
Source: Engineering Council Annual Registration Statistics 2013

The number of professionally-registered Engineering Technicians (Figure 16.6) is significantly below the number of potential technicians to be found in the UK workplace. Major initiatives are currently underway to address this. (See Section 10.3 for more information on registered technicians.)

Professionally registered female engineers and technicians

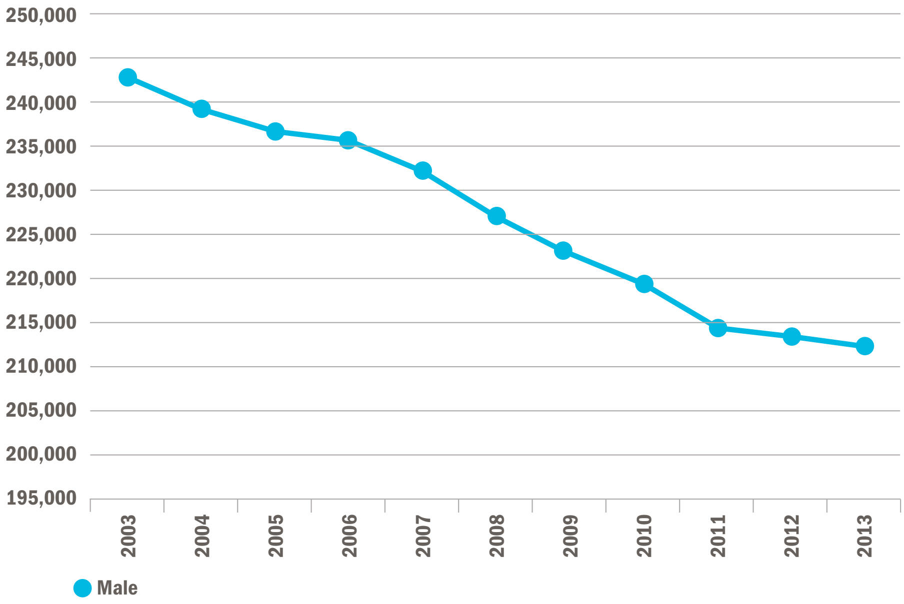
Although females currently only represent 4.36% of those on the national register, their total numbers continue to rise steadily. It is worth noting that this increase compares well when set against a backdrop of a decreasing male registrants over the same period. (Figures 16.7 and 16.8.)

Fig.16.6: Total number of Engineering Technicians (2002-2013)



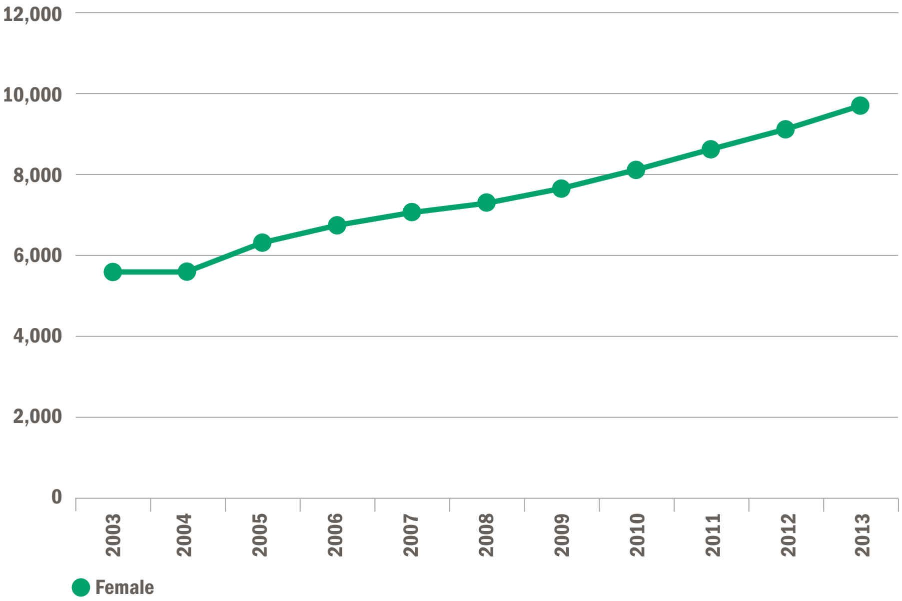
Source: Engineering Council Annual Registration Statistics 2013

Fig.16.7: Total number of male registrants (2003-2013)



Source: Engineering Council Annual Registration Statistics 2013

Fig. 16.8: Total number of female registrants (2003-2013)



Source: Engineering Council Annual Registration Statistics 2013

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 16.5 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.

