Engineering UK 2020
Educational pathways into engineering
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Foreword

A central part of EngineeringUK’s work is to provide educators, policy-makers, industrialists and others with the most up-to-date analyses and insight. Since 2005, our EngineeringUK State of Engineering report has portrayed the breadth of the sector, how it is changing and who is working within it, as well as quantifying students on educational pathways into engineering and considering whether they will meet future workforce needs. Despite numerous changes of government and educational policy, the 2008 recession and the advent of Brexit, the need for the UK to respond to the COVID-19 pandemic has provided the most uncertain and challenging context to date for our research.

Our analyses for this report started before the pandemic began. In light of the current and rapidly changing educational environment, EngineeringUK has not sought to update our findings. Instead, Educational Pathways into Engineering provides a comprehensive picture of where we were in early 2020, detailing the trends in science, technology, engineering and maths (STEM) educational participation and attainment across academic and technical pathways into engineering.

This intelligence is valuable for several reasons. First, it shows the encouraging progress made to this point. Across the UK, GCSE and A level entries in many engineering-facilitating subjects have been on the rise, as has the number of first degree undergraduate entrants to engineering and technology courses. Technical education reforms have centred on better preparing students for the world of work, especially in areas for which there are skills shortages, such as STEM.

But perhaps more importantly, this report highlights the barriers that existed prior to the pandemic and that are now likely to make it more challenging to increase the number and diversity of young people choosing engineering. Over the coming months, we will need to work together to quickly understand how the following issues are evolving and what can be done to mitigate them:

- There is underrepresentation of certain groups progressing into engineering, particularly female students and those from socioeconomically disadvantaged backgrounds. There are also unequal outcomes for those from minority ethnic backgrounds that cannot be explained by typical factors.
- School closures during the pandemic are likely to accentuate social disadvantages and introduce new ones. The use of predicted grades risks embedding societal biases in student outcomes. Our focus must be on understanding what causes underrepresentation and tackling it at every educational stage.
- Engineering has little curriculum presence and there is limited awareness and understanding of it among young people and their influencers. We must improve knowledge of engineering.
- We have an acute shortage of STEM teachers and they are likely to experience new pressures and challenges in the year ahead. We need to support teachers and schools to deliver high quality STEM education and careers guidance.

We urge those in education, government and industry to work together to foster the critical engineering and technology skills needed for the UK to be a leader in innovation and improve societal and economic resilience and environmental sustainability. We hope our findings serve to inform these endeavours and thank all the organisations and individuals who contributed invaluable insight – via critical review, case studies and thought pieces – to this report.

EngineeringUK aims to grow the collective impact of work across the sector to help young people understand what engineering is, how to get into it, and be motivated and able to access the educational and training opportunities to pursue a career in the profession.

Engineering is a varied, stimulating and valuable career and we need to work harder than ever to ensure that it is accessible for the current generation of young people – both for their own life chances and so that we have a diverse and insightful workforce that enables the UK to thrive.
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Executive Summary

STEM education has the potential to address the UK engineering sector’s long-standing skills shortage. The extent to which this potential is harnessed – and the next generation of engineers cultivated – depends on the educational opportunities presented to young people and the choices they then make.

In recent years, there has been a strong policy emphasis on using education as a means to better prepare students for the world of work, especially in areas for which there are skills shortages, such as STEM. This report details the trends in STEM educational participation and attainment across both academic and technical pathways into engineering. It also highlights the progress that has been made and the future opportunities and challenges for the engineering community.

Factors influencing young people

The UK education system is complex, offering a range of qualifications and subjects at each stage of a young person’s educational journey. Each stage represents a branching point at which young people are presented with a series of choices. These choices are, in turn, shaped by many factors, including their understanding of the options available, the opportunities presented to them and their own capabilities and personal motivations. Evidence suggests that the underrepresentation of certain groups in engineering, such as women, is in part driven by differences in these factors. However, there is much more work to be done to understand how these can be effectively addressed.

Prior and anticipated future attainment clearly factors into young people’s educational decision-making processes. However, pass rates for STEM subjects and non-STEM subjects at GCSE and A level are broadly similar, suggesting that young people are not opting out of STEM qualifications due to disproportionate levels of underachievement during the compulsory educational stages. A young person’s perception and knowledge of engineering is also likely to be a factor in their decision to pursue a career in the profession. Unfortunately, there is a widespread lack of awareness about engineering. Almost half (47%) of 11 to 19 year olds said they knew little or almost nothing about what engineers do. Parents who are themselves engaged in STEM make STEM familiar for their children, supporting young people during formative times and guiding them, consciously or otherwise, so that their self-identity is not at odds with their perceptions of a STEM identity. Our research suggests that there are strong socioeconomic and gender dimensions to this.

Teachers’ expectations also have a role to play in the opportunities available to young people, as well as their beliefs about their own capabilities and how well they think they can perform in STEM subjects. However, misallocation in setting and streaming practices is not uncommon, especially in STEM subjects, and this is patterned by socioeconomic background, gender and ethnicity. A study of Year 7 pupils across England, for example, showed that even after differences in socioeconomic background had been taken into account, girls were 1.6 times more likely to be wrongly allocated to a lower maths set than boys. Similarly, black pupils were 2.5 times more likely to be misallocated to a lower set in maths than white pupils.

The accuracy of predicted grades can pose barriers for young people progressing in STEM, particularly those from socioeconomically disadvantaged backgrounds whose grades are more likely to be under-predicted than their peers. A report by Cambridge Assessment showed that, of all OCR GCSE grades reported by teachers in 2014, just 45% of science and maths and 42% of ICT/technology grades were accurately predicted.

It is also apparent that key influencers such as parents and teachers need to be supported so that they, in turn, can support young people. Fewer than half of STEM secondary school teachers and under one third of parents express confidence in giving engineering careers advice, with both groups reporting low levels of knowledge about engineering. In addition, teachers across the country are faced with mounting workloads and time pressures resulting from understaffing and cuts to school funding. More generally, schools as institutions can provide both opportunities and constraints by broadening or restricting subject options available to students, or by guiding students towards certain paths. For example, not all schools offer their students the opportunity to take three separate science GCSEs, putting them instead on a combined course equivalent to two GCSEs.

Research suggests that careers education provision in schools has often been patchy and patterned in ways that are likely to exacerbate social inequalities. Recent evidence suggests that efforts to address this issue have been met with success, with schools serving disadvantaged communities making demonstrable progress against Gatsby benchmarks over the last year. But there is still a long way to go to ensure that young people from disadvantaged backgrounds are receiving the careers advice they need.

Secondary schooling

How well young people do in STEM in secondary schools and colleges is often a key determinant of whether they will continue on to further and higher STEM education, training and employment. The recent increase in GCSE and A level entries observed in some STEM subjects is therefore encouraging. However, a lack of presence of engineering in the curriculum, the persistent underrepresentation of girls in STEM, a decline in exam entries for some subjects that facilitate engineering and the acute shortage of STEM teachers remain key concerns.

Policy developments

Significant reforms to England’s secondary education qualifications to raise educational standards reached their final stage in 2019. The changes to STEM qualifications include more rigorous course content, the removal of almost all teacher assessment from grades, a move from modular assessments to final examinations and a new GCSE grading system.

While these reforms aimed to raise educational standards and better prepare students for further study and employment, some research suggests that these have not had their intended effect. For example, according to a study by the National Education Union, 73% of teachers believe that students’ mental health has worsened since the introduction of reformed GCSEs and 61% believe that student engagement in education has declined as a result of the reforms. There is also some evidence that the reforms have led to greater educational inequality. Research by the Sutton Trust suggests that before the reforms, non-disadvantaged pupils were 1.4 times more likely to achieve a GCSE grade 4 or above than disadvantaged pupils. However, since the reforms, the former are 1.6 times more likely to achieve a grade 5 than the latter.

Concerns within the teaching community have been raised that the new A levels are not adequately preparing students for the type of assessments they will face at university, despite being more rigorous in terms of content and better at promoting independent learning. For example, STEM A level assessments are based entirely on examinations at the end of the course. Conversely, most engineering-related degrees involve frequent project work, group work and modular tests and examinations that together constitute a student’s final degree classification.

STEM GCSE entries and attainment

Participation in the English Baccalaureate (Ebacc) – a set of subjects considered to open doors to further study and employment – continues to be a headline school performance measure. The government target is for 75% of students to take the Ebacc by 2022. This has benefitted STEM Ebacc subjects, including maths, sciences and computing, which have seen an increase in entries since the measure was implemented in 2010. However, it may be contributing to the long-term decline of non-Ebac STEM subjects, which provide essential skills for the engineering workforce.

Across the UK, the number of entries for GCSEs in maths, sciences and computing have been rising. At the same time, entries for design and technology and engineering have been falling. Entries for maths and double science rose by 4% and 5% respectively in 2019, whereas entries for engineering and design and technology fell by 31% and 22% respectively.

There continues to be a notable lack of girls taking elective STEM subjects, such as design and technology, computing and engineering. The GCSE STEM subject with the lowest participation among girls is engineering, where only 1 in 10 entries are by girls. Despite this, girls continue to outperform boys in almost all GCSE STEM subjects, with the widest performance gaps in engineering, design and technology and computing.

Young people often doubt their ability to succeed in STEM. 62% of 16 to 17 year olds in the UK felt that subjects like science and maths were more difficult than non-STEM subjects.
STEM A level entries and attainment

In the academic year 2018 to 2019, STEM subjects made up 4 of the top 10 most popular A level subjects across England, Wales and Northern Ireland. Maths remained in the top spot, with 12% of total A level entries. There were increases in entries of 8% to 9% for biology, chemistry and computing, with a more modest increase for physics (up 3%). Entries went down for maths and further maths (down 6% and 16%, respectively) and design and technology (down 5%).

Boys are still far more likely than girls to study the STEM A level subjects that are typical prerequisites for engineering degrees, including physics (77%) male, maths (61%) male and further maths (71%) male. Encouragingly, in 2019 there was an 11% increase in girls taking chemistry and an increase of 5% in physics.

The A to C pass rate for a level maths has dropped by 5 percentage points, which may be due to the introduction of the new, harder maths curriculum. Girls were more likely than boys to pass biology, design and technology, maths and physics, whereas boys performed better than girls in chemistry and computer science.

STEM Scottish National and Higher qualifications

Unlike in the rest of the UK, engineering has a direct presence on the secondary school curriculum in Scotland, with engineering science offered at National 5, Higher and Advanced Higher levels. Scotland also provides a wider range of STEM subjects, with applied subjects such as electronics and woodworking on offer alongside traditional STEM subjects.

National 5 entries were broadly stable for maths, physics and chemistry in 2018 to 2019. However, there were worrying decreases in entries in some engineering facilitating STEM subjects, including engineering science (down 9%), design and manufacture (down 3%) and computer science (down 2%).

Maths and chemistry were the most popular STEM subjects at both Higher and Advanced Higher levels. A to C pass rates fell in all STEM subjects at Higher level, except for administration and IT. However, some Advanced Higher subjects, such as engineering science and design and manufacture, saw large increases in pass rates.

STEM teacher shortages

The UK secondary education sector has had a longstanding teacher shortage and recruitment and retention issues are particularly acute in STEM subjects. The STEM subjects with the highest teacher vacancy rates in 2018 were information technology and science, both with 1.6 vacancies for every 100 filled roles. These were followed by mathematics and design and technology, which each have 1.2 vacancies for every 100 filled roles.

Consequently, many STEM teachers are not specialists in the subjects they teach. For instance, only 63% of physics teachers and 78% of maths teachers have relevant post-A level qualifications. This can have a bearing on the quality of teaching young people receive. Analysis by the Department for Education found a positive association between specialist teaching in maths and student attainment in the subject at the end of key stage 4 in England.

There is a clear socioeconomic gradient across England when it comes to being taught by STEM subject specialist teachers. Research by the Education Policy Institute found that outside London, 51% of maths teaching hours were taught by subject specialists in the least deprived areas, compared with only 37% in the most deprived areas. For physics, the socioeconomic gradient outside London is even more extreme, with a 35 percentage points gap between the least and most deprived areas in terms of teaching hours taught by subject specialists (52% compared with 17% respectively).

Technical education

The technical education landscape is in the midst of significant change, with a boost in further education funding and the introduction of new apprenticeship standards, an apprenticeship levy on large employers and new T level qualifications. Such reforms offer a key opportunity for the engineering community to shape a new technical education system that can address the sector’s skills shortages. Critical to this will be ensuring that the system adequately takes into account the often unique and specific requirements of engineering. It also needs to address longstanding issues, such as the lack of diversity among apprentices and STEM teacher shortages.

Policy developments

The role technical education can play in addressing the skills needs of the UK, particularly its STEM skills needs, featured heavily within the government’s 2017 industrial strategy and has been the focus of considerable educational reform in recent years.

The apprenticeship system in particular has changed significantly, moving from a system of ‘frameworks’ to employer-led ‘standards’. By 2019, some 227 apprenticeship standards were approved for delivery in engineering-related areas.

Starting in 2017, employers with an annual salary bill of over £3 million were taxed at 0.5% of their total salary bill to fund new apprenticeships as an apprenticeship levy. Evidence as to whether the levy has been effective in promoting apprenticeships has been mixed. Since it was introduced, employers have only drawn upon 9% of the available funds, with many criticising the rigidity of the funds and calling for a more flexible ‘training levy’. However, estimates by the Learning and Work Institute suggest that even in its current form, there is a risk that the apprenticeship levy will be insufficient and that employers will spend more on apprenticeships than is available to them from their levy funds. This is due to the increase in the number of higher level apprenticeship starts and apprenticeship standards, which cost more than lower level apprenticeship and apprenticeship frameworks.

2019 saw the opening of 12 Institutes of Technology that specialise in higher level technical STEM education. There was also a £400 million funding boost for 16 to 19 education, including the classification of further education (FE) courses such as engineering and construction as ‘high value’, with financial incentives for providers offering these subjects.

Perhaps one of the most significant changes in technical education is still to come in the form of T levels, which are due to be rolled out in 2020. These are 2 year courses developed in collaboration with industry and intended to have parity of esteem with A levels. Although surveys suggest this development is broadly welcomed by employers and providers alike, some have noted there may be sector-specific challenges to delivering T levels. For example, engineering is highly technical and safety and/or legal requirements may make it difficult for employers to take in students on a short-term basis to complete the required industry placements.

With the introduction of T levels, it is expected that demand for FE teachers will increase. This may prove to be difficult in a sector such as engineering, where there is a natural tension between teaching and addressing the wider skills shortages in industry.

FE colleges already report that they struggle to attract sufficiently qualified engineering teachers, with 74% of college principals ranking it as the most difficult subject to recruit for.

Engineering-related apprenticeship starts

In England, apprenticeship starts in the academic year 2018 to 2019 increased compared with the year before (by 5%). However, overall they have decreased by 21% since 2014 to 2015, with the largest drop seen immediately after the introduction of the levy.

Engineering-related apprenticeships have followed a similar pattern. There was a small year-on-year increase (4%) in the academic year 2018 to 2019, but there has still been an overall decrease of 4% since 2014 to 2015. The smaller drop for engineering-related areas means that their share of apprenticeship starts has risen to 26% from 22% in 2014 to 2015.

However, it is apparent that trends in participation vary by level. Across all engineering-related areas, higher level apprenticeship starts increased by 52% in 2018 to 2019 compared with the previous year. In contrast, the number of intermediate level apprenticeship starts has fallen. This is in line with trends across all apprenticeship sector subject areas and is a consequence of the shift towards higher quality apprenticeships by government, which believes such apprenticeships will increase productivity in the UK.

Women and people from minority ethnic backgrounds remain severely underrepresented in engineering-related apprenticeships. In 2018 to 2019, women made up low proportions of starts in construction (6%) and engineering and manufacturing. In ICT, on the other hand, they were overrepresented, with 19% of starts.

In Scotland and Wales, engineering-related apprenticeships represented 34% and 20% of all starts in 2018 to 2019, respectively. Women comprised just 4% of those on engineering-related apprenticeships in Scotland, a figure that
Higher education

The future of the HE landscape remains uncertain, with the UK having left the European Union in January 2020 without a clear implementation plan for the university sector. There are widespread concerns that the decision to leave the EU will make the UK’s HE sector less attractive to international staff and students and that it will be harder to access EU research funding and collaborations. HE engineering – which relies heavily on international students – will need to work hard to ensure that the UK remains a destination of choice for students and staff alike. Moreover, women and those from disadvantaged backgrounds are underrepresented and there are large degree attainment gaps by ethnicity. Engineering must therefore also address issues of access and equality in HE.

Policy developments

By far the most significant legislative change to impact the UK HE sector in recent years came about in 2017, with the implementation of the Higher Education and Research Act (HERA). Among other things, two new bodies were established under the Act – the Office for Students to regulate the English HE sector and UK Research and Innovation to oversee research and funding.

However, it is anticipated that the UK’s departure from the European Union will have significant impact on the HE sector. This may be a considerable issue for subjects such as engineering and technology where a significant proportion of students, particularly at postgraduate level, are international (41% of entrants across all levels are international, compared with 70% of postgraduate taught entrants and 59% of postgraduate research entrants). In fact, in the year 2018 to 2019, the subject was one of the most popular STEM subjects studied by EU students, second only to biological sciences.

The impact of Brexit cannot be fully understood until the final arrangements have been decided. Nevertheless, there is evidence to suggest the UK’s decision to leave the EU has already had an adverse effect on the university sector in terms of the degree to which the UK is seen as a desirable place to study by prospective international students.

Engineering and technology entrants

Trends in engineering and technology HE participation varied widely by level of study. Over the past 10 years, engineering and technology entries have increased at first degree undergraduate and postgraduate research levels, but declined at other undergraduate and postgraduate taught levels.

Although engineering and technology entries at first degree undergraduate level have increased by 6% since 2009 to 2010, this figure was lower than the overall increase in first degree entries across HE.

Over the past 10 years, the number of other undergraduate entrants in both engineering and technology and across HE overall has fallen dramatically. There was a particularly large drop (31%) across all HE between 2011 to 2012 and 2012 to 2013, when tuition fees were increased.

Since 2009 to 2010, there has been a 5% decrease in engineering and technology at postgraduate taught level. This is particularly concerning given that overall HE postgraduate taught entries rose by 10% over the same period.

At postgraduate research level, there has been a 10% rise in the number of entries to engineering and technology since 2009 to 2010. This is in line with the overall trend observed in postgraduate research numbers across HE.

Diversity

In the 9 years leading up to the academic year 2018 to 2019, the proportion of engineering and technology entrants who were female has increased by 5 percentage points. But gender disparities remain stark. Just one in 5 (21%) of all engineering and technology entrants were women in 2018 to 2019, whereas they accounted for more than half (57%) of the student population overall. If trends continue at the same rate, gender equality will not be attained on these courses for another 3 decades.

Engineering and technology fares better in terms of ethnic diversity. In 2018 to 2019, 30% of entrants were from minority ethnic backgrounds, which is higher than among the overall student population (26%). However, gaps in degree attainment are an issue. Among minority ethnic engineering and technology qualifiers, 73% achieved a first or upper second degree in that academic year, compared with 83% of White qualifiers. These ethnicity attainment gaps were also observed across HE more widely, suggesting there is a systemic issue within the UK HE system that needs to be addressed.

In 2018 to 2019, only 11% of engineering and technology entrants were from low participation neighbourhoods. This is lower than across all of HE generally (13%). Moreover, these figures have remained relatively static over the past 5 years.

Compared with the overall HE population, engineering and technology also had a low proportion of disabled entrants in 2018 to 2019. Only 8% were disabled compared with 12% of the wider student cohort. Such underrepresentation highlights the need for reasonable adjustments to be made to remove barriers to study.

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1 - Harnessing the talent pool

Key points

STEM education has great potential for addressing the skills crisis in the engineering sector. Unfortunately, however, young people still tend to opt out of STEM educational pathways, hindering opportunities to harness the engineering talent pool via education.

In addition, particular groups continue to be underrepresented in STEM, notably women, certain minority ethnic groups and those from lower socioeconomic backgrounds. Understanding and addressing the factors that are driving this will enable the engineering sector to both increase the overall numbers of young people progressing through STEM educational pathways and ensure they reflect a range of backgrounds and experiences, bringing a diversity of thought to the sector.

Factors influencing STEM educational choices

Young people’s educational choices are shaped by many factors, including their own capabilities, the opportunities presented to them and their personal motivations. The engineering community must address all of these components in order to change the decisions many young people make in relation to STEM.

There is a widespread lack of awareness about engineering. Almost half (46.7%) of 11 to 19 year olds say they know little or almost nothing about what engineers do. Worse, this limited knowledge is often distorted; not only is engineering seen as difficult, complicated and dirty, it is also considered a man’s profession. These inaccurate understandings can be particularly discouraging for girls and some minority ethnic groups.

Many young people think STEM is only suitable for those who are exceptionally clever, which can be a deterrer for those who are not confident in their academic capabilities. Among young people aged 16 to 17 in the UK, 62.2% feel that subjects like science or maths are more difficult than others.

Girls are more likely than boys to perceive themselves as lacking ability when it comes to STEM. In 2019, only 23.5% of 11 to 19 year olds had heard about engineering careers from careers advisors. Furthermore, young people who are high achieving but socioeconomically disadvantaged more often receive under-predicted grades at a level than their more advantaged peers. Knowledge of how to pursue an engineering career

Worryingly, relatively few young people know what steps they need to take to pursue an engineering career – just 42% of boys and 31% of girls aged 11 to 19 say they know what to do next to become an engineer. Young people seek education and careers guidance mostly from parents and teachers. Yet less than half of STEM secondary school teachers and under one third of parents express confidence in giving engineering careers advice, with both groups also reporting low levels of knowledge about engineering. It is also concerning that in 2019, only 23.5% of 11 to 19 year olds had heard about engineering from careers advisors.

There is a socioeconomic divide in the type and level of STEM qualifications pursued. Young people from disadvantaged backgrounds are more likely to follow vocational routes rather than academic ones than their more advantaged peers. There is also a greater likelihood that young people from disadvantaged backgrounds will leave education with lower-level qualifications.

Government, industry and wider sector initiatives to plug the skills gap

The government has committed to addressing the skills shortage, as shown by the industrial and careers strategies, and the introduction of educational reforms such as T levels. Government and the engineering community have also endeavoured to boost participation in STEM inspiration activities, with campaigns such as the Year of Engineering and This is Engineering. More than one quarter of young people aged 11 to 19 took part in a STEM inspiration activity in 2018. There is recognition across the sector of the need to drive up quality and bring about greater coordination of STEM inspiration efforts, which has spurred new initiatives such as a Code of Practice. Education employers are also recognising their key role: many now run or fund their own STEM engagement programmes, offer invaluable work experience placements and free up the time of their employees to volunteer in schools.

We are on deck in attempts to harness the talent pool and promote STEM education to tomorrow’s engineers.

Addressing the STEM skills crisis is going to be a long-term endeavour. We are yet to see any sustained upward trend in the take-up of STEM qualifications.

The reasons for the low levels of participation in STEM education are complex and are not comprehensively understood. However, one aspect that is well documented is the continuing underrepresentation of particular groups, including women, young people from lower socioeconomic backgrounds and some ethnic groups. This constrains opportunities for some young people to take up careers in engineering and reap the benefits associated with these careers, including higher than average salaries.

STEM qualifications are notably ‘high return’, with engineers having median full-time earnings around £10,000 a year more than the UK workforce as a whole.1 In the interests of promoting social mobility, therefore, it is crucial that social and/or demographic characteristics do not prevent young people from taking STEM qualifications. Furthermore, there is compelling evidence that increased diversity in the workplace can improve performance through, for example, increased creativity and innovation.2 Addressing the underrepresentation of particular groups in STEM is an inextricable part of narrowing the skills gap and, more generally, improving the UK’s economic prosperity.

Issues of attainment versus issues of choice

It’s important to understand whether low participation rates in STEM subjects are due to issues relating to attainment or choice. In other words, is young people failing to attend the right grades they need to pursue further and higher qualifications in STEM subjects? Or are there other factors that are discouraging them, including those who are capable? Attainment is an important consideration, given that young people are more likely to continue to study subjects in which they receive higher grades.3 However, although young people’s grades are assumed to reflect their innate academic ability, other factors can influence how well they perform in STEM subjects. For example, teaching quality plays an important role in determining students’ performance and this can be compromised when there are shortages of specialist teachers – an issue which is particularly pertinent in STEM, as we show in Chapter 2.

Average levels of attainment differ between STEM subjects. Pass rates in individual science subjects at GCSE, for example, tend to be very high (around 90% achieved A* to C) for 4 grades in chemistry, biology and physics in 2018 to 2019. Conversely, pass rates for engineering and maths tend to be lower (52.5% and 59.4% respectively). The pass rate in double science is also lower (55.9%), probably because young people with an affinity for or interest in science are more likely to opt for the individual sciences, which can lead to a greater depth of content. These trends are discussed in more detail in Chapter 2.

Evidence from the Joint Council for Qualifications (Figure 1.1) shows that pass rates for STEM subjects and non-STEM subjects at GCSE are similar, with an average 71.7% for STEM compared with an average 71.4% for non-STEM subjects. Results are also similar at A level (72.1% average for STEM and 77.4% for non-STEM). When only maths and physics are considered, average pass rates tend to be higher for STEM than for GCSE as a whole. This suggests that young people are not opting out of STEM qualifications due to disproportionate levels of underachievement during the compulsory educational stages.

1.3 House of Commons, Committee of Public Accounts. ‘Delivering STEM qualifications for the economy’, 2018.
Differences in attainment may, however, be one reason why some groups are underrepresented in STEM education. For example, lower average GCSE grades among lower socio-economic disadvantaged pupils could mean that they don’t meet the requirements to continue studying a subject and are ineligible for courses in STEM at the post-compulsory education stages.14 But this doesn’t account for the paradox in gender. As we show in Chapter 2, girls outperform boys in most GCSE STEM subjects, yet relatively few go on to study STEM.

Our Future data also apply calibration weights. Analyses of Next Steps data apply a major longitudinal study that has followed the lives of a sample of over 5,000 young people in England and Wales (LSYPE1) and 5,000 in Scotland (LSYPE2), beginning when the study began, through their final years of compulsory education and beyond. Our Future collects information annually, focused on individuals’ careers choices and the reasons for these choices. Analyses of Our Future data also apply calibration weights.

1.2 – STEM educational pathways: an overview

To assess what we, the engineering community, can do to increase rates of participation in STEM education, we must first improve our understanding of how qualification and subject choices are formed. Then we can identify when and how best to intervene.

The UK education system

Figure 1.2 presents an overview of the UK education system. Throughout England, Wales and Northern Ireland, children begin their primary education around age 4 with one year of reception or, in the case of Northern Ireland, a foundation stage (covering years 1 to 2). Students then progress through key stage 1 (approximately ages 5 to 7) and key stage 2 (ages 7 to 11), finishing their primary schooling around the age of 11. Following primary school, young people in all 3 countries enter secondary school and begin key stage 3 (ages 11 to 14).

Key stage 3 ends in year 9 (or year 10 in Northern Ireland), when most young people in England, Wales and Northern Ireland have to choose the subjects they would like to study at GCSE. Some subjects are compulsory (maths, English and science) and others are elective. Key stage 4 (ages 14 to 16) covers years 10 and 11 (equivalent to years 11 and 12 in Northern Ireland), culminating in GCSE examinations which mark the end of lower secondary education. The threshold for continuation in post-16 academic institutions is often 5 A* to C (or 9 to 4) grade GCSEs. GCSEs graded D to U (or 5 to 1) result in level 1 qualifications, whereas GCSEs graded A* to C (or 9 to 4) result in level 2 qualifications.

Since 2015, young people in England and Wales have been required to stay on in full-time education or training, including the option of starting an apprenticeship, until age 18. This period of education from age 16 to 18 in England and Wales is key stage 5, also known as the upper secondary educational level. During this period, young people can take academic AS level and A level qualifications, usually in a school sixth form or a sixth form college, or vocational qualifications that historically have varied widely in terms of subject combinations, course materials, and levels and types of qualification. Vocational qualifications are usually taken in sixth form or further education (FE) colleges. In an attempt to raise the profile of level 3 vocational qualifications and to make the further education sector more streamlined, new technical qualifications – T levels – are being introduced in England from September 2020 (see Chapter 3 for more information). Like their academic counterparts, T levels will be 2-year courses.

In Scotland, the education system is slightly different. The primary school years are P1 (equivalent to England’s reception year) to P7. Secondary education years are S1 to S6, which usually finish with young people taking National 5 qualifications (broadly equivalent to GCSE).15 At this stage in Scotland, English and maths are compulsory, as is at least one science and a ‘social’ subject – other subjects are either elective or made compulsory by individual schools. The principal difference is that, in contrast to England and Wales and consistent with Northern Ireland, after the age of 16, young people in Scotland can choose to continue in full-time education, to do an apprenticeship or take part in workplace-based training, or to leave education altogether and get a job. Age 16 therefore presents a crucial branching point for students in Scotland and Northern Ireland, when they are faced with their first key educational decision. In Scotland, at age 16 young people can choose an academic route, studying Higher, which are equivalent to AS levels, and Advanced Higher, which are equivalent (though slightly more challenging) than A levels, or they can choose a vocational route. Those wanting to go on to university tend to opt for the academic route, which is similar in England and Wales. Apprenticeship options at age 16 are usually offered at intermediate level (equivalent to a level 2 qualification, which is 5 passes at GCSE) or advanced level (equivalent to a level 3 qualification or 2 A level passes).

The next important decision point most young people across the UK are faced with is therefore at age 18, when it is possible, given the required grades, to:
- continue on in academic education, usually by taking a first degree (or undergraduate degree) at a higher education (HE) institution
- pursue other HE qualifications, such as diplomas, certificates, teaching or nursing qualifications, or foundation degrees
- pursue a higher-level apprenticeship or degree apprenticeship
- leave education and enter the workforce

They may also choose a combination of these options, including taking a ‘gap year’ before returning to education. Having attained HE qualifications, it is then possible to pursue postgraduate qualifications, including Masters and Doctoral degrees or postgraduate teaching qualifications. This path option is increasingly common due to the continuing expansion of the education sector and a trend of ‘credential inflation’16 in the UK.

Across the UK, young people face key educational junctures at the ages of 16 and 18. The qualification and subject choices they make can have long-lasting implications for their career opportunities later on in life.

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1. The national curriculum is split into 5 key stages in England, Wales and Northern Ireland. These represent the level of knowledge expected of children and young people at each age in the education system. Schools are required to follow the national curriculum, but academic institutions such as FE colleges are free to follow alternative curricula. This increase in the number of people with similar qualifications results in a lower return in the labour market, leading more people to pursue higher qualifications to secure a competitive advantage.

2. Some students in Scotland will instead sit National 4 qualifications, which are less academically demanding.

3. Crucial inflation occurs when increasing numbers of people gain qualifications (for example with educational expansion). This increase in the number of people with similar qualifications results in a lower return in the labour market, leading more people to pursue higher qualifications to secure a competitive advantage.
This overview shows when learners first encounter different stages in the education system. As such, some detail has necessarily been omitted, and some elements are simplified for ease of interpretation and comparability. For example, the age at which qualifications are taken can vary due to: examinations being taken early; exam retakes in the event of initial failure; returners to education; or region differences.

In some parts of the UK, students progress through 3 stages of schooling: primary school, middle school and high school. Variations of this kind have been omitted for the sake of simplicity. The lists of qualifications underneath each heading are intended to serve as examples and are not exhaustive. Level 2 qualifications for England, Northern Ireland and Wales have been divided into 2 boxes as apprenticeships are only available to learners aged 16 or older. * Indicates apprenticeships not yet developed.

This overview shows when learners first encounter different stages in the education system. As such, some detail has necessarily been omitted, and some elements are simplified for ease of interpretation and comparability. For example, the age at which qualifications are taken can vary due to examinations being taken early, exam retakes in the event of initial failure, returners to education, or region differences.
Engineer-facilitating pathways

At each of the educational stages depicted in Figure 1.2, young people will have to choose both the subjects they want to study and the type of qualifications they want to take. But defining the parameters of what constitutes an ‘engineering facilitating educational pathway’ is difficult, not least because there is no universally accepted definition of STEM.9,10

The ‘pipeline’ analogy is often referenced in relation to STEM careers because young people will typically need to choose particular elective subjects relatively early on, serving as prerequisites to further, and then higher, STEM qualifications. STEM educational pathways are therefore often considered to be linear, or even structurally impossible11 to join the STEM educational route at later stages.

The options chosen at any given point in a younger person’s education can have long-term implications,12 potentially resulting in young people inadvertently restricting the opportunities available to them later on. Researchers from the Institute of Education have commented on how problematic this can be, in particular in the English educational system, where specialisation and subject selection happens relatively early on.13

Early specialisation works to the detriment of engineering in particular, as this does not have a place in the national curriculum. If young people are not aware of engineering as a current or future subject option, they are less likely to consider it as a career or be aware of the educational pathways required to pursue it. Concerns about the ‘leaky pipeline’ in STEM are, in this sense, well founded.

However, it is also true that people arrive at engineering careers via a multitude of different pathways, which don’t always involve higher level qualifications or studying subjects which are typically considered as STEM. Looking at the educational qualifications of the current engineering workforce (Figure 1.3), 33.9% have a degree as their highest level of qualification, 39.4% have level 3 qualifications or above, 15.5% have level 2 qualifications and 4.2% have no qualifications at all.

Among those in engineering occupations,14 with a degree, almost one quarter (23.4%) studied engineering as their main subject, 20.2% studied mathematical sciences and computing and 10.2% studied architecture. However, as Figure 1.4 shows, some people in engineering occupations have degrees in subjects that are not STEM-related. For example, 6.1% of engineers have a degree in arts, 5.0% in social studies and 2.2% in humanities.

**Figure 1.4** Main degree subject areas among those in engineering occupations with degree-level qualifications (2019–UK)

<table>
<thead>
<tr>
<th>Main degree subject area</th>
<th>Working in engineering occupations (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>23.4%</td>
</tr>
<tr>
<td>Mathematical sciences and computing</td>
<td>20.2%</td>
</tr>
<tr>
<td>Architecture and related studies</td>
<td>10.2%</td>
</tr>
<tr>
<td>Business and financial studies</td>
<td>9.3%</td>
</tr>
<tr>
<td>Physical/Electrical sciences</td>
<td>8.7%</td>
</tr>
<tr>
<td>Arts</td>
<td>6.1%</td>
</tr>
<tr>
<td>Social studies</td>
<td>5.0%</td>
</tr>
<tr>
<td>Biological sciences</td>
<td>4.6%</td>
</tr>
<tr>
<td>Mass communications and documentation</td>
<td>2.2%</td>
</tr>
<tr>
<td>Humanities</td>
<td>2.2%</td>
</tr>
</tbody>
</table>


Clearly, the current engineering workforce holds a wide variety of qualifications. Nevertheless, there is some consensus on which subjects contain the most relevant material and will keep young people’s options open at the more advanced stages of typical engineering educational pathways. It is widely accepted that maths and physics are important at secondary education stage, providing the essential knowledge and skills base required for most kinds of engineering jobs. However, although it is compulsory for pupils to study maths and sciences at GCSE level in England, for example, the depth of material covered can vary. For example, pupils can elect to take additional numerical based subjects, like further maths or statistics, and in some schools pupils can choose between double or triple science (the latter involving a greater depth of material).15

Students who take triple science at GCSE are more likely to remain in STEM education at later stages than those who do not.16 In addition, maths and physics are often the pre-requisite A levels or Advanced Highers that are needed to study engineering and technology at degree level.17 Both of these may be an obstacle for some groups. For instance, students from less advantaged backgrounds are less likely to be offered the opportunity to take triple science at school than their more advantaged peers.18 And the pre-requisites for engineering degree courses are oft-putting for women in particular – for example, when UCL removed the requirement for maths and physics A levels, entry to their first engineering, undergraduate degree courses, they saw a surge in enrolments among women.19

Different types of STEM qualifications and their opportunities for social mobility

Different types of STEM qualifications lead to different engineering occupations, which vary in terms of salary, job security and longer-term promotion and income prospects. This has implications for the extent to which STEM education, and the engineering sector more generally, can provide opportunities for social mobility.

There are patterns in participation by, for example, socioeconomic background. Young people from disadvantaged backgrounds are more likely to pursue vocational, rather than academic, qualifications compared with their more advantaged peers20 and are more likely to leave education with lower-level qualifications. Both of these can put them on the back foot when entering the labour market. Historically, lower-level and vocational qualifications have been low return relative to their higher-level and academic counterparts, with academic qualifications above level 3 shown to lead to higher pay than their vocational equivalents.21 Young people from disadvantaged backgrounds are also far less likely than their better off peers to start high quality apprenticeships.22

In engineering, we particularly need to fill vacancies in level 3+ occupations. Given that, those from disadvantaged backgrounds are underrepresented in higher-level apprenticeships20 and academic STEM pathways, this may result in the engineering workforce which is stratified by socioeconomic status. This may, however, change with the introduction of new qualifications such as T levels that are intended to be parity of esteem with academic equivalents.

The aim must not simply be to funnel more young people into engineering careers via a STEM education, but also to ensure that young people from all backgrounds have the opportunity to pursue higher-level STEM qualifications. We also need to ensure they are encouraged and inspired to do so, for the benefit of each individual, the sector and the wider UK economy.

**Figure 1.5** The COM-B model of behavioural change

An underrepresentation of those from disadvantaged backgrounds in higher-level apprenticeships and academic STEM pathways may result in an engineering workforce that is stratified by socioeconomic status.

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Studies have shown that young people imagine a typical peer who favours science over other subjects as being someone ‘less attractive, less popular, and less socially competent’. Recent results from the EBM showed that nearly a third of young people see engineering as ‘too complicated’, ‘difficult’, ‘boring’ or ‘dull’, and one fifth view it as ‘too technical’ or ‘dirty’, ‘greasy’ or ‘messy’. 

Limited knowledge, misconceptions and narrow stereotypes

A widespread lack of awareness about engineering, including a limited knowledge of what careers in engineering entail, is a key problem for the sector. Among young people aged 11 to 19 surveyed as part of EngineeringUK’s 2019 ‘Engineering Brand Monitor’ (EBM), almost half (46.7%) reported that they know little or almost nothing about what people working in engineering do. As Figure 1.6 shows, their awareness doesn’t appear to improve as they get older.

Perceptions of engineering

Misinformation is not the only demotivating factor. Negative perceptions of STEM subjects and of engineering careers can also be damaging. Evidence from EngineeringUK’s 2019 EBM suggests that only half of 11 to 19 year olds in the UK hold positive views of engineering. This is significantly lower than for other areas of STEM. 63% hold positive perceptions of technology, 63% hold positive perceptions of science and 56% hold positive perceptions of maths. This finding is driven in large part by particularly poor perceptions of engineering among girls, an issue that can be observed from a relatively early age. Among girls aged 7 to 11, just 41% hold positive perceptions of engineering compared with 59% of boys. This pattern persists among older age groups, with an 18 to 20 percentage point gender gap among young people aged 16 to 19.

There is a pressing need for the engineering community to combat negative perceptions of the profession. Encouragingly, ‘much work is being done in this area. Comments by some respondents to EngineeringUK’s EBM reinforce this assertion, with one girl aged 16 to 19 stating: “[engineering is] not a glamorous job. Wouldn’t enjoy it’.

Misconceptions (right hand column) value on a scale ranging from ‘-10 – very negative’ to ‘10 – very positive’, with 0 representing a ‘neutral’ response.

There is a widespread belief that STEM is only for the brainy. This can be a deterrent for those who are not confident about their academic capabilities. In a nationally representative sample of young people aged 16 to 17 in England, 62.2% felt that ‘subjects like science or maths are more difficult than others’.

Self-efficacy and (mis)alignment between self-identity and STEM identity

There is a widespread belief that STEM is only for the brainy. This can be a deterrent for those who are not confident about their academic capabilities. In a nationally representative sample of young people aged 16 to 17 in England, 62.2% felt that ‘subjects like science or maths are more difficult than others’. 

Such a framework can serve as a useful reminder that if we are to increase the engineering talent pool, it is not enough to increase just one set of factors, such as devoting our attention wholly to inspiration building. We must recognise that changes in behaviour are dependent on young people being motivated to pursue engineering as a profession and also them possessing the capabilities and being given the opportunities to realise any such ambitions.

There is evidence that young people who are more confident in their own abilities are more likely to pursue STEM education. Among young people aged 11 to 19 who said that they get good marks for their work, 53% planned to take triple science at GCSE compared with just 36.1% of those who didn't agree that they get good marks for their work.1,4

In the 2019 EBM, 40% of the reasons given by young people aged 11 to 19 who said they didn't think they could become an engineer if they wanted to related to a self-perceived lack of ability or knowledge.2 Some responses were very self-deprecating, including "I don't study topics related to it and am too stupid" (boy aged 16 to 19), "I have a simple mind" (girl aged 11 to 14) and "I am not brany enough" (boy aged 11 to 14).

Swathes of research show that girls in particular perceive their capability in STEM as unrealistically low – that is, they have low self-belief in their ability to do well in STEM.1,2,17 In the 2019 EBM, when asked whether they thought they could become an engineer if they wanted to, just 55.2% of girls aged 11 to 14 said yes compared with 71.4% of boys (see Figure 1.9). This was even lower among those aged 16 to 19, at 53.4% for girls. Such findings are striking, given that girls outperform boys in most STEM subjects at GCSE and A level.

**Case study – An advocate for women in engineering**

Natalie Cheung, STEM Ambassador Coordinator, **STEM Learning**

At 17, I was the only girl in my maths, computing and physics A level classes, and it was clear to me that my male classmates were much more confident in their abilities than my female classmates. But I didn’t let this put me off! I went on to do a degree in civil engineering and started volunteering as a STEM Ambassador to set an example and to encourage others, particularly girls, to consider doing the same.

Having seen first-hand the hugely positive effect that role models can have in inspiring young people to consider STEM careers, I decided to move into my current role as STEM Ambassador Coordinator at STEM Learning. I help deliver the programme across London, which involves recruiting, training and supporting diverse STEM role models to volunteer in schools, museums, youth groups, science festivals, and so on.

I also work to promote diversity in STEM by sitting on the Women’s Engineering Society Council and the Institution of Civil Engineers Inspiration Panel and being part of the Women’s Engineering Society London Team, which organised their first work shadowing week in 2019. I was on the Tomorrow’s Engineers Week Big Assembly Panel and I’ve given a TED-Ed talk to share my experience as a proud female engineer!

While the root causes are undoubtedly complex, it’s clear that girls’ lower belief in their abilities in STEM is driven in part by a misalignment between their self-identities and what they perceive STEM identities to be. Responses from girls aged 11 to 19 in the 2019 EBM who said that they didn’t see a career in engineering as desirable included "I can’t see myself as an engineer" (girl aged 14 to 16), "It isn’t my type of career" (girl aged 11 to 14) and ‘I’m not technical. I’m a diva’ (girl aged 11 to 14).

Given the widespread misconceptions of engineers and engineering careers, young people who think STEM education careers don’t fit with their self-image or are “not for people like me” may be mistaken. Women are disproportionately affected by this mismatch between self-identity and STEM identity,1,2 as are some minority ethnic groups, including black students in particular.1,2

It is important that young people are made to feel as if they are capable of achieving whatever they set their mind. To them, you need to be encouraged to make ambitious choices that might encourage positive behaviours and choices related to STEM.