Table 16.5: 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	6,934	15,826	6,000	14,157	58,094	260,561	24,856
IEng/technologists (total in professional membership/registered)	31,443	163	4,593	200	1,230	1,074	65,000	3,369,240
Technicians (total in professional membership/registered)	14,447	30	4,207	300	0	-	-	0
CEng/professional engineers per 1000 population	2.79	1.51	3.33	1.36	1.97	2.51	7.78	1.08
Ratio								
Engineer:technologist	5.6:1	42.5:1	3.4:1	30:1	12:1	54:1	4:1	1:135
Engineer:technician	12.2:1	231:1	3.7:1	20:1				
Technologist:technician	2.2:1	5.4:1	1.09:1	0.66:1				

Source: Engineering Council August 2013 *data not available

16.4 The employer activists

It continues to be the case that engineering employers themselves will make the most significant contribution to UK economic growth and indeed their own success. Therefore, it is important that we note and record relevant evidence that shows that employers who work directly with schools and colleges can make a demonstrable difference to young people:

- There is strong evidence that on average, teenagers who have direct experiences of the labour market, whether through their social networks and/or directly through part-time employment, go on to achieve as young adults. Analysis commissioned by the Department for Education, drawing on evidence from longitudinal databases, shows, for example, that young people who combine full-time education with part-time work at the age of 16/17 are more likely to be in some kind of work at the age of 18/19 than those who just studied full-time.[1262] The former group, moreover, have a lower probability of becoming NEET up to five years later, compared with those who just study full-time.
- There is also emerging evidence that work experience plays a part in supporting admission to Higher Education.[1263] This implies that it may be as beneficial to high-achieving pupils as to those planning to enter the world of work soon after leaving school or college.
- Research by the OECD has found that strong pathways between formal education and the workplace lead to improved employment outcomes, concluding that "strong links between schools and local employers are very important means of introducing young students to the world of work."[1264]

This is a double-edged sword, as employers often state their dissatisfaction with the school-leavers who are applying to them for jobs, but fail to recognise that this is in no small part the result of insufficient links between firms and the education system. A large part of the problem arises because employers are not prepared to be sufficiently involved in young people's training to ensure that they develop meaningful, useful skills. The best way to increase employers' engagement is to have them take a financial stake in the success of the system.[1265]

In summary, businesses need to be prepared to take more responsibility for getting out into local schools. If they want to successfully recruit pupils from school, college or university, employers need to help shape the choices young people make about the qualifications they set out to achieve and the work experience that they gain.[1266]

16.4.1 Employer engagement – How much is enough?

Authored by Katy Morris, Senior Researcher, Education & Employers Taskforce

As research in the field of employer engagement in education progresses, it is increasingly clear that interaction with employers at an early age – be it through careers talks, CV workshops, mock interviews or work experience – is not a nice to have, but a must have for young people.

Peer-reviewed research by the Education and Employers Taskforce points to returns at scale for young people who have more contact with employers whilst they are at school. In 2011, we commissioned YouGov to survey 1,001 young people aged 19-24. Respondents were asked to think back to when they were at school and tell us about the number and type of contact with employers they could remember having between the ages of 14 and 19. They were also asked to tell us what they were doing at the point of the survey (working, studying and so on) and to provide some background information to enable us to compare outcomes for similar people.

The first, rather alarming, finding from this survey was that young people could not remember having had much interaction with employers when at school. As Table 16.6 shows, with the exception of work experience (which 90% of valid respondents had undertaken) no employer engagement activity reached more than 40% of those surveyed.

Table 16.6: Participation in, and perceptions of, employer engagement activities

Activity (773 19-24 YOs)	Percentage experienced this activity	Percentage found it useful for getting a job
Work experience	90%	58%
1-2 career talks	37%	55%
3 or more career talks	13%	84%
Mentoring	19%	78%
Short enterprise	18%	35%
Long enterprise	15%	50%

Source: Education and Employers Taskforce 2014

Yet where young people had met and interacted with employers at school, they believed that these experiences had been useful in helping to get a job after finishing full-time education. It is therefore concerning that young people from independent and grammar schools were more likely to have taken part in a greater number of employer engagement activities than their peers at comprehensive schools. Much like 'science capital',[1267] access to employer engagement activities is not distributed equally.