The trade-off between ‘high-risk’ and ‘high-return’ in STEM subjects are ‘high return’, with associated careers tending to offer higher salaries than other occupations. Many people tend to view STEM subjects as difficult as STEM subjects. A large body of evidence has shown that teachers’ expectations can affect the way they think of and behave towards their students. This introduces a bias – which may be positive or negative – that students internalise and in turn affect their performance.1,4

Such issues can take root before young people are faced with any educational choices. In the UK, many students experience setting and streaming at school (essentially, ability grouping).1,2 This tends to happen relatively early on in pupils’ educational careers, where differences in levels of ability being judged prematurely and in some cases according to teachers’ assessments, which may be relatively subjective. This can thwart young people’s opportunities to achieve the best possible grades.1,4

Misallocation in setting and streaming practices is not uncommon.1,2 This is of particular concern in STEM subjects, where ability grouping is most often used.1,2 The EBM figures from 2013 suggested that 95% of students in England were taught in ability groups in maths.1,2 What’s more, studies have shown that misallocation can be a particular problem for those from lower socioeconomic backgrounds,1,2 and is also patterned by gender and ethnicity. A study of Year 7 pupils across England, for example, showed that even after differences in socioeconomic background had been taken into account, girls were 1.55 times more likely to be wrongly allocated to a lower maths set than boys. Similarly, black pupils were 2.54 times more likely to be misallocated to a lower set in maths than white pupils.1,2

Female students from advantaged backgrounds may be choosing ‘riskier’ educational options, including STEM subjects, knowing that consequences in the event of failure are unlikely to be dire.

**References**


8. UCL, IOE. ‘IOE research raises concerns about setting’ [online], accessed 20/03/2020.

9. UCL, IOE. ‘IOE research raises concerns about setting’ [online], accessed 20/03/2020.
Knowledge of relevant educational pathways

Another factor that can prevent young people pursuing engineering careers is a lack of knowledge about relevant STEM educational pathways. In the 2019 EBM, just 39% of young people aged 14 to 16 said they ‘know what they need to do next in order to become an engineer’. This is a pivotal time in young people’s educational journeys as they are taking their GCSEs and are soon to make their post-16 choices, so this lack of knowledge about engineering educational pathways is particularly worrying. Among young people aged 16 to 19 who are approaching the next crucial juncture, only 36% said they knew what to do next to become an engineer.

There are clear gender differences in young people’s knowledge of engineering educational pathways. Some 42% of boys aged 11 to 16 said they knew what to do next to become an engineer, compared with only 31% of girls. Figure 1.10 shows that the gender gap is smaller among older age groups, but by the age of 16 to 19 it might be too late as this lack of knowledge may already have contributed to the huge drop-off of girls in STEM after GCSE.

Just 39% of 14 to 16 year olds say they ‘know what they need to do next in order to become an engineer’.

Of students aged 11 to 19 who reported that they probably or definitely wanted to become an engineer, more than a third didn’t know what to do next to become an engineer (35%). This proportion was even higher amongst those who indicated they would consider a career in engineering, at 42%. It’s important that young people are advised on relevant next steps, since this is part of providing them with the opportunity to pursue STEM, should they wish to do so. Evidence from Next Steps, a survey of young people aged 14 to 15 in England, shows that pupils get information about how GCSEs are related to later stages of education from a range of sources – most notably, parents (78.4%) and teachers (66.6%), as shown in Figure 1.11.

Case study – Ada is about solving industry problems in the classroom

Mark Smith, CEO, Ada National College for Digital Skills

Ada, National College for Digital Skills is a sixth form and higher education apprenticeship programme providing a unique digital education to learners and a sustainable pipeline of diverse digital talent to the tech sector. The digital industry is experiencing epic growth but there is a talent shortage. Over 130,000 tech jobs are available each year in the UK, but students are leaving education without sufficient knowledge and experience to access these jobs. Ada wants to change this.

At Ada, students can learn relevant digital skills to pursue their dream job in tech. We are a unique community that puts computer programming at the heart of everything we do. Our unique, industry-led education ensures that all our learners leave Ada, not only with the qualifications they need to succeed but the hands-on experience they can use to make informed choices about their careers. Ada collaborates with tech giants such as Google, Deloitte and Salesforce, helping students with their presentation skills and industry knowledge, and giving them a taste of how a tech project is managed in the real world.

At Ada, we particularly want to remove the glass ceiling for women and individuals from low-income backgrounds in the tech industry. Everyone, regardless of their background, is entitled to quality education and a better future. Also, as digital technology is proven to be the most socially mobile sector, it is crucial that otherwise overlooked groups are afforded the opportunity to enter this sector.

As the National College for Digital Skills, Ada’s focus on diversifying talent and making the pipeline of talent sustainable will ensure the country’s tech industry remains current, accessible and successful.

Access to high-quality careers advice and guidance

CAREERS EDUCATION IS CRUCIAL FOR PROVIDING THE ESSENTIAL INFORMATION young people need to make informed decisions about what they want to do when they complete education. The provision of careers education is particularly important from the point of view of sectors that face severe skills shortages. Appropriate advice and guidance is essential in encouraging young people to aspire to acquire the relevant skills to enter high-vacancy jobs and to boost the UK’s economic prosperity. The government’s careers strategy sets out a commitment to improve careers education in England. The Careers & Enterprise Company (CEC) was established in 2014 to provide schools in England with additional support in meeting the Gatsby benchmarks, which are a framework of 8 guidelines defining high standards of careers provision in secondary schools (Figure 1.12).
The fourth and fifth Gatsby benchmarks have particular relevance for STEM. The careers strategy sets out as a key action that by the end of 2020, every school should provide each young person at least 7 encounters with employers between the ages of 7 and 13, and that some of these encounters should be with STEM employers. CEC’s ‘State of the Nation’ report shows that significant progress has been made on this front: 31% of schools and colleges in England achieved the fifth Gatsby benchmark in 2017 to 2018 and just one year later, 56% had achieved it. However, there is still some way to go. In 2018 to 2019, 10% of schools and colleges were still failing to achieve the fifth Gatsby benchmark and a further 38% were only partially achieving it.1,4,11

The fourth Gatsby benchmark – linking curriculum learning to careers – notes that STEM subject teachers should “highlight the relevance of STEM for a wide range of future career paths”. In 2018/19, only 38% of schools and colleges had achieved this indicator, with a further 58% partially achieving it.1,4,11

One issue for engineering is that young people consider careers advice and parents tend to regard themselves as limited in their ability to provide this type of guidance. Among young people aged 11 to 19 surveyed in the 2019 EBM, 61% said they would consider going to their parents for careers advice and 56% said they would consider going to teachers. However, less than half of STEM secondary school teachers and under a third of parents expressed confidence in giving careers advice on engineering (45% and 32%, respectively).

Of the 11 to 19 year olds in the EBM, 59% said they would consider going to their careers advisers for careers advice in 2019, but only 23.5% had so far heard about engineering careers and 45% and 32%, respectively.

Of the 11 to 19 year olds in the EBM, 59% said they would consider going to their careers advisers for careers advice in 2019, but only 23.5% had so far heard about engineering careers and 45% and 32%, respectively.

The Gatsby benchmarks also state that “students must be trained to an appropriate level. These students have different careers guidance needs at different stages.” Opportunities for advice and support need to be tailored to the needs of each student. A school’s careers programme should embed equality and diversity considerations throughout.

The overwhelming influence of some parents in shaping career choices is shown by the tendency in some professions for children to follow the occupational footprints of their parents: children of doctors are 24 times more likely than their peers to become doctors, for example.11 Recent analysis of micro-class mobility by academics at the London School of Economics documents these trends for a number of ‘ elite occupations’86, including engineering. The rates of consecutive generations of engineers in the UK are relatively high, being second only to medical practitioners.11

Following evidence that careers education provision has often been patchy and patterned in ways that are likely to exacerbate social inequalities,1,4,11 efforts have been made to support schools in disadvantaged areas to perform in alignment with the Gatsby benchmarks. CEC’s ‘State of the Nation’ report provides encouraging findings that schools and colleges serving disadvantaged communities in England have made significant progress in this respect, which is a key objective of the careers strategy.1,4,11

### Case study – Hinkley Point C: Providing an educational pathway into engineering

Tom Thayer, HPC Inspire Education Lead, EDF

EDF’s Hinkley Point C (HPC) ‘Inspire’ education programme is preparing young Somerset people for the opportunities arising from the construction and operation of the UK’s first new nuclear power station in a generation. The programme aims to inspire young people to study both STEM and associated subjects, building a sustainable legacy for the future through a pipeline from education to skills and into future long-term employment. Inspire delivers a wide range of curriculum-aligned and Gatsby benchmark supporting free activities, engineering workshops, assemblies and events whilst supporting careers education for young people across the country.

The HPC team have visited almost 500 schools and colleges in the area, leading to over 170,000 student interactions since the programme began. An evaluation of the Inspire programme has evidenced its impact:

- More than 40% of apprentices at HPC who participated in the programme said Inspire had changed their career path for the better.
- Half of the young people taking part in Inspire said they wanted to try harder in Science, Technology, Engineering and Maths (STEM) subjects.
- Interest in some STEM careers increased by over 10% as a direct result of Inspire.
- Inspire has provided opportunities for social mobility, with 18% of HPC apprentices being eligible for free school meals – more than double the national average for level 3 apprenticeships (7%).
- More than half of those given careers advice said they found it easier to get work.

Tom Thayer leads the development of the Inspire programme. He said: “Our programme is helping to address a national skills shortage and is preparing young people for the wealth of opportunities at Hinkley Point C and beyond. I’m extremely proud of our commitment and the long-term career opportunities we can provide in a project that will play a big part in the UK’s fight against climate change.”

### Key influencers

**Key influencers** such as young people’s parents, teachers and friends, can play a particularly important role in shaping educational decisions.

**Parents and STEM capital**

Among young people in year 9 in England, 86.9% said they had the most say in deciding their year 10 subject choices,114 implying that the majority of young people feel that they have the autonomy to decide which educational pathways to pursue. Among others who had a say in subject decisions, parents were cited as having had the most influence (Figure 1.14). In a slightly older sample of young people aged 16 to 17 who had decided to stay on in full-time education after taking their GCSEs, parents were also cited as having had the most influence in this choice (Figure 1.15).


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<th>Key influencers</th>
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<td>Parents</td>
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<table>
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Source: CLS. ‘Next Steps (LSYPE1), wave 4’ data, 2008.

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5.4 Source: CLS. ‘Next Steps (LSYPE1), wave 4’ data, 2008.
Despite parents tending to hold positive views of engineering, evidence shows that their knowledge of the profession is limited.

While science capital can be an influential factor in decision making, most young people are not exposed to it in all its forms. Perceptions of STEM tend to be relatively positive among parents in the UK, with 69.3% reporting a positive view of engineering and 63% saying that they would recommend a career in engineering for their children (Figure 1.17). However, evidence from the 2019 EBM shows a worryingly low level of knowledge of engineering among parents, who are key influencers. As Figure 1.17 shows, only 27.5% of parents know what people working in engineering do. Shockingly, over half (51.3%) say that they know little or almost nothing about what people working in engineering do.

42.7% of parents in higher social grade positions say they know what people working in engineering do compared with just 23.0% of parents in lower social grade positions.

Science capital

Science capital is a concept developed by the ASPIRES2 (now ASPIRES2) team, led by Professor Louise Archer, to explain why there are disparate rates of participation in post-16 science.1.15 Their studies show that the more science capital a young person has, the more likely they are to aspire to pursue science education and careers.

There are 8 key dimensions of science capital:
- scientific literacy
- science-related attitudes, values and dispositions
- knowledge about the transferability of science
- science media consumption
- participation in out-of-school science learning contexts
- family science skills, knowledge and qualifications
- knowing people in science-related roles
- talking about science in everyday life

Source: Data adapted from Laurison, D. and Friedman, S. ‘The Class Pay Gap in Higher Education’ (2014) – UK

Social background makes a difference here. Further evidence from the 2019 EBM shows that although 42.7% of parents in higher social grade positions say they know what people working in engineering do, just 23.0% of parents in lower social grade positions agree, putting children from lower socioeconomic backgrounds at a disadvantage in terms of STEM capital.1.13 Similar patterns are found when looking at parents’ perceptions of engineering, their confidence in giving advice on careers in engineering and their likelihood of recommending careers in engineering to their children.


Q: ‘How positive or negative is your view of engineering?’ Percentages represent the proportions reporting ‘4 – quite positive’ or ‘5 – very positive’.
Q: ‘How positive or negative is your view of engineering?’ Percentages represent the proportions reporting ‘4 – quite desirable’ or ‘5 – very desirable’.
Q: ‘Would you recommend that your children consider a career in engineering?’ Percentages represent the proportions reporting ‘1 – yes’.

Q: ‘How much do you know about what people working in engineering do?’ Percentages represent the proportion reporting ‘4 – quite a lot’ or ‘5 – a lot’ on a 5-point Likert scale, with 1 representing ‘know almost nothing’ and 5 representing ‘know a lot’.
Q: ‘How much do you agree or disagree that engineers will have a positive impact on our future?’ Percentages represent the proportions reporting ‘4 – agree a little’ or ‘5 – agree a lot’.
Q: ‘How positive or negative is your view of engineering?’ Percentages represent the proportion reporting ‘1 – yes’.
Q: ‘How much do you know about what people working in engineering do?’ Percentages represent the proportions reporting ‘1 – yes’.
There are also differences between parents from higher and lower socioeconomic backgrounds in terms of the educational routes they encourage their children to follow. Parents in lower social grades are more likely to recommend that their child follow a vocational rather than an academic route into engineering (48.3% compared with 22.9% respectively). Parents in higher social grades are far more likely to recommend an academic route over a vocational route (68.8% compared with 20.2% respectively).

Parents also play an important role in preparing their children for the world of work through their social and professional networks. Work experience can provide influential workplace encounters for young people, and good quality placements can positively shape career choices. Since the removal of statutory work experience (and associated funding), placements are now more commonly organised by families than by schools. Young people whose parents are rich in STEM capital and have extensive social networks they can call on for favours are at a significant advantage in this respect. 1

Teachers

Teachers are key influencers because of their responsibility to effectively deliver the curriculum. They’re also responsible for ensuring their students are well informed when it comes to their next educational stage and/or well-equipped when it comes to their transition into the labour market. Teachers are arguably very well placed to gauge young people’s academic abilities and interests, and should be in a good position to provide young people with tailored advice and guidance on educational pathways and careers.

However, evidence from the 2019 EBM suggest that, like parents, STEM secondary school teachers in the UK have surprisingly low levels of knowledge of engineering careers (Figure 1.20).

STEM teachers may have low levels of knowledge of engineering because many deliver lessons on subjects in which they are not a specialist. This is a key challenge for the teaching profession generally and a problem which is particularly acute in STEM (see Chapter 2 for further information). Nevertheless, post-secondary qualifications in engineering or related subjects tend to have prerequisites, and it is up to teachers and schools to ensure all pupils are made aware of these considerations.

It is important that pupils have the opportunity to speak to their teachers about their future career plans, should they wish. A nationally representative sample of young people aged 15 to 16 in England were asked about how often they talk to their teachers about their plans for future study (Figure 1.21). Less than one third (30.7%) said that they do this a quite a lot or a lot, whereas 61.1% said they don’t speak to their teachers about future study very often, or they only do so a little. A further 8.2% said they don’t do this at all.

Schools

Provision of advice, guidance and opportunity is not only up to the individual teachers, who are often constrained for time. Teachers across the country are faced with mounting workloads and time pressures resulting from understaffing and cuts to school funding. As a result, they may not have the time they’d like to spend with individual pupils discussing future plans.

Schools as institutions can provide both opportunities and constraints by broadening or restricting subject options available to students, or by guiding students towards certain pathways. 1.9 For example, not all schools offer their students the opportunity to take triple science. This is known to correlate with both social background and an individual’s likelihood of studying physics at A level, 1.10 thus having obvious implications for the engineering talent pool.

Case study – STEM Learning, teachers and engineering careers

Amanda Dickins, Head of Impact and Development, STEM Learning

Investing in teachers makes sense: each teacher will teach thousands of young people during the course of their teaching career. Supporting one teacher to better understand engineering and use that knowledge to enhance and enrich their teaching will inspire students year after year. Teachers are particularly important for young people from disadvantaged backgrounds, who often lack the networks and connections that others enjoy.

STEM Learning supports teachers to become inspirational professionals, with the knowledge and confidence to enthuse young people about engineering and careers. UK teachers are young – 26% are under 30 years old – and too few understand engineering. STEM Learning helps them to develop their knowledge of engineering and careers, and the opportunities that engineering opens up for their students.

For example, the Lloyd’s Register Foundation is supporting 20enthuse partnerships, enabling STEM learning to work with teachers from 88 schools. The Partnerships are developing engineering education – using the framework provided by the Royal Academy of Engineering’s Engineering Habits of Mind – and engagement with engineering employers. There is a strong focus on inspiring and supporting young people facing disadvantage, as well as groups and communities that are underrepresented in engineering. Over 40,000 young people will benefit from greater awareness of engineering, the role of engineering in securing a safe and sustainable future, and the routes they can choose to take them into engineering careers.
A recent study has shown that the school a young person attends can have a greater influence on ethnicity. 17 The socioeconomic position of a school (that is, the proportion of all its students who are eligible for free school meals) has a notable effect on young people's academic achievements. The results of the study raise questions about whether schools in disadvantaged areas are tailoring their curriculum content according to the composition of their students. And in addition, questions around whether funding decisions made by local education authorities are effectively imposing constraints on the subject choices that schools are able to offer to their students. 18

Peer effects
Sociological research suggests that people tend to form close ties with others who are – or who perceive to be – socially ‘similar’ to themselves. The consequence of this is that beliefs, attitudes and norms tend to be affirmed rather than challenged. This phenomenon is widely documented in research on friendship networks, along with consideration of the implications for a range of social outcomes, including subject choices. 19

Girls' interest in STEM is reinforced when other girls in their classroom also have an affinity for these subjects.

The extensive influence that young people’s peer groups can have on their educational outcomes is well recognised. Academic attainment is driven up for pupils who are taught in classrooms containing an affinity for these subjects. Peer socialisation can have on their educational outcomes is well recognised. Peer socialisation can have an affinity for these subjects. Academic attainment is driven up for pupils who are taught in classrooms containing an affinity for these subjects.

Industrial strategy
The government’s industrial strategy, implemented at the end of 2017, signalled its commitment to boost productivity and build the UK’s economy, in part by ensuring that young people are well equipped to do the high-skill jobs needed in the face of rapid technological change and the emergence of industry 4.0. The strategy commented specifically on the need to tackle the shortage of STEM skills. It also aimed to make progress by creating the conditions for new businesses to thrive and offer up opportunities for the next generation.22

A House of Commons report in 2018, Delivering STEM Skills for the Economy, documented the myriad of efforts that have been made over recent years to harness STEM skills among young people in the UK. In one example, the Department for Education (DfE), which is responsible for schools, colleges, apprenticeships and higher education (HE) institutions in England, has now has a dedicated STEM team – the STEM and Digital Skills Unit. In addition, it has set up Skills Advisory Panels (SAP) that work with Local Enterprise Partnerships (LEPs) to better gauge local and regional skills needs. And it has recently undertaken an employer skills survey dedicated to improving understanding of future skills demand. All of these will inform future decisions to shape policy and strategies to improve and expand STEM education.

Separately, the Department for Business, Energy & Industrial Strategy (BEIS) is tasked with developing the career landscape and increasing the number of young people to consider STEM via engagement programmes. Across government departments, in the 10 years leading to 2017, almost £1 billion was spent on initiatives to increase participation in STEM pathways within the further education sector.

Careers strategy
The government’s careers strategy was 23 for England came into effect in 2017, in response to the long-standing issue of inadequate careers provision across the country, with a particular focus on increasing young people’s engagement with STEM careers. It aims to complement the UK’s industrial strategy by promoting high-quality technical education and improving knowledge of where different educational paths lead.

The careers strategy recognised that careers advice had, for some time, been unevenly distributed across the country, hindering opportunities for some groups to receive guidance. As a result, it also seeks to make Britain a fairer place and promote social mobility by ensuring that everyone, regardless of background, has the opportunity to build a rewarding career. Understanding the career landscape was a priority for the Careers & Enterprise Company (CEC) was given greater responsibility to provide additional support for schools and colleges in England to improve their careers education and guidance and to meet their Gatsby benchmarks (see Figure 1.12), some of which focus on STEM. Although there is much work to be done in this area, CEC’s delivery plan, which was published in 2018, is focused on improving careers education and guidance has improved across the country, with secondary schools and colleges demonstrably progressing in every dimension of careers support, including increasing young people’s frequency of interactions with employers. The Gatsby benchmarks have been instrumental in building schools to connect with, providing guidance on how to improve careers education. In 2019, schools and colleges in England achieved a mean score of 3.2 out of 8 Gatsby benchmarks, representing an increase of over 50% since 2017.26

Devolved nations
In early 2019, Scotland implemented its 5-year STEM education and training strategy, which intends to narrow the skills gap and focus in particular on ensuring equality of access and opportunities to study STEM in order to address the underrepresentation of particular groups.27 Scotland’s STEM strategy, its Developing the Youth Workforce Programme and its Learner Journey Review provide mutual support to ensure the next generation of young people are equipped to meet the skills needs of employers across the country.

Over the past decade, Northern Ireland has taken important steps to address skills shortages. ‘Success Through STEM’ was launched in 2016 to help implement Northern Ireland’s STEM strategy and the innovation strategy 28

Wales’ ‘Skills implementation plan – Delivering the policy statement’ was published in 2015 to help Wales move towards becoming a highly skilled society that can tackle poverty and be sustainable in the face of ever scarcer resources. The strategy included a key commitment to help Wales drive forward a more vibrant, diverse, high-skilled society.

Case study – The Young STEM Leader Programme, Scotland
Jamie Menzies, Young STEM Leader Project Officer, SSERC
The Young STEM Leader Programme (YSLP) is derived from the Scottish Government’s 2017 strategy for STEM Education and Training to address participation barriers and improve STEM engagement.

Aiming to spark greater interest and participation in STEM, YSLP enables children and young people to lead, inspire and mentor their peers through the creation of STEM activities, events or interactions in any context within schools and communities. From descriptive demonstrations to one-on-one mentoring and everything in between, every Young STEM Leader will develop their own skills through the creation of engaging experiences.

For younger pupils, YSLP offers a chance to explore their creativity and get hands on with STEM. For teens, it represents an excellent way to develop personal skills that will enable them stand out from the crowd with employers or in further or higher education. Morgan, a Young STEM Leader from Dalmanock Primary in Glasgow, said that YSLP had been “one of the most fun experiences” of her life, improving her confidence and skills in STEM.

There are 2 versions of YSLP, each with 3 levels. In the non-formal version (YSL 2, 3 and 4), young people can complete digital badges – Discover, Create, Inspire and Lead – to gain the qualification. The formal qualifications are mapped to Curriculum for Excellence levels 2, 3 and 4 in the physical version (YSL 4, 5 and 6), young people gain a formal Scottish Credit and Qualifications Framework (SCQF) level 4 or 5 award, credit rated by the Scottish Qualifications Authority (SQA).

Within their delivering centre, young people are supported and mentored by staff from Scottish Enterprise. Supported by the project team at Scottish Schools Education Research Centre (SSERC), the YSLP is being delivered in over 70 pilot schools and community groups across Scotland. As YSLP progresses towards the completion of a full national launch in summer 2020, it is hoped that 400 centres will be involved by the end of the year. The eventual aim is that every young person in Scotland will have access to the programme in 2021.
Educational reform
Further commitments by UK governments have included the introduction of new qualifications that it is hoped will meet the growing demand for skills, in particular at level 3 and above. T levels – new technical qualifications equivalent to A levels – are being introduced in England in September 2020. These will offer another route for post-16 study of subjects such as engineering and manufacturing. There will also be an increased focus on higher level technical qualifications and degree apprenticeships, which aim to bring together higher and vocational education to meet skills needs. These have been offered in engineering since 2015 (see Chapter 3). Increased spending to address issues of teacher recruitment and retention has also been introduced by government, including bursaries and schemes to recruit teachers from other occupations. This may address shortages in specialist science and maths teachers in particular (see Chapter 2).

Government campaigns
The ‘Year of Engineering’ was a cross-government campaign led by the Department for Transport that took place throughout 2018. It involved hundreds of industry partners and employers working to raise the profile of engineering and boost engagement in STEM outreach programmes. The campaign was an important step forward, signalling an unprecedented coordination of efforts by government, professional bodies, industry and the wider community to celebrate and promote the profession. Activities included large-scale outreach programmes, such as a £1 million investment from Shell in the ‘Tomorrow’s Engineers Energy Quest’ programme, which gave an additional 80,000 children the opportunity to experience hands-on engineering activities. Organisations such as Thales, Crocsrail, Siemens were also involved.

The campaign is considered to have been a huge success, reaching over one million children. Six months into the campaign, the number of 7 to 11 year olds who said that they would consider a career in engineering had increased by 30%,100 its legacy has continued with the ‘Take a Closer Look’ campaign, which aims to continue the drive to boost participation in STEM outreach and engagement.

1.5 – Wider sector initiatives to increase STEM participation
There are numerous efforts being rolled out across the engineering community to drive up participation in STEM, and to engage and inspire young people.

STEM engagement and outreach
The STEM engagement landscape is growing exponentially. In 2016, a mapping exercise by the Royal Academy of Engineering identified over 600 providers who were actively involved in supporting engineering education in the UK – a number which is likely to have grown substantially since. These opportunities range widely in scope, duration and target audience, from the ‘Big Bang UK Fair’, which saw 60,000 young people visit in 2019, to small-scale one-off interactions such as 1:1 mentoring opportunities. Figure 1.23 shows the extent of out-of-school science-related engagement among young people aged 7 to 11 in 2019.

It’s difficult to unequivocally determine how much difference these engagement programmes make in inspiring young people to consider engineering careers and on raising attainment and participation in STEM education. While some studies have been sceptical about the success of STEM engagement experiences,101 others have made the point that their influence will vary according to the characteristics of each activity.102 No single intervention is likely to be successful in addressing the skills shortage. Instead, activities need to be sustained and holistic, and between them help with each of the elements of behavioral change – together they should drive up motivation, enhance opportunities and improve capabilities.

Evidence from the 2019 EBM shows that among young people aged 11 to 19, those who attended a STEM careers activity in the 12 months prior to being surveyed (27.4%) had significantly more positive views of engineering and science. They more often viewed careers in engineering and science as desirable, and had greater knowledge of what to do next to pursue careers in engineering and science (see Figure 1.24). Further, when comparing those who had and had not attended a STEM careers activity in the 12 months prior to being surveyed, there were statistically significant differences between the proportions reporting that they wanted to become an engineer (18% compared with 7%) and a scientist (11% compared with 5%) when they finish full-time education.

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Figure 1.23 Participation in science-related activities outside school among 7 to 14 year olds by gender and age group (2019) – UK

<table>
<thead>
<tr>
<th>Age 7–11</th>
<th>Male</th>
<th>33.8%</th>
<th>18.5%</th>
<th>38.0%</th>
<th>30.4%</th>
<th>31.6%</th>
<th>17.2%</th>
<th>19.3%</th>
<th>310</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>37.1%</td>
<td>16.3%</td>
<td>35.0%</td>
<td>31.3%</td>
<td>26.8%</td>
<td>15.1%</td>
<td>24.6%</td>
<td>303</td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>35.4%</td>
<td>17.4%</td>
<td>36.5%</td>
<td>30.8%</td>
<td>29.2%</td>
<td>16.2%</td>
<td>21.9%</td>
<td>618</td>
<td></td>
</tr>
<tr>
<td>Age 11–14</td>
<td>Male</td>
<td>32.9%</td>
<td>20.7%</td>
<td>40.7%</td>
<td>32.8%</td>
<td>34.7%</td>
<td>17.3%</td>
<td>19.5%</td>
<td>353</td>
</tr>
<tr>
<td>Female</td>
<td>30.9%</td>
<td>12.5%</td>
<td>30.2%</td>
<td>25.7%</td>
<td>28.8%</td>
<td>13.8%</td>
<td>29.8%</td>
<td>351</td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>31.9%</td>
<td>16.7%</td>
<td>35.7%</td>
<td>29.4%</td>
<td>31.9%</td>
<td>15.6%</td>
<td>24.5%</td>
<td>704</td>
<td></td>
</tr>
</tbody>
</table>

Q: Do you do any of the following science related activities outside of school?

- Visit science exhibitions/museums
- Attend a science, technology, engineering or maths club
- Watch science programmes
- Read science books
- Read about science on the internet
- Go to a science and engineering fair
- None of the 6 options given
- Total No.

1.96 RaEng. ‘The UK STEM Education Landscape’, 2016.
1.97 Bayesley, P.A. ‘Is informal education the answer to increasing and widening participation in STEM education?’ Rev. Educ., 2012.
Employer engagement

Employers are key in providing young people with the opportunity to experience the real world of work, giving them invaluable insights into what a career in engineering might look like. The positive effect that employer interactions can have on young people’s education and employment prospects is well known. For example, employer engagement is associated with a reduced likelihood of becoming NEET (not in education, employment or training) and also with increased earnings.1,2

EngineeringUK’s evaluation surveys reinforce the view that interactions with employers and exposure to real-world experiences are important. Meeting an engineer at a STEM engagement activity was positively associated with perceptions of engineering, knowledge about engineering careers and knowledge of the educational pathways to pursue engineering careers.

Employer engagement is key to inspiring young people. It is associated with both reduced likelihood of becoming NEET and with increased earnings.

Many employers run their own STEM engagement programmes or provide funding to support others. EngineeringUK’s Skills Partnership supports a network of employers across the UK in their efforts to drive up employer-led engagement and the effect of the experiences they offer young people.1,2 Led by the Careers & Enterprise Company to drive forward the careers strategy, engineering employers now also provide enterprise advisers to support schools and colleges by providing funding and offering the time of industry professionals.3,4

Other important employer initiatives include freeing up the time of employees to volunteer as STEM Ambassadors. These are professionals working in STEM careers who offer free-of-charge school visits and face-to-face interactions with young people to engage and inspire them in STEM.

STEM employers also play an important role in providing relevant work experience opportunities and apprenticeships. Organisations such as the STEM Exchange1,2 exist to help connect teachers and young people with employers who are offering work experience opportunities. Others, such as Education and Employers,3,4 work to promote employer engagement in the UK more generally.

The many efforts across the sector signal recognition that more needs to be done to harness the potential engineering talent pool and to ensure that the sector is one which promotes equality, diversity and inclusivity.

Case study – Drax commitment to improving social mobility

Vicky Bullivant, Group Head of Sustainable Business, Drax

At Drax Group, our social strategy focuses on improving opportunity and social mobility by promoting Science Technology Engineering and Maths (STEM) skills and employability through partnerships with schools and colleges, free educational tours and work experience opportunities. In 2019, we signed the UK cross-party Social Mobility Pledge, demonstrating our commitment to widen access to the energy industry and cultivate talent among young people from all social backgrounds.

Drax invested £35,000 in Greenpower electric car kits for our 7 partner schools in the Selby area. To encourage students to study STEM subjects, Drax colleagues volunteered more than 160 hours supporting learners in designing, building and racing these electric-powered vehicles. We also sponsored the UK’s first ever schools’ electric car race in Hull.

Last year, we hosted our first ‘Women of the Future’ event at Drax Power Station, where more than 100 girls from local schools and colleges learned from female employees about their skills and careers. In addition, more than 3,800 visitors from schools and academic institutions visited Drax Power Station’s Visitor Centre, where tours are focused on learning outcomes. Tours of Cruachan Power Station have been made free for schools and academic institutions during term time.

Drax also provides work experience opportunities, apprenticeships and graduate recruitment schemes. Last year, we recruited 18 apprentices and 6 graduates. This included expanding our apprenticeship scheme to Drax’s Scottish sites, where we recruited 5 new apprentices. Our partnership with Teach First enabled the recruitment, placement and training of 8 STEM teachers in 2019, improving the STEM education of 1,000 students.

“Companies like Drax are developing and innovating using new technologies which will help to combat the climate crisis. It’s important that communities are not left behind during the transition to a more sustainable future – making sure people have the right skills is a key part of that” – Andy Koss, Drax CEO Generation.

1.100 EngineeringUK. ‘Skills Partnership – EngineeringUK – Inspiring tomorrow’s engineers’ [online], accessed 20/03/2020.
1.104 EngineeringUK. ‘Skills Partnership - EngineeringUK - Inspiring tomorrow’s engineers’ [online], accessed 20/03/2020.

1.6 Summary

STEM education has a crucial role to play in equipping young people with the relevant skills they need to fill the demand for occupations with vast shortages, such as engineering. The UK education system is relatively complex, offering a range of different qualifications and subjects at the various stages of young people’s educational journeys.

The following chapters in this report provide detailed information on attainment and participation in STEM at key points along engineering educational pathways, from secondary through higher education, and with a focus on both academic and vocational routes.

These young people represent the next generation of potential engineers. Their educational decisions are key in determining the extent to which the UK will be equipped to deal with continuing technological advancements that are so crucial to the country’s economic health.
A career in engineering has deep roots. A young person that aspires to work at one of the UK’s leading engineering firms needs to make a series of decisions about what to study, starting all the way back to the age of 13 or 14 when they choose their GCSEs.

And there is strong evidence the ‘roots’ extend deeper still. We know that stereotypes about careers start to form at an early age, as far back as primary school. If we want to encourage more young people into engineering, we need to make sure they get the right information, advice and inspiration all the way through their school journey.

The good news is that as a country we’re getting better at careers education. But the demand for a highly skilled workforce is only going to increase, and there is still a huge amount that the engineering community can do to help secure tomorrow’s workforce.

What does an ‘engineer’ look like?

We know that young people start to form stereotypes about careers as early as the age of 7. It’s also at this early stage that disparities in career aspirations begin to develop.

Research by Education and Employers found that, among primary school pupils, nearly twice as many boys wanted to become scientists as girls. And the numbers were even more concerning for engineering: boys were 4 times more likely to want to become an engineer than girls.

Among primary school pupils, boys are 4 times more likely to want to become an engineer than girls. 

Careers education is no longer a box-ticking exercise; now it is about exposing young people to a rich variety of opportunities across their school journey.

Careers education is now about exposing young people to a rich variety of opportunities across their school journey, using a framework called the Gatsby benchmarks. These benchmarks, derived from international best practice, ensure that every young person has information about the local labour market and the pathways to enter an industry; has experience with employers, apprenticeship providers and further and higher education establishments to bring that information to life; and receives support to make informed choices based on their ambitions, capabilities and knowledge of the available pathways.

You can’t be what you can’t see

For young people who don’t consider engineering as being for ‘people like them’, an experience with an inspiring role model could be a life changing moment.

Employer engagement works

Evidence shows that young people who enjoy regular employer engagements while at school have improved employability and earnings prospects. And the affect appears to be cumulative – the more interactions with employers they enjoy, the bigger the benefits.

Employers have an important role to play in strengthening the talent pipeline. A case study published by the Careers & Enterprise Company shares the stories of 2 young women, Rebecca and Katie, who have progressed through the engineering educational pipeline and who attribute their success to the engineering firms they completed their degree apprenticeships at.

The more interactions young people have with employers while they are at school, the better their employability and earning prospects.
Design and technology GCSE entries decreased by 21.7% in 2018/19, continuing a trend of long-term decline.

Key points
Performance in secondary school STEM qualifications is one of the main ways to predict whether young people will continue to higher levels of STEM education, training and employment. Thus, the health of the school system is reflected in the results of almost all teacher assessment from grades, a move from modular assessments to final examinations, and a new GCSE grading system.

Qualification reforms and performance measures
The government’s GCSE and A level reform process reached its climax in 2019. These reforms aim to raise educational standards and better prepare students for further study and employment. The changes to STEM qualifications include more rigorous courses, the removal of all teacher assessment from grades, a move from modular assessments to final examinations, and a new GCSE grading system.

Participation in the English Baccalaureate (EBacc) – a set of subjects considered to open doors to further study and employment – continues to be a headline school performance measure, with a government target of 75% of students taking the EBacc by 2022. This has benefitted STEM EBacc subjects, including maths, sciences and computing, which have seen an increase in entries since the measure was implemented in 2010. However, it may be contributing to the long-term decline of non-EBacc by 2022. This has benefitted STEM EBacc subjects, including maths, sciences and computing, which have seen an increase in entries since the measure was implemented in 2010. However, it may be contributing to the long-term decline of non-EBacc STEM subjects, which provide essential skills for the engineering workforce.

STEM GCSE and A level entries and attainment
Across the England, Wales and Northern Ireland, the number of entries for GCSEs in STEM EBacc subjects has been rising. For example, entries for maths and double science rose by 4.2% and 4.2% respectively in 2019. At the same time, entries for computing science have been increasing, with 8.4% of secondary school classes having 31 to 35 pupils in 2019, up from 7.7% in 2018. However, there may be several reasons for this increase, including more emphasis on STEM education in secondary schools. Providing young people in the UK with a comprehensive and inspiring STEM education that is accessible to all students, with high participating rates and good levels of attainment, is vital for the future health of the engineering sector.

Gender differences for GCSE and A level STEM subjects
There continues to be a notable lack of girls taking elective STEM subjects. The GCSE STEM subject with the lowest participation among girls is engineering, where only one to 10 entries are by girls. Despite this, girls continue to outperform boys in almost all GCSE STEM subjects and the performance gaps are widest in engineering, design and technology and computing.

Encouragingly, girls were more likely than boys to pass A level biology, design and technology, maths and physics. However, boys are still far more likely than girls to study STEM A level subjects that often serve as pre-requisites for engineering degrees, including physics (77.4% male), maths (61.3% male) and further maths (71.5% male).

STEM Scottish National qualifications
Unlike in the rest of the UK, engineering has a direct presence on the secondary curriculum in Scotland, with engineering science offered at National 5, Higher and Advanced Higher level. Scotland also provides a wider range of STEM subjects, with applied subjects such as electronics and woodworking on offer alongside traditional STEM subjects.

National 5 entries were broadly stable for maths, sciences and computing science. However, there were worrying decreases in entries for some engineering-facilitating STEM subjects, including engineering science (down 9.0%) and design and manufacture (down 2.6%). Maths and chemistry were the most popular STEM subject both at Higher and Advanced Higher qualifications. A to C pass rates in all STEM subjects at Higher level, except for mathematics and IT, went down compared with the previous year. However, some Advanced Higher subjects, including engineering science and design and manufacture saw large increases in pass rates.

STEM teacher shortages
The UK’s secondary education sector has a longstanding problem with teacher shortages and recruitment and retention rates are exceptionally poor for STEM subjects. Additionally, these subjects have low specialism rates, with only 17.5% of teachers having relevant post-A level qualifications.

The shortage of specialist teachers is most acute for high priority subjects in deprived areas outside London. However, there are several initiatives aimed at improving STEM teacher recruitment, retention and specialisation. These include financial incentives, recruitment programmes aimed at STEM graduates and professionals; and training programmes aimed at upskilling or reskilling current teachers.

2.1 – Context
Secondary school is a crucial early stage of a young person’s journey into the wider world of further study, training and employment, and therefore a formative time in their education. Gaining a solid foundation in STEM at secondary school is also essential for navigating everyday life and understanding our world. But STEM isn’t just important for each individual – it also has strategic importance for the engineering sector and for advancing the fields on which the future economy of the UK depends.

Young people need to have good GCSE and A level (or equivalent) qualifications in STEM subjects to progress on to typical academic routes into engineering careers. Maths and physics A levels are essential for most engineering-related degrees in England. Qualifications in subjects such as the other sciences, further maths, computer science, and design and technology are also accepted. If we wish to grow the talent pool of prospective engineers in the UK, it is vital that we inspire more young people to take up these subjects at secondary school and ensure that those students are provided with a positive learning experience. Improving attainment in STEM subjects is also crucial in tackling the STEM skills shortage because increased attainment makes it more likely that a young person will continue to higher levels of STEM education (see Chapter 1 for further discussion).

The engineering community faces a significant problem with visibility at this vital educational stage because engineering rarely has an explicit presence in the curriculum. So few secondary education institutions in England, Wales and Northern Ireland offer engineering GCSE that it accounts for only 0.06% of GCSE entries across all 3 nations. There are no A level engineering courses. Instead, students wishing to take academic routes into engineering careers must understand which of the available secondary school qualifications will facilitate their entry. Things, are different in Scotland, where engineering has a direct presence on the curriculum, and engineering science is taught at National 4, National 5, Higher and Advanced Higher levels.

As we show in Chapter 1 of this report, when young people are at the stage of making important decisions about GCSE and A level subjects, they still have low levels of understanding about engineering careers and the various entry routes. For example, results from the Engineering Brand Monitor (EBM) found that just 39% of people aged 14 to 16 say that they “know what they need to do next in order to become an engineer.” Young people are opting out of STEM GCSEs and A levels under the illusion that they are opening doors to engineering higher education and training, and doing so long before they have a good understanding of the opportunities a career in engineering has to offer.

Another challenge for the engineering community is that fewer girls than boys take engineering facilitating subjects at both GCSE and A level. Girls outperform boys in most GCSE STEM subjects, make up the majority of A level entries overall and are more likely to progress to higher education generally. But parents and teachers, surprisingly few decide to study elective STEM subjects at GCSE (particularly engineering and computing).

2.1.1 The gender gap widens still further at A level – which is surprising given girls’ higher attainment in STEM GCSEs – with a particularly large drop-off in the number of girls studying core STEM subjects.

It’s crucial that the engineering sector works with government and the secondary education sector to advocate the importance of STEM education in secondary school. Providing young people in the UK with a comprehensive and inspiring STEM secondary education that is accessible to all students, with high participating rates and good levels of attainment, is vital for the future health of the engineering sector.

Demographic trends in the secondary school population
The secondary school sector in England is under increasing pressure because a demographic ‘bulge’ of pupils is currently moving into secondary schools. The latest Department for Education (DfE) release on schools, pupils and their characteristics: January 2019 data revealed that the population of state-funded secondary school age pupils has grown for the fifth year in a row, to 3.33 million in 2019 (Figure 2.1). This growth trajectory is expected to continue as children born during the mini baby boom from the mid-2000s move into secondary schools.2,3

As a consequence of this population boom, the average state-funded secondary school now has 961 pupils on its roll, up from 948 in 2018.4 The school census shows that class sizes have been increasing, with 8.4% of secondary school classes having 31 to 35 pupils in 2019, up from 7.7% in 2018.4 There has also been a 258% rise in the number of secondary school pupils in ‘super-sized’ classes of 36 or more, from 6,107 in 2010 to 21,843 in 2019.