Of particular interest in the context of the question of 'how much is enough?' is the difference between having one or two career talks compared with three or more career talks. Table 16.0 shows that just over half of the 37% of respondents who'd had one or two career talks when at school said they had found these useful in finding a job, rising to 84% of the smaller proportion of young people who had experienced three or more career talks during their secondary school days.

Whereas mentoring and enterprise competitions often tend to take a similar format, careers talks vary enormously in their nature, focus, style of delivery and duration. Survey respondents were therefore reporting on very different experiences. But this seems to matter less than we might expect. Having one careers talk was seen as beneficial to employment prospects over the longer term by the majority of respondents. But having more career talks was seen to be even more useful. In other words, one is good, but more is better.

1262 Crawford, C., Duckworth, K., Vignoles, A. and Wyness, G. *Young people's education and labour market choices* added 16/17 to 18/19, London: Department for Education, 2011 **1263** Jones, S, *The personal statement: a fair way to assess university applicants?* London: Sutton Trust, 2012 **1264** *Learning for Jobs: Summary and policy messages,* Organisation for Economic Co-operation and Development [OECD], 2010, http://www.oecd.org/edu/skills-beyondschool/46972427.pdf **1265** *Remember The Young Ones: Improving Career Opportunities For Britain's Young People,* IPPR, August 2014, p2 **1266** *Driving a generation: Improving the interaction between schools and businesses,* IPPR North, January 2014, p2 **1267** Archer, L et al (2013) *ASPIRES: Young people's science and career aspirations, age 10 –14.* London: Kings College London

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And it wasn't just that more was seen to be better by young people. Over the longer-term it also proved beneficial, in terms of both employment and wage outcomes.[1268] Using more sophisticated analysis that controlled for the influence of where respondents lived, the type of school they attended and their highest qualification, we found that young people who could recall more contact with employers at school were less likely to be unemployed at the point of the survey than similar peers who could remember none.[1269]

Moreover, respondents working on a full-time basis who remembered having more interaction with employers tended to be earning more than comparable peers who could not remember having any such contacts. Each additional contact with employers whilst at school was on average associated with a £900 wage premium,[1270] a difference that is all the more remarkable given that those surveyed were relatively early on in their careers.

We can therefore say with confidence that employer engagement in education – be it through careers talks, CV workshops, mock interviews or work experience placements or other forms of interaction with employers whilst at school – has profound and long-lasting consequences for young people. And the more of it there is, the greater the longer-term benefits seem to be.

Why might this be? A newly developed framework highlights three different ways in which meeting employers at an early age can benefit young people:[1271]

1. It can help young people **enhance their stock human capital**, through improved employability skills and more informed decisions about the best qualifications to pursue.
2. It can **increase social capital** through offering the opportunity to connect with 'people in the know' who possess trustworthy information and useful ideas, and who have access to broader social networks.
3. And finally, meeting employed professionals can **influence young people's cultural capital** through influencing their perceptions of themselves and their understanding of professional life and the world of recruitment.

There remains much that we don't yet know. We still don't know what the 'optimal' number of employer contacts is for young people and we're not able to pinpoint the different benefits associated with particular activities or for particular groups of young people. But we do know that employer engagement has lasting, and powerful, effects. So how much is best? The answer is simple: more.

Highlighting how proactive many enlightened employers have indeed been in determining their destinies, Figure 16.9 provides several brief cameos from companies who belong to our high-level Business and Industry Panel.[1272] They describe responses to the question, "What key challenges is your organisation expecting to face over the next five years?"

1268 Percy, C and Mann, A (2014) In Mann, A, Stanley, J and Archer, L (eds) *Understanding Employer Engagement in Education: Theories and Evidence, London: Routledge* **1269** Across a range of models, higher levels (defined as two or more) employer contacts were associated with a lower likelihood (typically between 5 and 20 percentage points) of being NEET at the point of the survey **1270** Mann, A and Percy, C (2013) **1271** Stanley, J and Mann, A (2014) A theoretical framework for employer engagement, in *Employer Engagement in Education: Theories and Evidence* (Routledge, 2014) eds. Anthony Mann, Julian Stanley and Louise Archer. **1272** http://www.engineeringuk.com/View/?con_id=258

Fig. 16.9: What key challenges is your organisation expecting to face over the next five years?