The increase in class sizes can be linked to severe funding pressures faced by the state education sector, which has meant that schools can afford to hire fewer staff.5 The budgetary cuts disproportionately affect schools in the most disadvantaged areas, with reform cuts being three times deeper for schools educating the poorest pupils compared with schools in the wealthiest areas.6 The government has pledged an additional £7 billion to be spent on state and special schools between 2020 and 2024, however, for 1 in 3 schools this will mean only a 1% increase in funding, which still amounts to a real-world cut after inflation.6 Many schools
are therefore likely to continue to face financial pressures and teacher shortages in future. The demographic composition of the secondary school population is changing. There has been a steady increase in ethnic diversity, with 31.3% of secondary school pupils in 2019 being from an ethnic minority background, up from 27.9% in 2016 (Figure 2.2). Pupils with Asian ethnic origins are the largest minority in all school types, comprising 11.3% of all students.

Figure 2.2 Pupils in state-funded secondary schools by ethnicity (2016 and 2019) – England

White British 70.9%
White Non-British 67.0%
Asian 10.3%
Black 5.5%
Mixed 4.7%
Chinese 0.4%
Any other ethnic group 1.6%
Unclassified 1.7%


Secondary schools in England

Following successive government reforms, there are many different types of providers delivering school education. This panel briefly explains the general characteristics of the more common types of the landscape is complex, so there may be exceptions not included here.

State maintained schools are publicly funded via local authorities. In voluntary aided schools the governing body contributes approximately 10% of capital costs. All are required to follow the national curriculum and employ those with Qualified Teacher Status. They cannot select pupils by academic performance. Community and voluntary controlled schools are directly accountable to the local authority, as are some foundation schools. Other foundation schools plus all voluntary aided schools are accountable via their governing body. In community schools the premises are owned by the local authority, which also employs the school staff. Where the founding body of a voluntary aided or voluntary controlled school is the church, it may be referred to as a faith school.

Academies, which can be primary or secondary schools, are classified as independent, even though they are publicly funded via central government. They are not required to follow the national curriculum or employ staff with Qualified Teacher Status. Academies are overseen by an academy trust. ‘Free schools’ are academies that are new (rather than existing schools that converted to become academies). Academies can also be described as ‘converter’ (former schools that were deemed to be performing well) or ‘sponsored’ (former schools often deemed to be underperforming and now run by sponsors). University technical colleges (UTCs) and studio schools are academies with a strong vocational orientation for young people aged 14 to 19 years, with the latter being smaller. Each UTC is backed by employers and a university.

Grammar schools are required to follow the national curriculum and employ qualified teachers, but can select pupils for admission by academic performance. Although they are funded via the local authority, they may be accountable either via the local authority or a governing body.

Independent, private, fee-paying schools are not obliged to follow the national curriculum or employ staff qualified in teaching and can select pupils for admission by academic performance.

Further education (FE) colleges offer provision (including general education) for students aged 14 and over, while sixth form colleges offer post 16 education.

More pupils than ever are eligible for and claiming free school meals (FSM), reaching 14.1% in 2019.21 The sharp increase in FSM eligibility is partly due to the transitional protections in place during the roll out of Universal Credit, which means that as pupils continue to become eligible for FSM, fewer pupils stop being eligible. Rates of FSM eligibility vary by state school type. Overall, academies have lower levels of students eligible for and claiming FSM, compared to local authority maintained schools, at 12.7% and 15.5% respectively. Secondary sponsored academies have the highest FSM rate, with 22.1% of students eligible and claiming free school meals. Secondary converter academies have a lower than average FSM rate, at 10.4%.


GCSE reforms

Pupils who sat their GCSE examinations in summer 2019 will have taken reformed qualifications in most subjects. Additional STEM subjects were included in the list of reformed subjects being awarded in 2019, such as design and technology, electronics and engineering.

The reforms to GCSEs have resulted in the following changes in England:

- GCSEs are now graded on a numeric 9 to 1 scale (Figure 2.3) – this allows greater differentiation at the top and middle of the grade scale, with grade 9 equivalent to a high A* and grade 5 equivalent to a high C
- course syllabuses have been updated to include content of a more challenging standard for all learners
- reformed GCSEs have a linear structure with the discontinuation of modular assessments, so that all assessments are taken as exams at the end of the 2-year course
- coursework no longer contributes to finals grades in most subjects, although in science GCSEs pupils are required to take mandatory practicals during the course, with exam questions relating to the practicals comprising 15% of the total mark
- science exams must include questions relating to maths skills that account for at least 20% of marks, divided between biology, chemistry and physics in the ratio 1:2:3
- the use of tiering has been restricted to selected subjects including maths, science, statistics and modern foreign languages (see STEM subject tiering on page 40)

Differences in secondary school qualifications across the United Kingdom

Secondary education is a devolved policy area in the UK, with academic qualifications in each nation being overseen by independent examination boards, namely Ofqual in England, the Scottish Qualifications Authority in Scotland, Qualification Wales in Wales and The Council for Curriculum, Examinations and Assessment in Northern Ireland. In England, Wales and Northern Ireland offer GCSEs and A levels as the main academic qualifications for secondary school pupils, whereas Scotland has its own qualification system which includes National Higher and Advanced Higher qualifications. Since the latest policy reforms in secondary education, the differences in qualifications across England, Wales and Northern Ireland have widened. There is no longer alignment in grading scales, subject content, course structures and assessment methods. This means that making comparisons between England, Wales and Northern Ireland is more difficult and care needs to be taken with generalisations.

There are now 3 different GCSE grading scales across the 3 nations:
- England grades on the new 9 to 1 scale, with 9 being the highest grade
- Wales still uses an A* to G grading scale
- Northern Ireland uses a 9-point scale from A* to G, which includes a new C+ grade to align with grade 5 in England

Figure 2.3 Comparison of the reformed and legacy GCSE grading scales – England

Source: Figure taken from Ofqual. ‘Grading new GCSEs from 2017, 2017.’

New grading structure
Current grading structure

9
8
7
6
5
4
3
2
1
A*
A
B
B
C
D
E
F
G
U
U

GOOD PASS
AWARDING

Source: Ofqual. ‘Statement from the qualification regulators on changes to GCSEs, AS and A levels’, 2019.

2.10 Ofqual. ‘Statement from the qualification regulators on changes to GCSEs, AS and A levels’, 2019.

2.11 Good Pass = above the Baseline

4 and above = bottom of C and above

3 and above = top of C and above

2 – Secondary education

2 – Secondary education
Impact of GCSE reforms

In 2018 to 2019, nearly all GCSE subjects have been through the reform process and we have exam results data for these subjects. We can therefore get a clearer picture of the effects of the GCSE qualification reforms.

One of the benefits of the reformed GCSEs is that the new grading system allows schools, colleges and universities to better recognise the most exceptional students. This is because there is now greater differentiation at the top of the grading scale, with the previous A* and A grades now spread over three grades (9 to 7). In 2018 to 2019, only 817 students who took 7 or more GCSEs achieved grade 9 in all of them, 66% of whom were girls.12

There is also greater differentiation at the former B to C range, which is now also spread over 3 grades (6 to 4). Grade 4 is now considered a ‘standard pass’ and grade 5 is a ‘strong pass’. Currently, grade 4 is the minimum entry or continuation requirement for students wishing to move on to further education. However, there is a risk that educational institutions may start raising the threshold to grade 5, which could affect many young people’s chances of continuing their academic education.11

A poll found that 31% of employers were completely unaware of the new GCSE 9 to 1 grading system.

There is a well-founded concern that employers and universities are inadequately informed about the new 9 to 1 grading system and therefore susceptible to misinterpreting the grades, which may have implications for young people’s educational prospects and employment outcomes. A YouGov poll in April 2018, commissioned by Ofqual, found that 23% of employers, 16% of parents and 6% of head teachers incorrectly thought that 1 was the top GCSE grade.10

In this poll, almost a third of employers (31%) and 15% of universities were completely unaware of the new GCSE 9 to 1 grading system. Another reason given for the reforms was a concern that schools in disadvantaged areas were not providing students with an adequate core academic education. However, research by The Sutton Trust suggests that the GCSE reforms have led to greater educational inequality.10 The findings show that the gap in attainment between disadvantaged and non-disadvantaged students was wider after the reforms than before. Before the reforms, non-disadvantaged pupils were 1.42 times more likely to achieve a grade C or above than disadvantaged pupils, whereas since the reforms the former are 1.63 times more likely to achieve a grade 5 than the latter. This will matter when it comes to entry into post-16 courses or university admission if, as expected, grade 5 becomes the new standard for educational progression.

The move from modular to linear assessment was driven by the goal of reducing the time students spend in exams and relieving pressure on teachers. However, the concentration of high stakes exams at the end of the school year has led to an increase in students feeling stressed, overwhelmed and demotivated. A National Education Union (NEU) poll of teachers found that 73% of teachers believe that students’ mental health has worsened since the introduction of reformed GCSEs and 61% find that students’ overall well-being in secondary education has declined as a result of the reforms.14 Some teachers have reported that the new examination structure has not reduced the amount of time students spend in exams because schools have increased the number of internal assessments and mock exams.14

The increase in the amount of content in the curriculum and level of difficulty has had an impact on teaching and learning styles. Some maths teachers claim that the harder maths content and increased emphasis on problem solving better prepares students for maths A level. However, other subject teachers say they feel increasing pressure to cover all the curriculum content within allotted teaching time, which in turn is increasing their already high levels of stress.2,14 There are also concerns that more content leads to rote learning and reduces scope for creativity and enjoyment of the subject.14

73% of teachers believe that students’ mental health has worsened since the introduction of the reformed GCSEs.

AS and A level reforms

The reforms of AS and A levels are also in their final stages.16 In September 2019, 1.3 million students sat AS examinations for the first time since the previous modular courses were made linear and there are no longer exams in January. AS exams are taken at the end of one year of study and A levels taken at the end of 2 years of study.

AS qualifications are now entirely separate from A level, with AS grades no longer contributing towards the final A level grade. Course content has been updated with greater input from universities and professional institutions and societies to ensure they adequately prepare students for university. Exams may make greater use of ‘synoptic questions’ that require students to integrate content from across different topics and are designed to test both breadth and depth of learning.

STEM subject tiering

Some GCSE STEM subjects, including maths, physics, chemistry, biology and combined science, are tiered so that students can be entered for either foundation level or higher level papers. Foundation tier is designed for students aiming for a 1 to 4 (G to C) grade, whereas higher tier is for those aiming for grades 4 to 9 (C to A*).

Around 20% of questions on exam papers will be the same for foundation and higher tier levels. These questions are used by exam boards to align standards between tiers so that it isn’t easier to attain a grade one in higher tier than in the other. In 2018 to 2019, there was a ‘safety net’ for higher-tier students who just missed the grade 4 boundary, but if they missed the safety net, they didn’t receive a grade in that subject at all. The safety net worked by allowing exam boards, in exceptional cases, to offer a 4-3 or 3-3 grade for higher tier combined science or grade 3 for separate sciences. These exceptions were made to prevent thousands of higher tier students from going ungraded.

Around one third of schools and colleges in 2017 to 2018 had higher tier students who could have achieved 3-3 in combined science and many more schools had pupils who achieved a 4-3.

With no safety net now in place, Ofqual recommends that students with a target grade of 4 or 5 should be entered for foundation tier to prevent them from missing out on a grade entirely.15 Schools with a large number of exceptions made for higher tier grades 3 in 2017 to 2018 were asked to consider whether more students should be entered for foundation tier exams, as no exceptions would be made in 2018 to 2019. Schools appear to have been more cautious in 2018 to 2019, as there were fewer ungraded higher tier students compared with previous years.

Grades for AS and A levels have retained the same A* to E grading scale as before the reforms. For newly reformed subjects, the regulatory bodies have carried forward the grading standards from the previous year, so that candidates will receive the same grade as if they were taking the legacy qualification. However, the Joint Council for Qualifications cautions that comparisons between year-on-year outcomes are made during times of reform.14
The first examinations of the reformed A level mathematics qualifications, for students following a 2-year course of study, took place in summer 2019. These qualifications now have compulsory core content that includes pure mathematics, statistics and mechanics. A copy of the content can be found in the Ofqual Conditions document.2,3 The previous qualifications had pure mathematics in the compulsory content but offered students the opportunity to study either statistics, mechanics or decision mathematics, or a combination of these.

The content of the reformed qualifications was developed by the A level Content Advisory Board (ALCAB) panel for mathematics on behalf of the Department for Education. The specialist subject panel was made up of experienced academics from higher education.

Previously, A level maths qualifications were unised, enabling students to take a series of smaller assessments throughout their course of study. They were assessed at 2 levels (AS and A level) that were combined in the final result (giving the grade). The unised structure also enabled students to re-sit individual units as they progressed through their course of study—an opportunity that the majority took.

The new A levels are linear, so assessment takes place at the end of the course of study, which normally lasts 2 years. Students are examined on a wider body of content in each examination, enabling them to demonstrate their knowledge, understanding and skills across the full course of study, which reflects the government’s policy decision.

As a result of these changes, higher education and employers can have confidence that all A level mathematics students will have followed the same course of study and assessment that is appropriate for progression to further study or employment.

Impact of AS and A level reforms

STEM A levels have been updated with new content, developed with input from subject experts from universities and professional institutions and societies. The updated syllabuses include increased mathematical and quantitative content in physics, chemistry, biology and computer science. There has also been a significant overhaul in the computer content in physics, chemistry, biology and computer science.

The specialist subject panel was made up of experienced subject experts from universities on behalf of the Department for Education. The content of the reformed qualifications was developed with input from subject experts from universities and training.

There has also been a significant overhaul in the computer content in physics, chemistry, biology and computer science.

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Case study—Changes to A level maths

Janet Holloway, Associate Director Standards for Design, Development and Evaluation of General Qualifications, Ofqual

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There are concerns within the teaching community that despite the new A levels being more rigorous in terms of content and better at promoting independent learning, they are not adequately preparing students for the type of assessments they will face at university.4,5 For example, whereas STEM A level assessments are based entirely on end of year examinations, most engineering related degrees will involve frequent project work, group work and modular tests and examinations to make up the final degree classification.

The decoupling of AS and A level qualifications in England means that AS qualifications no longer contribute to final A level grades but are instead an optional supplementary qualification. An AS qualification is worth 40% of an A level in the Universities and Colleges Admissions Service (UCAS) points system. For university applications where courses use the tariff system, an A grade at AS level is worth 48 points and a grade at A level is worth 20.6,7

The decoupling and effective devaluing of AS level has led to AS entries falling to small numbers. In 2018 to 2019, there were 114,000 AS level entries, more than a 10-fold decrease from the 1.25 million entries in 2014 to 2015.8,9 Some universities are in favour of schools continuing to offer AS level qualifications, as these are useful predictions of A level performance and could be used as the deciding factor on results day if a student misses their target A level grades. Other universities are now placing greater emphasis on attainment at GCSE to predict A level performance.

School performance measures

School quality in England is assessed based on a number of performance measures, published in secondary school performance tables.10,11 The rationale of these performance measures, as provided in the DfE’s statement of intent, is to improve educational standards and provide an accessible source of comparative information on pupil progress and attainment.12,13

The headline performance measures14–16 used to rank secondary schools in the 2019 performance tables are:

• entries into the English Baccalaureate (Ebacc) – the percentage of pupils at a school taking GCSE qualifications in: English (language and literature), maths, science (double or triple science), a language (either modern or ancient) and a humanity (either geography or history) (Figure 2.4)

• Ebacc average point score (Ebacc APS) – the average point scores across the five pillars of the English Baccalaureate

• Progress 8—measured by calculating the progress that pupils have made between the end of key stage 2 and the end of key stage 4, compared with pupils across the country who attained similar results in key stage 2, based on outcomes in 8 qualifications: English, maths, 3 Ebacc subjects and 3 other GCSE or approved qualifications (Figure 2.5)

• Attainment 8—measured by attainment at key stage 4 in the same 8 qualifications as in progress 8

• pupil destinations—the percentage of students who continue on to education or employment after key stage 4

• attainment in English and maths—the percentage of pupils who achieve grade 5 (a ‘strong pass’) or above in English and maths GCSE

2.28 Ofqual. ‘GCE subject-level conditions and requirements for mathematics’, 2016.
2.29 The Conversation. ‘Why reformed A levels are not preparing undergraduates for university study’ [online], accessed 24/03/20.
2.32 Ofqual. ‘Vocational/qualifications, Progress 8 and ‘giving’’, 2018.
The impact of school performance measures on STEM subjects

The headline performance measures used in the school performance tables strongly influence which areas of the curriculum schools choose to spend time and resources on. This is good news for most STEM subjects, such as maths, physics, chemistry, biology and computer science, which are included in the EBacc and Progress 8 performance measures. These subjects have seen greater uptake by students (see the section on STEM GCSE entries and attainment for more in-depth discussion) and have been given more teaching time and budget since the introduction of the EBacc. Research by the National Foundation for Educational Research using data from the School Workforce Census has found that curriculum time allocated to EBacc subjects rose from 55% to 67% between 2010 and 2018.1,2 However, both the teaching and engineering communities have raised concerns that the EBacc incentivises a narrowed focus on ‘core’ STEM subjects to the detriment of non-EBacc STEM subjects, such as design and technology, which are vital for developing the breadth of skills needed for the engineering sector and the wider economy.2,3,4 Not only are these subjects being given less teaching time, but in subject specialist teachers are being replaced and budgets are being cut.1,4 This concerns the engineering and technology sectors, which rely on student participation in these subjects to grow their talent pool.

One reason given for the introduction of the EBacc was to ensure all students receive a core academic education that will open doors to higher education and employment. This is based on government concern that pupils at schools in disadvantaged areas are more likely to participate in what it considers ‘Mickey Mouse subjects’ that do not facilitate entry into higher education and employment.2,4 However, evidence suggests that there is still a clear gap in participation in the EBacc between students in advantaged and disadvantaged areas. In 2018 to 2019, only 27.5% of disadvantaged pupils were entered into the EBacc, compared with 44.5% of all other pupils.1,4 This disparity in EBacc participation exists even for high achieving disadvantaged pupils.

One argument in favour of Progress 8 is that it provides a positive step forward in how we measure school performance.1,2 This is because it does not focus only on attainment, which is strongly correlated with intake, but also on the degree to which students have improved in their academic achievements compared with students with similar prior attainment. This focus on progress rather than attainment incentivises schools to be accountable for the academic achievements of all students and not just the ones that need to get over the grade 4/5 or C/D threshold in exams.

However, Progress 8 does have limitations because it doesn’t take into account pupil characteristics, including level of disadvantage. Disadvantage is strongly correlated with progress at key stage 4, with disadvantaged pupils achieving lower Progress 8 scores on average. Another concern is that the focus on progress rather than attainment could instil lower academic expectations, given that colleges and universities base their acceptance decisions on attainment, not progress.

New Ofsted inspection framework

Following an in-depth consultation process, Ofsted published a new education inspection framework that has been used in school inspections since September 2019.3 It is claimed to be ‘the most evidence-based, research informed and tested framework in Ofsted’s 26-year history’.1,3 The new inspection framework is intended to redress the focus on the curriculum, reduce unnecessary workload for teachers and ensure students have access to high-quality education.

Some of the main changes include:

• a new quality of education judgement to focus inspection on what pupils learn through the curriculum and reduce reliance on performance data, meaning that pupil outcomes won’t be the primary factor for inspection judgement
• an end to the collection of internal performance data, with the aim of reducing the administrative workload for teachers
• an end to the culture of ‘teaching to the test’ and off-teaching students with poor academic performance
• a new separate behaviour judgement to give parents reassurance that behaviour in the school is good

The inspection framework states that schools should have high and equal aspirations and provide an ambitious curriculum that all pupils study. The curriculum must be broad and balanced, providing a wide range of subjects that are coherent and well sequenced.

We welcome the ambitions of these changes, given how interwoven subjects are in the real world – especially in the application of engineering – and we will be watching closely how they are implemented in practice.

2.3 – STEM GCSEs in England, Wales and Northern Ireland

In the academic year 2018 to 2019, over 5.5 million GCSE results were issued,4,5 with pupils sitting exams for an average of 8 or 9 subjects.

GCSEs are an important stage in engineering educational pathways as they are globally recognised academic qualifications that are highly valued by schools, colleges and employers. Entry and attainment rates in GCSE subjects that facilitate engineering provide a useful early indicator of the supply of potential engineers entering educational pathways towards engineering.

GCSE selection is the first opportunity for students to choose which subjects to study and which to drop. Students may be offered the choice between taking the double award science GCSE (combined science) or the triple award science subjects (separate sciences).1,6,7 They may also choose to take elective STEM subjects, such as design and technology, and computer science. GCSE subject choices and results shape the options available to young people in terms of their next qualifications, university application and overall career prospects.

STEM GCSE entries

In 2018 to 2019, the total number of GCSE entries in England, Wales and Northern Ireland was just over 5.5 million, increasing in step with the growing population of 16 year olds (increases of 1.4% and 1.5%, respectively).1,4

As can be seen in Figure 2.6, there were increases in entries for some GCSE STEM subjects in the academic year 2018 to 2019, including large increases in computing (up 7.2%), maths (up 4.2%) and double science (up 4.8%). These smaller increases of around 1% in biology, chemistry and physics. Other GCSE STEM subjects had striking decreases in entries including ICT (down 82.9%), engineering (down 31.1%) and design and technology (down 21.7%).

The dramatic decrease in entries for ICT GCSE was due to the discontinuation of the subject, which in 2018 to 2019 was only available in Wales. Many students who would have chosen to take ICT GCSE are now studying computing, which has contributed to the uplift in computing GCSE entries. However, total entries into computing are still worryingly low given the growing dominance of the tech sector and the need for computer science skills.

The EBacc is changing the subjects students are choosing to study at GCSE: over the past 5 years, entries in STEM subjects included in the performance measure substantially increased while entries for those excluded significantly decreased.

Maths entries are increasing, in part due to the requirement for those entering post-16 education to have a minimum of a grade 4 in both GCSE maths and English. This has resulted in a growing number of people aged 17 or over taking maths GCSE. In addition, more independent schools are entering their pupils into GCSEs instead of international GCSEs (IGCSEs), which are not counted in the entry statistics.4,5

When looking at the change in STEM GCSE entries over the last 5 years, a clear pattern emerges: entries for all STEM subjects included in the EBacc have increased substantially, whereas entries for all STEM subjects not included in the EBacc have decreased considerably. For example, GCSE entries in biology, chemistry and physics have increased by over 20% over 5 years, whereas engineering GCSE entries have decreased by 31% and design and technology by 53.5%. It seems apparent that the EBacc is changing the subjects students are choosing to study at GCSE. Five years ago there was a 70:30 split between entries into EBacc and non-EBacc subjects, whereas now the divide is 80:20.5,6 It is important that the engineering community considers how this will impact the skillsets of young people entering post-16 education and training.

Figure 2.6 Changes in GCSE entries over time in selected STEM subjects (2013/14 to 2018/19) – England, Wales and Northern Ireland

<table>
<thead>
<tr>
<th>Subject</th>
<th>Entries in 2018/19 (No.)</th>
<th>Change over 1 year (%)</th>
<th>Change over 5 years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>177,454</td>
<td>0.6 ▲</td>
<td>25.1 ▲</td>
</tr>
<tr>
<td>Chemistry</td>
<td>170,034</td>
<td>1.0 ▲</td>
<td>23.0 ▲</td>
</tr>
<tr>
<td>Computing</td>
<td>80,027</td>
<td>7.2 ▲</td>
<td>37.7 ▲</td>
</tr>
<tr>
<td>Design and technology</td>
<td>99,659</td>
<td>-21.7 ▼</td>
<td>-53.3 ▼</td>
</tr>
<tr>
<td>Engineering</td>
<td>3,424</td>
<td>-31.1 ▼</td>
<td>-31.9 ▼</td>
</tr>
<tr>
<td>ICT</td>
<td>9,515</td>
<td>-82.9 ▼</td>
<td>-90.2 ▼</td>
</tr>
<tr>
<td>Mathematics</td>
<td>778,858</td>
<td>4.2 ▲</td>
<td>5.8 ▲</td>
</tr>
<tr>
<td>Physics</td>
<td>168,330</td>
<td>1.7 ▲</td>
<td>22.7 ▲</td>
</tr>
<tr>
<td>Science: double award</td>
<td>839,258</td>
<td>4.8 ▲</td>
<td>6.3 ▲</td>
</tr>
</tbody>
</table>

All subjects | 5,547,447 | 1.4 ▲ | 6.3 ▲ |

Source: JCQ. ‘GCSE (Full Course) Results, Summer data, 2014 to 2019, included in the academic year 2017 to 2018 in a new combined science award dataset. This replaces the single GCSE awards in sciences and additional science. The entries will be included to reflect the uptake of the dataset.

– denotes no value available as subject was introduced after 2014 or has been discontinued.

To view this table with numbers from 2010/11 see Figure 2.6 in our saved resource.

2.3.1 Ofsted launches a consultation on proposals for changes to the education inspection framework’, 2019.
The perfect storm for Design and Technology in secondary schools

The number of secondary school students studying design and technology (D&T) subjects in Key Stage 4 is in long-term decline. Between the academic years 2002 to 2003 and 2018 to 2019, the number of pupils studying D&T at GCSE has fallen by over three quarters (77%), from 439,600 students to 99,700.A,B

This considerable drop is concerning for the engineering sector because, as stated in a report by the James Dyson Foundation, “D&T is the subject that most directly equips students with the skills they need to become engineers”.C,D,E,F

Understanding the reasons why D&T is in decline is necessary if we wish to reverse the trend. In a speech to the Innovative Conference in 2019, Amanda Spielman, Ofsted’s Chief Inspector of Education, outlined the main contributing factors that has built up to a ‘perfect storm’ for D&T over the past 20 years.G,H,I

Some of the key points have been summarised below.

Changes to education policy

D&T stopped being a compulsory subject in Key Stage 4 in 2000. Since then, schools have been able to choose whether or not to offer the subject. In 2004, BTECs and vocational qualifications were given equivalent value in the league tables to GCSEs, which dramatically changed the subjects students were selecting at GCSE and A level, with D&T GCSE losing ground faster than focusing on innovation and new design. Typically, pupils would be given closed briefs to design near-identical products using traditional technologies. In 2017 a new D&T GCSE curriculum was introduced, which has made steps to improve and modernise D&T with the addition of newer technologies and approaches to design including robotics, 3D printing and iterative product design.

Outdated and uninspiring course content

The previous specification for D&T GCSE was heavily weighted towards knowledge and traditional skills rather than focusing on innovation and new design. Typically, pupils would be given closed briefs to design near-identical products using traditional technologies. In 2017 a new D&T GCSE curriculum was introduced, which has made steps to improve and modernise D&T with the addition of newer technologies and approaches to design including robotics, 3D printing and iterative product design.

Perceptions of D&T

D&T has an image problem as there is little of a clear understanding of what the subject involves. It isn’t considered to be an academically rigorous subject and is not given the same credence as other STEM subjects, such as engineering and maths. It is associated with a narrow set of skills, such as ‘wood working’ or ‘fixing things’ and is considered a subject that is more suited to boys than girls.

The only exceptions are maths and physics, in which boys perform marginally better than girls. The differences in attainment for elective STEM subjects are even larger, with girls far outperforming boys in some subjects. For example, girls outperform boys in electrical and electronic engineering; girls’ GCSE pass rate in this area is 58.5% compared with 55.0% for boys, a difference of 3.5 percentage points. However, here we need to take account of the small sample sizes – only 235 (10.4%) of entries into engineering GCSE were made by girls. Similarly, there was a 15.9 percentage points gender gap in design and technology, where 75.0% of girls achieved grades A* to C or 9 to 4 compared with 59.1% of boys.

Despite lower than average pass rates for some STEM subjects, Figure 2.9 shows that pass rates for all of them increased between 2017 and 2019, with large increases in for ICT (up 7.7 percentage points), engineering (up 6.5 percentage points) and design and technology (up 2.0 percentage points). Some GCSE STEM subjects have seen considerable changes in pass rates over 5 years. For example, pass rates in engineering GCSEs have increased by over 10 percentage points, from 41.6% in 2013 to 2014 to 52.3% in 2018 to 2019.

Figure 2.9 Changes in GCSE pass rates over time in selected STEM subjects (2013/14 to 2018/19) – England, Wales and Northern Ireland

Table: GCSE subjects with the lowest participation by girls is engineering, in which they account for only one in 10 entries (10.4%). This is followed by computing (21.4%) and design and technology (29.8%)female.

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### STEM GCSE entries by gender

The subject with the lowest participation by girls is engineering, in which they account for only one in 10 entries (10.4%). This is followed by computing (21.4%) and design and technology (29.8%)female.

### STEM GCSE attainment

GCSE pass rates, as measured by the percentage of entries resulting in grades A* to C or 9 to 4, were more or less the same in 2018 to 2019 as the previous academic year, with just a small increase of 0.4 percentage points.1.2 The pass rate across all GCSE subjects currently stands at 67.3% and this has remained stable for the past 5 years.

### STEM GCSE attainment by gender

Girls outperform boys in almost all GCSE STEM subjects in terms of pass rates at A* to C or 9 to 4. For example, the pass rate in double award science was 58.5% for girls and 53.4% for boys, a difference of 5.1 percentage points. The only exceptions are maths and physics, in which boys perform marginally better than girls. The differences in attainment for elective STEM subjects are even larger, with girls far outperforming boys in some subjects. For example, girls outperform boys in electrical and electronic engineering; girls’ GCSE pass rate in this area is 58.5% compared with 55.0% for boys, a difference of 3.5 percentage points. However, here we need to take account of the small sample sizes – only 235 (10.4%) of entries into engineering GCSE were made by girls. Similarly, there was a 15.9 percentage points gender gap in design and technology, where 75.0% of girls achieved grades A* to C or 9 to 4 compared with 59.1% of boys.

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Regional trends in STEM GCSE attainment

The proportion of students achieving A* to C or 9 to 4 in their GCSEs varies between England, Northern Ireland and Wales. Within England, the difference between the regions with the highest and lowest pass rates is 6.8 percentage points.2,20 As shown in Figure 2.12, London has the highest proportion of students attaining grades 4/C and above, at 70.6%, closely followed by the South East at 70.2%. The West Midlands and the North East have the lowest pass rates at 4/C and above, at 53.8% for both regions.

There is substantial regional variation in pass rates for GCSE STEM subjects.2,19 For maths, the difference between the counties with the highest and lowest pass rates was 26.5 percentage points in 2018 to 2019. Qualifications Wales has called on the Welsh government and regulators to work together to understand the reasons behind the long-term decline.

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It’s important to understand the regional context, including levels of deprivation, when interpreting regional differences in attainment. A report by the Institute for Public Policy Research found that when factors that are outside a school’s control are taken into account, such as levels of deprivation, special educational needs and gender, schools in poor performing areas are actually adding more value to their pupils’ learning than those in other parts of the country.1,11

2.4 — STEM National 5s in Scotland

National 5s are the qualifications Scottish pupils take at age 15 or 16. They are broadly equivalent to GCSEs. Students typically study between 6 and 8 National 5 subjects, which are assessed through a mix of coursework and exams. Subjects range from traditional academic subjects, including maths and sciences, to more practical subjects, such as electronics and woodworking. They are graded from A to D and ‘No award’, with grades A to C equivalent to GCSE grades 9 to 4.

In 2017 to 2018, changes were made to the National 5 qualifications, removing mandatory unitised assessments to reduce the assessment workload for teachers and students. Grades are now based on final exams and externally assessed coursework.

STEM National 5 entries

As can be seen in Table 2.12, the most popular STEM subjects in 2018 to 2019 in terms of National 5 entries were maths (41,586), biology (21,549), chemistry (16,035) and physics (13,792). Entries in these subjects were more-or-less stable, with the exception of biology where there was 3.0% increase.

There were large increases in entries for some applied STEM subjects, including the newly introduced applications of mathematics (up 79.6%), music technology (up 25.7%), practical electronics (up 16.8%) and practical woodworking (up 11.6%). However, there were worrying decreases in entries in some engineering facilitating STEM subjects, including engineering science (down 9.0%), design and manufacture (down 2.6%) and fashion and textile technology (down 14.0%).

Over 4 years, National 5 entries for maths increased by 14.0%, probably due to the discontinuation of the life skills mathematics course, which was last examined in summer 2017. Across the same time period, there were decreases in entry for computing science (down 17.2%), administration and IT (down 13.1%) and design and manufacture (down 12.3%); these are key subjects for the engineering sector, so this is a concern. Encouragingly, there have been substantial increases in entries for some practical subjects, including practical electronics (up 67.2%), practical metalworking (up 35.7%) and practical woodworking (up 23.8%).

To view this table with entries from 2014/15, see Figure 2.13 in our Excel resource.

2.5 Institute for Public Policy Research. “Northern schools putting education at the heart of the northern powerhouse”, 2016.

2.51 Ibid.
2.5 – STEM in England, Wales and Northern Ireland

A level entries for STEM subjects in 2018/19.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Percentage of total</th>
<th>Number of entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>11.5%</td>
<td>91,895</td>
</tr>
<tr>
<td>Biology</td>
<td>8.6%</td>
<td>69,196</td>
</tr>
<tr>
<td>Psychology</td>
<td>8.1%</td>
<td>64,598</td>
</tr>
<tr>
<td>Chemistry</td>
<td>7.4%</td>
<td>59,090</td>
</tr>
<tr>
<td>History</td>
<td>6.4%</td>
<td>51,438</td>
</tr>
<tr>
<td>Art and design subjects</td>
<td>5.3%</td>
<td>42,307</td>
</tr>
<tr>
<td>English literature</td>
<td>5.1%</td>
<td>40,824</td>
</tr>
<tr>
<td>Physics</td>
<td>4.9%</td>
<td>38,958</td>
</tr>
<tr>
<td>Sociology</td>
<td>4.7%</td>
<td>38,015</td>
</tr>
<tr>
<td>Geography</td>
<td>4.4%</td>
<td>34,960</td>
</tr>
</tbody>
</table>


To view this table with entries from 2011/12 and the percentage of female entrants, see Figure 2.15 in our Excel resource.

STEM A level entries by gender

Boys are still substantially more likely than girls to choose to study A level STEM subjects that typically serve as entry requirements for engineering-related higher education courses – see Figure 2.17. These include physics (77.4% boys), design and technology (68.2% boys), maths (51.3% boys) and further maths (71.5% boys).

In 2018/19, entries into computer science GCSE increased by 8.1%.
For the first time ever, in 2018 to 2019 girls outnumbered boys across the core sciences (biology, chemistry and physics), comprising 50.3% of entries. However, this overall figure was driven largely by entries for biology, where girls accounted for 62.9%, and chemistry (53.7%) girls. Girls are still considerably under-represented in physics, for which they only made up 22.6% of entries. Encouragingly, in 2018 to 2019 there was an 11.2% increase in female entries for chemistry and an increase of 4.9% in physics compared with the previous academic year.

The underrepresentation of girls is most stark in computing, where only 13.3% of entries were from girls. Female entries went up by 21.8% compared with 2017 to 2018, but as computing is a new subject, this represents an increase of only 264 entrants.

When we look at entries over the longer term, there are signs of movement towards greater gender parity in A level STEM subjects. In all STEM subjects apart from ICT and biology, there is a rise in the percentage of girls among entrants. ICT has the largest gender difference, with 73.4% of girls and 65.6% of boys achieving pass grades, a 10.5 percentage points difference. Girls also far outperform boys in design and technology at A level: 73.9% of girls and 62.9% of boys attained A* to C grades.

In STEM A level subjects, girls were more likely than boys to attain pass grades in biology, design and technology, maths and physics, whereas boys performed better in chemistry and computer science. For most STEM subjects, the gender difference in pass rates is small, but there are large gender attainment gaps for some. ICT has the largest gender difference, with 73.4% of girls and 62.9% of boys achieving passing grades, a 10.5 percentage points difference. Girls also far outperform boys in design and technology, with 73.9% of girls and 65.6% of boys attaining A* to C grades, an 8.3 percentage points difference.

2.62 The ‘sawtooth effect’ is a pattern of change caused by assessment reform. Specifically, performance in high stakes assessments is often adversely affected when that assessment undergoes reform, followed by improving performance over time as students and teachers gain familiarity with the new test.
National and regional trends in STEM A level attainment

Students in Northern Ireland consistently outperform their English and Welsh counterparts when it comes to STEM A level results, just as they do at GCSE. For physics, the A to C pass rate in Northern Ireland was 80.6%, compared with 74.2% in Wales and 70.7% in Northern Ireland. Similarly, for mathematics the pass rate in Northern Ireland is far higher at 89.0% than in Wales (76.6%) or England (75.1%). However, any comparisons between UK nations must be handled with caution because the devolution of secondary education policy means that the attainment statistics are not directly comparable.

Figure 2.20 shows the variation in A to C pass rates across all STEM subject by nation and region. In England, the South East has the highest pass rate at 78.0%, followed by the North East with 76.3%. The West Midlands and Yorkshire and the Humber had the lowest A to C pass rates at 72.8% and 74.7% respectively.

For physics, the difference in pass rates between the highest and lowest pass rates was 40.9 percentage points. Computing science had the lowest pass rate, with 68.1% of students achieving an A to C grade. The STEM subjects with the lowest pass rates were Earth science, human biology or physics, and design and manufacture, with 59.8% and 61.9% respectively. The STEM subjects with the highest pass rates were mathematics (89.7%), chemistry (87.2%) and computing science (85.4%).

The proportion of entries resulting in A to C grades in 2018 to 2019 across all Higher subjects stands at 74.8%, a slight decline on 2017 to 2018 when it was 76.8%. The STEM subjects with the highest pass rates in 2018 to 2019 were mathematics and IT (78.4%), chemistry (75.5%) and physics (74.8%). The STEM subjects with the lowest pass rates were design and manufacture (54.2%), computing science (63.9%) and engineering science (65.3%).

A to C pass rates in all STEM subjects, except for administration and IT, were notably lower compared with the previous year. There were large decreases in fashion and textile technology (down 7.2 percentage points) and design and manufacture (down 6.9 percentage points). Computing science and engineering science also saw notable decreases in pass rates (down 4.8 and 4.1 percentage points respectively).

To view this table with attainment from 2015/16, see Figure 2.23 in our Excel resource.

2.6 – STEM Highers and Advanced Highers in Scotland

In Scotland, fifth and sixth year students (equivalent to years 12 and 13 in England) typically sit Higher and Advanced Higher qualifications. Higher qualifications are broadly equivalent to the legacy AS levels, whereas Advanced Highers are considered slightly harder than A levels. Most Scottish universities require students to have Higher qualifications to be accepted on a course, whereas English universities typically require students to have Advanced Highers. Higher and Advanced Higher qualifications cover a wide range of subjects, including academic and applied subjects, and are graded at A to D.

In Scotland, some educational establishments give students the option to take the Scottish Baccalaureate in Science. There are 4 different study groups for students, each of which involves studying a group of coherent subjects. The science baccalaureate is a 2-year course that comprises a mandatory component in mathematics (or mathematics of mechanics or statistics), plus one of the following 2 options:

- 2 core courses, which include biology, chemistry, environmental science, human biology or physics
- 1 core and 1 broadening course, chosen from computer science, design and manufacture, engineering science, graphic communication, geography or psychology

Students also have to produce an interdisciplinary project, which aims to add breadth and value, and equip students with the skills and confidence needed for the move into higher education.

Students are graded on each component of the course and also receive either a pass or distinction grade on completion of the baccalaureate.

STEM Higher qualifications in 2018 to 2019, the number of entries into Higher qualifications decreased by 3.1% compared with the previous year. Of the STEM subjects, maths had the highest number of entries (18,266), followed by chemistry (10,047) and physics (8,225) (Figure 2.21).

There were large declines in entries for some STEM subjects compared with 2017 to 2018; entries in fashion and textile technology dropped by 41%, computing science by 21% and design and manufacture by 20%. Promisingly, engineering science saw a 9.5% increase in entries compared with 2017 to 2018, up from 1,014 to 1,110.

The proportion of entries resulting in A to C grades in 2018 to 2019 across all Higher subjects stands at 74.8%, a slight decline on 2017 to 2018 when it was 76.8%. The STEM subjects with the highest pass rates in 2018 to 2019 were administration and IT (78.4%), chemistry (75.5%) and physics (74.8%). The STEM subjects with the lowest pass rates were design and manufacture (54.2%), computing science (63.9%) and engineering science (65.3%).

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To view this table with attainment from 2015/16, see Figure 2.23 in our Excel resource.

2 – Secondary education

STEM Advanced Higher qualifications

Entries into Advanced Higher qualifications were down 3.6% Figure 2.22 shows that in the 2018 to 2019 academic year compared with the previous year. The most popular STEM subjects for Advanced Highers, in terms of entries, were mathematics, chemistry, and biology. The most popular STEM subjects for the lowest pass rates were design and manufacture (64.6%), computing science (65.5%) and biology (74.1%).

A to C pass rates across all Advanced Higher subjects remained stable. Some STEM subjects saw very large year-on-year increases in pass rates. For example, engineering science and design and manufacture increased by 15.5 and 10.8 percentage points respectively.
### 2.7 – STEM teacher shortages

The UK secondary education sector faces a longstanding issue of teacher shortages. Data from the 2018 School Workforce Census shows that the number of teachers in state secondary schools in England has been falling since 2011, whereas pupil numbers have been growing. As a result, pupil-teacher ratios (PTR) in England rose to 16.3 in 2018, continuing an upward trend since 2011 (Figure 2.23). There is considerable variation in PTR across the UK. Wales has the highest PTR at 17.0 pupils for every teacher, whereas Northern Ireland has a lower PTR at 15.7. Scotland has the lowest PTR at 12.4.

#### Figure 2.23 – Pupil-teacher ratios in state funded secondary schools (2011 to 2018) – England

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTR</td>
<td>14.9</td>
<td>14.9</td>
<td>15.0</td>
<td>15.0</td>
<td>15.3</td>
<td>15.6</td>
<td>15.8</td>
<td>15.3</td>
</tr>
</tbody>
</table>


Teacher shortages follow a socio-economic gradient, with schools in the most disadvantaged areas reporting the highest number of vacancies and positions filled by temporary staff. Outside London, around 29% of secondary schools in the most disadvantaged areas reported teaching vacancies or temporarily filled roles compared with 22% in the most advantaged areas – a 7 percentage points difference. Within London, the socio-economic gradient is much larger, with 46% of schools in the most disadvantaged areas reporting vacancies compared with 26% of schools in the most advantaged areas – a 20 percentage points gap. It is therefore important that the Department for Education and recruitment initiatives consider the influence of disadvantage on teacher shortages and focus on the areas that are most in need.

Teacher vacancies by subject

As can be seen in Figure 2.24, teacher vacancies are most acute for STEM subjects. The STEM subjects with the highest teacher vacancy rates in 2018 were information technology and science, both with 1.6 vacancies for every 100 filled roles, followed by mathematics and design and technology, which each have 1.2 vacancies for every 100 filled roles. This compares with an average vacancy rate of 1.0 per 100 filled roles across all subjects and as low as 0.4 to 0.5 per 100 filled roles for non-STEM subjects, including drama, PE, the arts and history. It should be noted, however, that vacancy statistics are unlikely to fully reflect recruitment difficulties, in part because they are collected in November when vacancy rates are comparatively low.