AIRBUS

Airbus is a leading aircraft manufacturer with the most modern and comprehensive family of airliners on the market, ranging in capacity from 100 to more than 500 seats. Airbus champions innovative technologies and offers some of the world's most fuel efficient and quiet aircraft. As such, it requires a highly skilled and diverse workforce of engineers to ensure its leadership for the future. Airbus is helping to close the skills gap and to increase diversity in the profession by offering apprenticeship programmes which combine college or university studies with practical training, supporting engineering outreach in communities, and recognising promising engineering students.

ATKINS

As one of the world's leading design, engineering and project management consultancies, it's vital we listen, understand and take steps to meet the increasing demands on the engineering sector for better efficiency and smarter solutions. In the face of strong global competition for talented people, the industry must get better at forging strong collaborative partnerships and consortia which can deliver engineering projects seamlessly through the design, construction/manufacture and operation phases. At the same time we need to continue developing innovative thinking and best practice across traditional market sectors and engineering disciplines.

CH2MHILL

CH2M HILL, like all other companies in the engineering sector, is successful because of its highly skilled people. Ensuring that young people are inspired to pursue STEM subjects and go on to take up careers in engineering, either via apprenticeships or as graduates is an area we all must invest in if we are to have British engineers of the future. As we continue to invest in our UK business, identifying these talented young people and supporting their development early on in their careers will increasingly form a critical part of our success and remains one of the biggest challenges for the sector too.

AngloAmerican

Anglo American is one of the world's diversified mining companies, producing a wide array of metals and minerals to meet our customers' changing needs. Given the nature of our business, success is founded upon coupling world class engineering, business processes and other technical skills, with high quality ore bodies – these are all vital to the delivery and continuous improvement of reliable, safe, viable businesses that meet our community and social requirements. We search for constant innovation and "step change" processes and technologies to leverage the defining facets of our businesses, all based on the fundamental premise that "people are our business".

Balfour Beatty

As the UK construction industry returns to growth, our biggest challenge lies in sourcing the right people to create the engineers and other skilled people who will drive our continuing success as a global infrastructure group operating in over 80 countries around the world. Our membership of 'The 5% Club' commits us to ensuring 5% of our UK workforce is an apprentice, sponsored student or graduate within five years. Furthermore, our participation in the Government's Trailblazer Apprenticeship scheme, Prince's Trust Get into Construction, the Skills Show and the Big Bang event all raise awareness of STEM subjects for young people and help create ours and the industry's workforce of the future.

DOOSAN

Doosan Babcock is a specialist in the delivery of engineering, aftermarket and upgrade services to the thermal power, nuclear, oil and gas, petrochemical and process sectors. Our products and services are only as good as the people behind them, so we work hard to recruit, train and develop the best engineering talent. At present, the UK faces an engineering skills shortage that threatens to undermine the strategic needs of our economy. We will continue to invest in apprenticeships, graduate schemes and other training programmes to support the UK's industrial future. However, other avenues of funding support for UK skills development are essential to meet the challenges that lie ahead.

ARM

ARM Holdings is the world's leading semiconductor intellectual property (IP) supplier reaching around 75% of the people in the world, with chips based on our technology driving billions of products every day. It is crucial for our long-term success that we attract, engage and retain the most talented employees. The greatest challenge is to ensure that a sufficient pipeline of high quality talent is developed from which we can attract future employees. ARM is working with partners to support quality in education and to promote the skills necessary for a career in engineering, going beyond the technical competencies to include 21st century skills such as creativity, imagination and team-work.

CATERPILLAR

Caterpillar is the world's leading manufacturer of construction and mining equipment, diesel and natural gas engines, industrial turbines and diesel-electric locomotives; so ensuring our manufacturing operations have a strong, skilled workforce for tomorrow and the right skills for today remains a challenge. Graduates and apprentices of the science, technology, engineering and mathematics (STEM) fields are a critical piece of the Caterpillar talent pipeline. Today, we have more than 800 engineers and technologists in the UK developing innovative solutions for our customers. Continuing this pace of innovation and maintaining our competitive advantage requires a sustainable pipeline of technical STEM talent and that is why Caterpillar is a strong advocate for STEM subjects throughout the UK education system.

e.on

E.ON is one of the leading UK energy suppliers working in an energy market that is undergoing a period of significant structural change. This is happening upstream where, in the UK, we need to ensure we can contribute to global efforts to prevent climate change whilst ensuring security of supply. It is also happening downstream, where we need to ensure customers pay a fair price for their energy and help them to reduce their energy usage. Operating in an industry which is becoming increasingly influenced by politics, adapting to and managing these changes is a significant challenge.