#### Figure 2.24 – Teacher vacancy rates in state funded secondary schools by subject taught (2013 to 2018) – England

<table>
<thead>
<tr>
<th>Subject</th>
<th>Main subject taught</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information technology</td>
<td></td>
<td>1.0</td>
<td>1.5</td>
<td>1.5</td>
<td>1.8</td>
<td>1.8</td>
<td>1.6</td>
</tr>
<tr>
<td>All sciences</td>
<td></td>
<td>1.0</td>
<td>1.4</td>
<td>1.3</td>
<td>1.6</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Commercial/business studies</td>
<td></td>
<td>0.4</td>
<td>0.8</td>
<td>0.9</td>
<td>0.8</td>
<td>1.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Mathematics</td>
<td></td>
<td>1.1</td>
<td>1.4</td>
<td>1.3</td>
<td>1.3</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Design and technology</td>
<td></td>
<td>0.6</td>
<td>1.1</td>
<td>0.9</td>
<td>2.1</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>English</td>
<td></td>
<td>1.0</td>
<td>1.3</td>
<td>1.0</td>
<td>1.2</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Computing</td>
<td></td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Geography</td>
<td></td>
<td>0.6</td>
<td>1.2</td>
<td>1.2</td>
<td>1.3</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Music</td>
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<td>0.3</td>
<td>1.0</td>
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<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
</tr>
<tr>
<td>Languages</td>
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<td>0.7</td>
<td>0.7</td>
<td>1.0</td>
<td>0.6</td>
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<tr>
<td>Social sciences</td>
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<td>1.4</td>
<td>0.7</td>
<td>0.8</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>Religious education</td>
<td></td>
<td>0.7</td>
<td>0.6</td>
<td>0.4</td>
<td>1.0</td>
<td>0.7</td>
<td>0.6</td>
</tr>
<tr>
<td>History</td>
<td></td>
<td>0.4</td>
<td>0.8</td>
<td>0.7</td>
<td>0.6</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Art/visual design</td>
<td></td>
<td>0.5</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Physical education/sport/dance</td>
<td></td>
<td>0.3</td>
<td>0.4</td>
<td>0.3</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Drama</td>
<td></td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.6</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>All subjects</td>
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<td>0.8</td>
<td>1.1</td>
<td>1.0</td>
<td>1.1</td>
<td>1.1</td>
<td>1.0</td>
</tr>
</tbody>
</table>


#### Figure 2.25 – Teacher Supply Model target and vacancy rates for state-funded secondary schools

<table>
<thead>
<tr>
<th>Subject</th>
<th>2018/19 (provisional)</th>
<th>2019/20 (provisional)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target</strong></td>
<td><strong>Recruited</strong></td>
<td><strong>Contributions to</strong></td>
</tr>
<tr>
<td><strong>target (%)</strong></td>
<td><strong>target (%)</strong></td>
<td><strong>Target</strong></td>
</tr>
<tr>
<td><strong>Computing</strong></td>
<td>723</td>
<td>540</td>
</tr>
<tr>
<td><strong>Design and technology</strong></td>
<td>1,167</td>
<td>299</td>
</tr>
<tr>
<td><strong>Mathematics</strong></td>
<td>3,116</td>
<td>2,174</td>
</tr>
<tr>
<td><strong>Total science, of which:</strong></td>
<td>3,460</td>
<td>3,236</td>
</tr>
<tr>
<td><strong>Biological</strong></td>
<td>1,188</td>
<td>1,819</td>
</tr>
<tr>
<td><strong>Chemistry</strong></td>
<td>1,053</td>
<td>838</td>
</tr>
<tr>
<td><strong>Physics</strong></td>
<td>1,219</td>
<td>579</td>
</tr>
</tbody>
</table>


#### STEM teacher supply

The Teacher Supply Model (TSM) is used to predict the number of postgraduate initial Teacher Training (ITT) places that need to be filled to provide enough qualified teachers for the state funded school sector in England. According to the model, ITT targets have not been reached since 2011 to 2012. The state secondary school sector currently requires 20,087 entrants into ITT in 2019 to 2020 in order to reach ITT targets, though provisional data suggests that just 85.1% of this target has been achieved.

Figure 2.25 shows that ITT recruitment targets weren’t met in any STEM subjects in the academic year 2018 to 2019, except for biology, which was at 153.1% of the target. The subjects furthest from meeting their recruitment targets were design and technology, where only one quarter (25.6%) of the target was achieved, and physics, where less than half (47.5%) of the target was achieved. The provisional data for 2019 to 2020 suggests that recruitment of STEM teacher trainees is still a problem.

In 2018, no ITT recruitment targets were met for any STEM subjects except for biology. The subjects furthest from meeting their targets were design and technology and physics.

#### STEM teacher specialism

A teacher is considered a subject specialist if they have a relevant post-A level qualification in the subject they teach. Although a degree may not be necessary to be a good teacher, evidence suggests that it is a good predictor of teacher quality, particularly in maths and sciences. Analysis conducted by the DfE finds a positive association between specialist teaching in maths and student attainment in the subject at the end of key stage 4 in England. Figure 2.26 shows that teacher specialism rates vary widely between STEM subjects in England. For example, biology, where there is no shortage of teachers, has a very high specialism rate (89.6%) compared with chemistry (72.3%) and physics, which has the lowest specialism rate of the science subjects (62.7%). Engineering has the lowest level of teacher specialism of any STEM subject, with only 17.0% of engineering teachers having relevant post-A level qualifications. Teacher specialism is also a concern in computing, where just 36.0% of teachers have relevant qualifications.

There is a clear socio-economic gradient when it comes to access to subject specialist teaching in STEM subjects across England. Research by the Education Policy Institute found an 11 percentage points gap between the most deprived and least deprived areas in London in terms of the proportion (45% compared to 56%) of maths teaching hours being taught by a subject specialist. Outside London this gap increases to 14 percentage points, with 51% of maths teaching hours taught by subject specialists in the least deprived areas, compared with only 37% in the most deprived areas. For physics, the socio-economic gradient outside London is more extreme, with 52% of physics teaching hours taught by subject specialists in the least deprived areas, compared with just 17% in the most deprived areas – a 35 percentage points gap. This highlights the need to hire more specialist STEM teachers in deprived areas, particularly in physics.
Secondary schools are struggling to attract and recruit STEM teachers, in large part due to teaching salaries being uncompetitive compared with the considerably higher salaries offered by careers within industry.

As can be seen in Figure 2.27, STEM graduates tend to earn more in professions outside teaching, whereas non-STEM graduates with degrees in English, modern foreign languages, history and PE tend to earn more within the teaching profession. The largest pay difference is for physics graduates, where non-teachers earn on average £6,400 more per year than teachers. However, differences in pay may be due to the type of people who choose to go into teaching, as well as being due to the job itself.

STEM graduates tend to earn more in professions outside teaching, whereas non-STEM graduates with degrees in English, modern foreign languages, history and PE tend to earn more within the teaching profession.

Among newly qualified science teachers, those with a physics or engineering degree are most likely to leave the profession. The odds of this sub-group leaving teaching within their first 5 years is 29% higher than for non-science newly qualified teachers.224 The problem is compounded by the fact that there is a high demand for graduates in these degree subjects in both teaching and other sectors. They are therefore more likely to find jobs with more competitive pay than graduates with degrees in other subjects.

Some of the reasons why STEM teachers are leaving teaching are common across the teaching profession generally. A survey of 1,200 current and former teachers by the UCL Institute of Education found that the top reasons given for leaving teaching were:2.226

- to improve work life balance (75%)
- workload (71%)
- target driven culture (57%)
- government initiatives (43%)
- lack of support from management (38%)

Teaching salaries were affected by public sector pay freezes between 2010 and 2013 and caps in pay increases between 2013 and 2018. During this time, teachers’ real average hourly pay fell by 1.5%, which was more than other public sector professions, including nursing and policing.2.211 The National Union of Teachers (NUT) pay loss calculator found that teachers were more than £5,000 a year worse off in real terms compared with 2010 due to the pay freeze.2.212

In July 2019, the government announced a 2.75% uplift to teachers’ pay rates for the 2019 to 2020 academic year.2.213 Although pay increase has been welcomed by the teaching community, the National Education Union says it is not enough to address the erosion of the value of teacher pay against inflation and earnings in the wider economy.2.214 The government has also announced that it is committed to increasing minimum teacher starting salaries (MNTS) by September 2020. We welcome the government’s ambition as it is crucial for the engineering sector that teaching STEM subjects is considered a well-respected and well-paid career option.

STEM teachers exit rates

STEM teachers have higher exit rates compared with other subject teachers, both in terms of leaving their current job to teach at another school and leaving the teaching profession entirely. A report by Education Datalab shows that science teachers are 26% more likely to leave their school and 5% more likely to leave the teaching profession within 5 years than similar non-science teachers.2.215

Exit rates are much higher for teachers early in their careers. For newly qualified science teachers, the odds of leaving their first school is 35% higher than newly qualified teachers in other subjects and 20% higher for leaving the profession within the first 5 years of teaching.2.216

The proposed initiatives to meet these challenges include:

- simplifying the accountability system to reduce unnecessary workload
- transforming support for early years teachers
- ensuring teaching remains an attractive career as lifestyles and aspirations change
- making it easier for people to become teachers

The government’s teacher recruitment and retention strategy2.229 builds upon myriad retention and recruitment initiatives designed to recruit additional teachers and encourage teacher retention since 2015, many of which focus on STEM subjects. A selection of the initiatives focusing on recruiting, training and retaining STEM subject teachers are outlined below.

### Bursaries and scholarships

The government offers financial incentives to encourage recruitment into initial teacher training in understaffed subjects. In the academic year 2016 to 2017, 16,600 tax-free bursaries and 330 tax-free scholarships were awarded to trainee teachers at a total cost of £191 million.2.231 Figure 2.28 shows that the level of bursary a trainee is eligible for depends on the teaching subject. For the 2020 to 2021 initial teacher training intake, postgraduate trainees looking to teach ‘priority subjects’, including physics, maths, chemistry and computing, are eligible for a scholarship of £28,000 or a bursary of £26,000. Financial support for ‘non-priority’ subjects is lower: for example, the bursaries for art and design, history, music and religious studies are £9,000.2.232

The government has also announced that it is committed to recruiting, training and retaining STEM subject teachers are common across the teaching profession. A selection of the initiatives focusing on recruiting, training and retaining STEM subject teachers are outlined below.
Case study – National Centre for Computing Education (NCCE)

Julia Adamson, Director of Education, BCS, The Chartered Institute for IT

A high-quality computing education equips young people with the knowledge, understanding and computational thinking skills to thrive in our increasingly digital world. Taking steps to improve the provision of computing education is key to meeting the evolving needs of the UK economy and its labour market.

In 2018, a consortium made up of STEM Learning, BCS, The Chartered Institute for IT and the Raspberry Pi Foundation established the National Centre for Computing Education (NCCE). The 4-year programme was created with government funding of £34 million, with the aim of upskilling thousands of computing and computer science teachers in England so that every child could benefit from a world-leading computing education. The NCCE website is an important resource for teachers, where they can find tailored, region-specific information on CPD opportunities and bursaries, and a complete curriculum programme of training.

The NCCE is already seeing signs of success. The first cohort of GCSE computer science teachers graduated from the NCCE’s Computer Science Accelerator CPD course, culminating in a wonderful celebration event at Google HQ. Subsequent cohorts are currently participating in a wide range of other subject knowledge CPD activities. As of February 2020, 4,260 teachers had attended a range of CPD courses.

Almost 14,500 teachers have engaged with the NCCE from almost 4,500 primary and 2,000 secondary schools. Helen Brant, an NCCE graduate, successfully transitioned from teaching music to teaching computer science. She said: “There’s a definite correlation between learning an instrument and learning how to programme. Both can be frustrating, but very rewarding when you get them right. There was a community of people on the course, all starting from different levels. We shared feedback on each other’s work and if I got stuck, there were a plethora of resources that I could draw on. All the online courses were free, and the face-to-face courses were bursary-supported, which covered my time out of the classroom.”

The NCCE is also receiving support from industry.

Employers have shown interest in providing sponsorship for the NCCE, with over £1.5 million pledged to support online courses and additional bursaries for teachers from priority schools, as well as a wide range of pro bono support.

The NCCE has come a long way since its launch in 2018 and although there are many challenges ahead, there is a lot to be hopeful about in the near future!

Case study – Training a new generation of teachers

Richard Warrensca, Project Manager, Future Teaching Scholars

The Future Teaching Scholars programme was launched in 2015 as a unique approach to teacher training, with the aim of bringing more exceptional maths and physics students into the teaching profession. We need passionate and brilliant teachers in order for us to develop the next generation of engineers, scientists, innovators and inventors.

Unlike other routes into teaching, this programme allows students, who truly love their subject, to continue that in-depth study on a full-time course at university while also learning about teaching and undertaking practical in-school experiences throughout their undergraduate study.

A Future Teaching Scholar is a special kind of maths and physics graduate. They become subject specialists who have taken part in a 3-year structured programme of learning, delivered by outstanding Teaching Schools, preparing them to teach. During their undergraduate years, these students spend time in schools and have many classroom experiences including teaching, team teaching and lesson study, and spend time learning about creating the conditions needed for high quality learning to take place.

Luke Berry is a Future Teaching Scholar from the first cohort. “Experiencing the classroom from the other side has been pivotal on this programme – I never imagined how strange it would be! However, it has been the perfect way to solidify my career plans of becoming a teacher. I have gained a teaching experience so far, I am already beginning to see the rewards and joys that teaching can bring, such as knowing that you’ve helped at least one student to understand a topic further and become more confident. Maths is such a broad and interesting subject – the more people who can experience this and find some enjoyment from it, the better!”

Case study – Researchers in Schools Programme

Kikelomo Agunbiade, National Programme Director, Researchers in Schools, The Brilliant Club

In England, it is estimated that schools require 1,000 new physics teachers every year to keep up with demand. The need for maths teachers is equally urgent. And demand for teachers in these subjects is rising. The solution to this problem is not only a matter of increasing the quantity of teachers but also the level of subject expertise.

The Maths and Physics Chairs programme, delivered by Researchers in Schools, aims to increase the number of subject experts teaching in secondary schools across England by delivering a training and development programme exclusively for those with a PhD in their teaching subject. The programme runs over a 3-year period, during which participants achieve nationally recognised teaching qualifications alongside our own tailored award, the Research Leader in Education (RLE).

The RLE includes a range of high-impact activities and projects designed to use participants’ research skills and subject expertise for the benefit of their schools.

Researchers also benefit from one day a week off timetable to focus on these additional activities, as well as any academic study that comes from their training year.

Since 2014, over 300 PhD scholars have taken part in our programme and over 2,500 pupils have benefitted from one of our main participant-led activities – Uni Pathways. This is a series of university-style tutorials where participants aim to increase subject knowledge by bringing their unique area of study into the classroom. Through activities such as this, the programme not only seeks to make an academic impact but also a social one.

In 2018 to 2019, 93% of Uni Pathways programme participants said the programme not only seeks to make an academic impact but also a social one.
Towards a twenty-first century education system

Great engineering requires more than just theory and knowledge. We want our future engineers to be strong in head, heart and hand. Of course, they need to understand the essential and rich body of knowledge that underpins the profession, but this is not sufficient. Whatever engineering discipline they work in, we need them to be skilled makers, to develop models and prototypes, to be excited by experimenting with physical space and dimensions. We also want them to understand people, to tackle global challenges, to live lives focused on more than just economic gain and be creative as they solve problems.

Engineering is by no means unique in this. Speaking to a leading surgeon recently, Professor Roger Kneebone from Imperial College, he explained that while he can pick from thousands of applications of young people with strong academic records, very few of them have the manual dexterity and hand skills needed to succeed in the operating theatre. He has brought a lace maker into the College as an artist in residence to help students to develop those hand skills that they have lacked in earlier phases of their education.

Across sectors, employers are looking for a mix of skills and behaviours: technical, practical and people skills.

Going wider, our analysis of the skills needed in the economy and the future of work suggests that employers across sectors are crying out for this broader mix of skills and behaviours. The CBi/PEARSON’s Educating the Modern World shows that over half of employers (63%) value broader skills such as problem solving and three quarters (75%) say they prefer a mix of academic and technical qualifications. The DfE’s own Employer Skills Survey 2017 showed that two particular themes emerged when employers were asked about skills shortages – technical and practical skills, and people skills. In our increasingly global labour market, this is not unique to the UK; LinkedIn’s Global Talent Trends 2019 found that 92% of employers felt so-called ‘soft skills’ are equally or more important than hard skills, with creativity highlighted as of particular value.

As the evidence set out in this chapter shows, despite the amazing hard work of teachers and staff around the country, the schools policy in England is not cultivating the right behaviours to deliver what is needed. EBacc and Progress 8 are pushing out the technical and creative subjects that are best placed to deliver this broader range of skills, like design and technology and art. Even entries in computing subjects are pitifully small given that we are going through the digital revolution. In other subjects, the constant focus on ‘knowledge-rich’ curriculum simply means more rote learning and fewer opportunities for things like practical experimentation in science that can help to develop the hand as well as the head. While T-Levels may be a helpful development, the planned removal of standalone vocational qualifications will give fewer young people the opportunity for blended learning rather than having to choose between a wholly academic or vocational curriculum.

The picture is much more positive outside England. The broader Curriculum for Excellence in Scotland and the strong focus on Developing Young Workforce gives room for schools to prioritise developing rounded future workers and citizens. The excellent Foundation Apprenticeships programme is a model that England and others should follow, allowing young people to take a subject like Engineering alongside their Scottish Highers, which is recognised by both Universities and Apprenticeship providers, creating a no-wrong-door approach. In Wales we have strongly welcomed the recent announcements on curriculum development which place a genuine focus on breadth and balance, with subjects working together holistically.

Across sectors, employers are looking for a mix of skills and behaviours: technical, practical and people skills.

As we proceed through the fourth industrial revolution,rote learning is not the future of education – in engineering or any other discipline. There is another way.

In School 21 in East London, they use project-based learning to set real world challenges for their pupils, who work together in teams to address them. Meanwhile, they call employer engagement their ‘ninth GCSE’ devoting the resources and curriculum time of a subject to giving every student a rich experience of Real-World Learning. Every Year 10 and Year 12 spends half a day a week out in a business or organisation working on a real project.

Meanwhile, Edge in Doncaster blends together subjects in either STEM or humanities, breaking down boundaries to offer students the chance to work on rich and deep projects with an engaging guiding question and a clear and public finished product. Students look at ‘who speaks for the trees?’ or ‘what did the railways do for Doncaster?’ developing research, teamwork and problem-solving skills and creating finished products from wall murals to books published and available in the local Waterstones.

Both schools have good GCSE results. Both schools are rated Outstanding by Ofsted. This is not an either or – we can give young people access to the rich body of knowledge whilst also helping them to develop the skills and behaviours they will need as professionals and as adults. We can have heart and hand as well as head.

To support students in gaining the transferable skills demanded by employers, successful educational institutions worldwide are focusing on cross-curricular projects.

The principles that underpin XP and School 21 are common to more than 15 world leading models that Edge has been working with to make education relevant for the twenty-first century. From High Tech High in San Diego to the Academies of Nashville or the Finnish College system, successful schools and colleges worldwide are focusing on cross-curricular projects that help to give students the transferable skills that employers are demanding. They are creating rich and deep opportunities for engagement with employers and community organisations to set real world challenges, guide students and act as an authentic audience for their end products. Above all, they are recognising that exam results are not everything and judging themselves on their students’ holistic development and on their destinations.

This is the approach that we need to create the successful engineers of the future.

Schools in England already have the freedom to transform their own curriculum and pedagogy to a large extent, and the new Ofsted Framework encourages this behaviour. We are working with seven schools and colleges in the North East of England, and in partnership with the Wood Foundation with four schools in the North East of Scotland to develop and embed these practices, making education more relevant and engaging for pupils and teachers alike.

To go further, education policy must change so that every school and college is incentivised to focus on head, heart and hand. The EBacc in England would benefit from a more broad and balanced curriculum building on what is already in place in Scotland, what is being introduced in Wales and what is recognised internationally through the IB. Performance tables should be changed to reflect this, focusing on breadth, on the development of wider skills and on destinations. The tone of inspection policy should be on collaborative improvement not heavy-handed judgement, with Ofsted continuing to move in its current direction of valuing curriculum development. Finally, there should be opportunities at each stage for curriculum blending, offering young people a rich mix of subjects and approaches that crosses the academic-vocational divide.

60% of employers value broader skills such as problem solving.

75% of employers say they prefer a mix of academic and technical qualifications.

92% of employers feel that ‘soft-skills’ are equally or more important than hard skills.
The apprenticeship levy came into full effect in April 2017. As of 2019, there were 227 apprenticeship standards approved for engineering employers, which offer potentially higher salaries. In England, apprenticeship starts increased by 52.3% in 2018 to 2019. However, across all engineering-related areas, higher level apprenticeship starts increased by 52.3% in 2018 to 2019 compared with the previous year, reflecting a wider trend towards higher quality apprenticeships in all subjects. 

Skills Plan, a host of reforms have been introduced with the aim of addressing long-term issues such as the lack of diversity among apprentices. Vocational qualifications: Other vocational qualifications are more attuned to the needs of employers, paving the way for the introduction of apprenticeship standards in 2013 and the 20% ‘off-the-job’ training requirement for apprenticeships. 

Technical education can be thought of as a sub-set of FE, as the UK government and others in the sector prefer the term ‘technical education’ – increasingly, with 60.6% aged 19 and over. However, as the focus of this report is the participation of young people in pathways to engineering, in this chapter we predominantly focus on the engineering options in technical education for those aged 16 to 18. 

The Richard Review of Apprenticeships in 2012, which called on the government to improve the quality of apprenticeships, was carried out in large part to address wider issues such as the lack of diversity among apprentices and other vocational qualifications.