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Jaguar Land Rover is the largest automotive business in the UK. To continue to meet the requirements of our global customers, we have invested significantly in innovative skills development programmes. Partnering with some of the leading Engineering Universities in the UK we have pro-actively pioneered Bachelors and Masters degree level modular programmes to up-skill experienced and early career engineers and technicians. We have an established Advanced level 3 and Higher level 6 Apprenticeship programmes championing new Trailblazer standards broadening the talent within the business and supporting a newly opened UTC academy to nurture the diverse talent for the future.

Network Rail's investments mean that by 2019 the country's rail network will deliver 225m more passenger journeys each year, more trains per day will run between our northern cities, 170,000 extra seats will be available on trains going into large cities, and 500 more level crossings will be closed. Passenger and freight traffic is forecast to increase; simultaneously we are aiming to reduce the cost of running the railway. We welcome that challenge; however it will only be possible if we, and the rest of the railway, work in a fundamentally different way – through new ways of working and innovative technology.

Siemens, a leading global technology and engineering company, is committed to driving the UK forwards into taking a leading role in the next industrial revolution. Sixty percent of our UK employees are engaged in engineering and manufacturing. Nurturing this talent, as well as attracting and developing the next generation of engineers, is critical to our future. Siemens has a thriving apprenticeship and graduate scheme and an ongoing commitment to communicating the opportunities and excitement to be found in engineering alongside policy makers, the industry and education sector. Adoption of the latest technologies and support for the supply chain are key to helping us take a leading role in the next industrial revolution.

As the UK's no.1 engineering recruitment company we understand that attracting and retaining talent is a key challenge as demand for specialist engineering skills continues to outstrip supply. Extending our professional network and geographical reach enables us to interact with more engineers who possess the niche skills and levels of experience to satisfy recruitment demand. Mitigating the skills gap is a long-term challenge to which we have responded by supporting and facilitating numerous activities that engage with key stakeholders from the engineering community, addressing issues such as education, the perception of engineering, diversity imbalance, and skills transfer.

Rolls-Royce is a global company, providing integrated power solutions for customers in civil and defence aerospace, marine and energy markets. "Trusted to Deliver Excellence," we invest heavily in our people. Graduate and internship schemes are externally accredited and can be individually tailored resulting in high retention levels. We encourage women into engineering and see increased numbers on our schemes. Ofsted graded our Young, Advanced and Higher Apprentice programmes as "outstanding". Our Apprentice Academy has supported a fivefold increase in apprentices for our supply chains and other local engineering companies. All Engineering employees are developed through a network of Skill Owners spanning our business and keeping them at the leading edge of delivering excellence to customers.

Ultra Electronics is a world leading defence and aerospace, security and cyber, transport and energy company. One of the main challenges we face is related to the recruitment and retention of people. The Group's businesses are capital-light, but specialist knowledge-intensive. If we fail to attract, develop and retain people with the required specialist competencies, we could lose key staff or capabilities. Consequently we operate a strong culture aimed at developing high quality individuals and have high-class training strategies in place. We also ensure that we engage with potential recruits at an early stage through links with schools and universities.

National Grid connects people to the energy they use, safely. We run systems that deliver gas and electricity to millions of people, businesses and communities. Over the next five years we will help Britain meet its future energy needs in a sustainable, secure and affordable way by connecting new low carbon power generation to the grid. To deliver this we need regulatory and planning policy stability, frameworks which support investment, and public trust and understanding. With stakeholders we are developing a narrative to raise awareness of the need for, and benefits of energy infrastructure, and continuing our work to inspire the engineers of tomorrow.

Shell is a global group of energy and petrochemical companies employing 92,000 people in over 70 countries. One of the biggest challenges we face is how to deliver enough affordable and sustainable energy to meet demand while reducing carbon emissions. We're working hard to meet this challenge but the scale is unprecedented and requires a new level of collaboration between companies, Government and civil society. Inspiring a new generation of science and engineering talent will be equally important in transforming our energy system into one that is cleaner and more sustainable.

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_2015_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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