• Apprenticeships: The government defines an apprenticeship as a job with a formal programme of training. At least 20% of this training must be ‘off-the-job’, taking place during the apprentice’s normal work hours to advance the knowledge, skills and behaviours set out in the apprenticeship agreement (that is, it is not training for the sole purpose of enabling the apprentice to perform the work for which they have been employed). 

Vocational qualifications: Other vocational qualifications are more attuned to the needs of employers, particularly in education institutions, where learners benefit from a mixture of theoretical and practical learning, often including some form of work experience. 

Technical education caters for a range of learners, including those who are already employed and aiming to increase their skill set or perhaps change careers, as well as young people who have recently finished their compulsory secondary education. In 2018 to 2019, just 24.8% of apprenticeship starts were by those aged under 19, with 28.7% aged 19 to 24 and 46.5% aged 25 and over. The picture is similar for broader further education and skills, with 60.6% aged 19 and over. However, as the focus of this report is the participation of young people in pathways to engineering, in this chapter we predominantly focus on the engineering options in technical education for those aged 16 to 18.

Over the past 10 years, considerable efforts have been made to review and overhaul the further education system, including: 

- The Richard Review of Apprenticeships in 2012, which called on the government to improve the quality of apprenticeships, was carried out in large part to address wider issues such as the lack of diversity among apprentices and other vocational qualifications.
- Vocational qualifications: Other vocational qualifications are more attuned to the needs of employers, paving the way for the introduction of apprenticeship standards in 2013 and the 20% ‘off-the-job’ training requirement for apprenticeships.
- English apprenticeships: our 2020 vision – a 2015 plan put forward by the then Department for Business, Innovation and Skills to increase the quality and quantity of apprenticeships, setting out new standards and including the introduction of the apprenticeship levy, with the goal of achieving 3 million apprenticeships per year by 2020.
- The Sainsbury independent review on technical education in 2016, which highlighted that within the current system, over 13,000 qualifications – often with little value for either individuals or employers – were available to 16 to 18 year olds. Its recommendations have led to the creation of T levels, a new technical qualification starting in September 2020.
- The Augar Review in 2019, an independent panel review of post-18 education and funding. This included wide-ranging proposals, such as the technical education white paper, which included ‘increasing opportunities for everyone’, ‘reforming and refining the FE college network’ and ‘improving the apprenticeship offer’.
Changes to the further education landscape

In the future, the further education landscape will be easier to navigate, with clear vocational pathways into engineering.

### 3.2 – The further education landscape

As Figure 3.1 illustrates, the FE sector is vast. It comprises a range of providers and serves a diverse student population. Because this is based on DfE data and therefore only includes those studying with publicly funded providers, not private sector providers, the true number of learners is likely to be higher.

Adults studying within the FE sector outnumber young people. Similarly, education and skills learners – which includes those studying technical qualifications and other modes of study – outnumber apprentices. However, as the focus of this report is the participation of young people in pathways into engineering, the analysis in this chapter predominantly focuses on the engineering options in technical education for 16 to 18 year olds.

#### 3.2.1 – Further education and apprenticeships

The review of level 4 and 5 education, yet to be completed but first announced in 2017 to examine Level 4 to 5 education, with a focus on how technical qualifications at this level can best address the needs of learners and employers. The Department for Education (DfE) launched a proposal in 2019 detailing plans to align the new T level qualifications with new level 4 and 5 (higher technical) qualifications.

The government has given increasing prominence to technical education and the role it can play in ensuring students have the relevant skills to succeed in the workplace, particularly STEM skills. Within its 2017 industrial strategy, for example, the government pledged to:

- establish a technical education system that rivals the best in the world to stand alongside our world-class higher education system;
- invest an additional £406 million in maths, digital and technical education, helping to address the shortage of STEM skills;
- create a new National Retraining Scheme that supports people to re-skill, beginning with a £6.5 million investment for digital and construction training.

An additional £406 million of funding for 16 to 19 education was announced by the government in November 2019. This includes the introduction of a high value course premium (HVCP) – further funding designed to encourage and support the teaching of selected level 3 courses in subjects that lead to higher salaries.3,4

Within these changes, the government has made clear its intention to encourage young people to undertake STEM subjects – the majority of subjects eligible for the HVCP fall within this category. Likewise, in recognition that they cost more to deliver, 5 of the 6 subjects that will receive an uplift in funding under the current programme cost weightings (PCWs) in the academic year 2020 to 2021 are STEM: science, engineering, manufacturing technologies, transportation operations and maintenance, and building and construction.

This renewed investment in technical education, with a focus on STEM, is encouraging. This is particularly so given that the current system lags behind that of other countries in terms of funding.5,6,7,8 and has seen a funding decline since 2011 to 2012 compared with other areas of education, especially higher education.9,10 Only 8% of 14 to 18/19-year-olds in the UK11 graduating from vocational programmes have completed an engineering, manufacturing and construction qualification. Not only does this place the UK far below the Organisation for Economic Co-operation and Development (OECD) average of 34% and the EU2312 average of 33% for the proportion of young people on vocational courses doing these subjects, it also means the UK ranks last.13

#### About the data

Due to the vast range of provider types, students and age groups in UK further education (FE), collection and analysis of related data is often complex.

For students in schools, data is collected via the school census, whereas for those in the FE sector – including both those apprenticeships and those studying other vocational qualifications – data is recorded in the Individual Learner Record (ILR).

DfE publishes a range of data releases using the ILR data, and most of the analysis in this chapter comes from one of 3 associated DfE data collections:

- **Further education and skills data** – information on learners, learning programmes and learner achievement. This is used for headline measures across the entire FE sector. Information for the 2018 to 2019 year was released in November 2019.

- **Apprenticeships and traineeships data** – information on the number of apprenticeships starts, achievements and participation, and additional traineeship measures. Most of the apprenticeship analysis in this chapter is drawn from this data collection. Underneath each figure is a detailed description of the DfE data table used. Full data for the 2018 to 2019 academic year was released in November 2019.

- **National achievement rates tables** – apprenticeship, education and training annual national achievement rate tables (NARTs) are used for both apprenticeship and non-apprenticeship achievement rates. Data for the 2018 to 2019 academic year was published in March 2020.

Other data sets are used, and where EngineeringUK has analysed publicly available data the reference or source will indicate this with the word ‘data’.

Given that reforms have been centred in England, this chapter mainly focuses on analysis of English data, though some discussion of the devolved nations is also provided.

### 3.2.2 – Further education and apprenticeships

There are 2 main routes that 16 to 18 year olds can choose from within the FE sector: academic – that is, A levels and/or applied general qualifications14 – or technical, in the form of either classroom based technical education (which often includes a short work experience element) or an apprenticeship. Currently, learners within the FE sector overall predominantly pursue vocational qualifications (Figure 3.2).

#### Figure 3.2: Level 3 education and skills achievements among 16 to 18 year olds by provider type and qualification pathway

<table>
<thead>
<tr>
<th>Provider type</th>
<th>Apprentices (all ages)</th>
<th>16–18 Education and skills</th>
<th>19+ Education and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>General FE college</td>
<td>206,820</td>
<td>27.9%</td>
<td>470,830</td>
</tr>
<tr>
<td>Private sector funded</td>
<td>441,210</td>
<td>59.4%</td>
<td>50,690</td>
</tr>
<tr>
<td>Other public funded</td>
<td>86,170</td>
<td>11.6%</td>
<td>46,700</td>
</tr>
<tr>
<td>Sixth form college</td>
<td>2,290</td>
<td>0.3%</td>
<td>118,260</td>
</tr>
<tr>
<td>Special colleges</td>
<td>6,130</td>
<td>0.9%</td>
<td>18,030</td>
</tr>
<tr>
<td>All provider types</td>
<td>742,620</td>
<td>100.0%</td>
<td>705,710</td>
</tr>
</tbody>
</table>

Source: DfE. ‘Education and skills learner participation by provider, level, funding stream and learner and learning characteristics’ 2018 to 2019 data, 2019.

The ‘Education and skills’ figures include those studying A levels and other academic qualifications in non-school settings. It is therefore not possible from this data to obtain a picture of current students studying technical qualifications.

General FE colleges include tertiary providers.

Private sector public funded includes private sector organisations (such as limited liability partnerships and private limited companies) that deliver FE training funded by the DfE. They are sometimes called ‘independent training providers’.

Other public funded refers to local authorities (LAs) and HE providers.

Special colleges include agriculture and horticulture, art design and performing arts, and Specialist designated college.

In the future, the further education landscape will be easier to navigate, with clear vocational pathways into engineering.

Notes:


2. UK Government. ‘16 to 19 funding: programme cost weighting changes’, online, accessed 15/05/2020.


4. The limited kingdom ranks (listed out of the 35 OECD countries for which data is available in terms of total expenditure on educational institutions per full-time equivalent student relative to GDP per capita for upper secondary vocational programmes).


6. The International Standard Classification of Education (ISCED) categories are used for international comparisons. In this scheme, upper secondary refers to 14 to 18/19 year olds, but first announced in 2017 to examine Level 4 to 5 education, with a focus on how technical qualifications at this level can best address the needs of learners and employers. The Department for Education (DfE) launched a proposal in 2019 detailing plans to align the new T level qualifications with new level 4 and 5 (higher technical) qualifications.


9. The ‘Education and skills’ figures include those studying A levels and other academic qualifications in non-school settings. It is therefore not possible from this data to obtain a picture of current students studying technical qualifications.

10. General FE colleges include tertiary providers.

11. Private sector public funded includes private sector organisations (such as limited liability partnerships and private limited companies) that deliver FE training funded by the DfE. They are sometimes called ‘independent training providers’.

12. Other public funded refers to local authorities (LAs) and HE providers.

13. Special colleges include agriculture and horticulture, art design and performing arts, and Specialist designated college.

14. Applied general qualifications are level 2 qualifications for post-16 students who want to continue their education through applied learning. These are normally BTEC or diplomas qualifications and allow students to apply their learning to a general/occupational area such as law, business or health.

The sheer volume of disparate vocational qualifications on offer has frequently been cited as one reason why the FE sector needs to be reformed. Engineering-related qualifications are no exception. In August 2019, 2,290 engineering-related vocational qualifications44,45 for 16 to 18 year olds had been approved for funding (Figure 3.4).46

There are 49 distinct awarding organisations offering qualifications within the engineering and manufacturing sector subject area alone. The DfE has assessed that this complex situation has resulted in “qualification proliferation in the labour market” and “large numbers of young people enrolling on courses, which do not help them succeed in the world of work”.47,48

One driving force behind the introduction of T Levels, therefore, is to dramatically reduce the number of both qualifications and awarding organisations. Each T Level pathway will replace an old sector subject area, and will be represented by just one high quality qualification. An awarding organisation will be granted exclusive delivery rights for each available qualification.49,50

As Figure 3.3 shows, some engineering-related sector subject areas are more likely to be studied at certain provider types than others. In 2018 to 2019, for example, the vast majority of those studying within either construction, planning and the built environment or engineering and manufacturing technologies did so in FE colleges, whereas provider types were much more varied for ICT students.

To view engineering-related vocational achievements for all ages, see Figure 3.5. As at mid-2020, there were 901,374 engineering-related vocational achievements recorded in the whole of England (LAs) and HE providers. Special colleges includes agriculture and horticulture, art design and performing arts and specialist designated college. ‘-‘ denotes there were no achievements.

Source: DfE. 'Education and training overall qualification level achievement rates tables 2018/19' data, 2020.

Figure 3.3 Qualification pathways into engineering

<table>
<thead>
<tr>
<th>Qualification pathways</th>
<th>Technical pathways</th>
</tr>
</thead>
<tbody>
<tr>
<td>A career in manufacturing and engineering</td>
<td>Full-time employment</td>
</tr>
<tr>
<td>Engineering degree</td>
<td>Degree apprenticeships</td>
</tr>
<tr>
<td>Higher technical qualification</td>
<td>Higher technical apprenticeships</td>
</tr>
<tr>
<td>Achieved 14-16 UCAS points (ACP)</td>
<td>A levels</td>
</tr>
<tr>
<td>Achieved 5 grades 9 to 4 including English and maths</td>
<td>Students aged 16</td>
</tr>
<tr>
<td>Students aged 16</td>
<td>Transition year to achieve five grades 9 to 4 including English and maths</td>
</tr>
</tbody>
</table>

Source: Figure adapted from RaEng. 'Engineering skills for the future: The 2013 Perkins review revisited', 2019.

Figure 3.4 Engineering-related vocational qualifications approved for funding by level (2019) – England

<table>
<thead>
<tr>
<th>Sector subject area</th>
<th>Entry level</th>
<th>Level 1</th>
<th>Level 1/2</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 3+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction, planning and the built environment</td>
<td>34</td>
<td>134</td>
<td>8</td>
<td>379</td>
<td>242</td>
<td>8</td>
<td>803</td>
</tr>
<tr>
<td>Engineering and manufacturing technologies</td>
<td>28</td>
<td>122</td>
<td>18</td>
<td>528</td>
<td>470</td>
<td>27</td>
<td>1,193</td>
</tr>
<tr>
<td>Information and communication</td>
<td>41</td>
<td>76</td>
<td>11</td>
<td>104</td>
<td>122</td>
<td>38</td>
<td>392</td>
</tr>
<tr>
<td>All engineering-related sector subject areas</td>
<td>103</td>
<td>332</td>
<td>37</td>
<td>1,011</td>
<td>834</td>
<td>73</td>
<td>2,390</td>
</tr>
<tr>
<td>All sector subject areas</td>
<td>1,552</td>
<td>1,944</td>
<td>162</td>
<td>3,849</td>
<td>3,170</td>
<td>310</td>
<td>10,677</td>
</tr>
</tbody>
</table>

Source: ESFA. ‘List of qualifications approved for funding in 14 to 19 FY data 2019.’ Vocational qualifications are counted as any qualification that is not one of the following: GCSE, AS, A level, advanced extension award, project or principal award. This is in line with the methodology in Ofqual’s ‘Vocational qualification and other qualifications quarterly.’

Figure 3.5 Engineering-related vocational achievements among 16 to 18 year olds in FE by provider type and level (2018/19) – England

<table>
<thead>
<tr>
<th>Provider type</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>General FE college</td>
<td>21,389</td>
<td>11,703</td>
<td>5,386</td>
<td>45,775</td>
</tr>
<tr>
<td>Private sector public funded</td>
<td>1,130</td>
<td>149</td>
<td>14</td>
<td>1,393</td>
</tr>
<tr>
<td>Other public funded</td>
<td>52</td>
<td>17</td>
<td>16</td>
<td>95</td>
</tr>
<tr>
<td>Sixth form college</td>
<td>66</td>
<td>32</td>
<td>32</td>
<td>130</td>
</tr>
<tr>
<td>Specialist college</td>
<td>424</td>
<td>32</td>
<td>2</td>
<td>460</td>
</tr>
<tr>
<td>All provider types</td>
<td>23,061</td>
<td>12,035</td>
<td>625</td>
<td>39,290</td>
</tr>
<tr>
<td>General FE college</td>
<td>10,804</td>
<td>14,608</td>
<td>12,391</td>
<td>37,803</td>
</tr>
<tr>
<td>Private sector public funded</td>
<td>635</td>
<td>256</td>
<td>23</td>
<td>914</td>
</tr>
<tr>
<td>Other public funded</td>
<td>83</td>
<td>38</td>
<td>27</td>
<td>148</td>
</tr>
<tr>
<td>Sixth form college</td>
<td>32</td>
<td>152</td>
<td>625</td>
<td>809</td>
</tr>
<tr>
<td>Specialist college</td>
<td>149</td>
<td>207</td>
<td>65</td>
<td>421</td>
</tr>
<tr>
<td>All provider types</td>
<td>21,170</td>
<td>15,261</td>
<td>3,135</td>
<td>40,315</td>
</tr>
<tr>
<td>General FE college</td>
<td>5,386</td>
<td>5,299</td>
<td>13,513</td>
<td>24,158</td>
</tr>
<tr>
<td>Private sector public funded</td>
<td>115</td>
<td>123</td>
<td>10</td>
<td>248</td>
</tr>
<tr>
<td>Other public funded</td>
<td>127</td>
<td>210</td>
<td>1,755</td>
<td>2,092</td>
</tr>
<tr>
<td>Sixth form college</td>
<td>32</td>
<td>152</td>
<td>625</td>
<td>809</td>
</tr>
<tr>
<td>Specialist college</td>
<td>149</td>
<td>207</td>
<td>65</td>
<td>421</td>
</tr>
<tr>
<td>All provider types</td>
<td>5,628</td>
<td>6,345</td>
<td>19,235</td>
<td>31,208</td>
</tr>
<tr>
<td>General FE college</td>
<td>37,579</td>
<td>31,732</td>
<td>30,098</td>
<td>99,409</td>
</tr>
<tr>
<td>Private sector public funded</td>
<td>1,880</td>
<td>427</td>
<td>115</td>
<td>2,422</td>
</tr>
<tr>
<td>Other public funded</td>
<td>262</td>
<td>277</td>
<td>2,025</td>
<td>2,564</td>
</tr>
<tr>
<td>Sixth form college</td>
<td>98</td>
<td>905</td>
<td>4,592</td>
<td>5,595</td>
</tr>
<tr>
<td>Specialist college</td>
<td>573</td>
<td>300</td>
<td>65</td>
<td>938</td>
</tr>
<tr>
<td>All provider types</td>
<td>40,392</td>
<td>33,641</td>
<td>36,780</td>
<td>110,813</td>
</tr>
<tr>
<td>General FE college</td>
<td>148,283</td>
<td>124,707</td>
<td>189,922</td>
<td>462,912</td>
</tr>
<tr>
<td>Private sector public funded</td>
<td>29,703</td>
<td>10,664</td>
<td>4,418</td>
<td>45,785</td>
</tr>
<tr>
<td>Other public funded</td>
<td>3,328</td>
<td>3,191</td>
<td>24,507</td>
<td>31,026</td>
</tr>
<tr>
<td>Sixth form college</td>
<td>4,049</td>
<td>15,756</td>
<td>45,238</td>
<td>65,043</td>
</tr>
<tr>
<td>Specialist college</td>
<td>3,737</td>
<td>8,278</td>
<td>7,475</td>
<td>19,490</td>
</tr>
<tr>
<td>All provider types</td>
<td>188,900</td>
<td>163,756</td>
<td>217,590</td>
<td>624,246</td>
</tr>
</tbody>
</table>

Source: DfE. ‘Education and training overall qualification level achievement rates tables 2018/19 data 2020.’ For 16 to 18 year olds, there were no higher level vocational achievements in 2018 to 2019. Across all sector subject areas, 66% to 18 year olds achieved higher level vocational qualifications. General FE college includes tertiary providers. Private sector public funded includes private sector organisations (such as limited liability partnerships and private limited companies) that deliver FE training funded by the DfE. They are sometimes called independent training providers. Other public funded refers to local authorities (LAs) and HE providers. Special colleges includes agriculture and horticulture, art design and performing arts and a specialist designated college. ‘-‘ denotes there were no achievements. This is in line with the methodology in Ofqual’s ‘Vocational qualification and other qualifications quarterly.’
Also striking is the high proportion of 16 to 18 year olds across all 3 engineering-related sector subject areas whose qualification was at level 3 or below. At two-thirds (66.8%), this is significantly more than for learners generally across all subject areas (56.5%).

It’s not clear what will happen to the vast numbers of students currently on lower level qualifications after T levels are introduced, as these will replace qualifications currently offered at level 3. DfE has outlined its vision for a ‘T level transition programme’ aimed at students who are likely to be able to progress onto a T level after one year of preparation, which should cover a number of those currently studying at level 2.3,9 But for those on level 1 qualifications, this programme will not be appropriate. Given we are in the midst of a DfE ‘Review into post-16 qualifications at level 3 and below in England’,9,9 it is understandable that there may be some confusion and concerns.

Although successful T level students who will receive UCAS points in line with A levels, it is not yet clear whether all universities will accept these students.

3.3 – T levels

In 2015, the government asked Lord Sainsbury to lead an independent review of technical education in England. The ensuing report, ‘Report of the Independent Panel on Technical Education’9.24 was wide-ranging and contained a variety of recommendations. One of the most radical suggestions was that there should be 15 ‘technical education routes’ to replace the current system of multiple qualifications offering similar content. The rationale for this overhaul was that the existing landscape is extremely confusing for both prospective students and employers, as there are a multitude of available vocational qualifications that are often not linked to one specific occupation. For example, learners wishing to study for a level 3 vocational qualification in plumbing have 26 qualifications to choose from, delivered by several different awarding organisations and without clarity around which is the ‘best’ or most suitable to study.9,15 Employers are often unable to determine whether job applicants have studied a qualification that has provided them with a comprehensive set of skills or behaviours that will allow them to perform the role to the expected standard.

The government accepted all the recommendations made by the Report of the Independent Panel on Technical Education and published the Post-16 Skills Plan in July 2016, which outlined how it would implement technical education reforms.9,16 Central to these reforms are T levels, a ‘brand new, 2-year qualification… that brings classroom learning and an extended industry placement together on a course designed with businesses and employers’.9,9,9 Within each of the 15 principal T level routes there will be individual ‘pathways’. These pathways are more detailed as they relate to occupational specialisms within each route.

Figure 3.6 shows the different T level routes and pathways (correct at November 2019):

### What is a T level?

T levels are new courses that will be available to study in England for the first time in September 2020. They will follow on from GCSEs and will be equivalent to 3 A Levels. These 2-year courses have been developed in collaboration with employers and businesses so that the content meets the needs of industry and prepares students for work.

T levels will offer students a mixture of classroom learning and ‘on-the-job’ experience during an industry placement at least 315 hours (approximately 45 days). They will provide the knowledge and experience needed to open the door into skilled employment, further study or a higher apprenticeship.9,15

Key to the new T level qualifications will be the ‘extended industry placement’, which at a minimum of 45 days is far longer than placements currently undertaken by the majority of learners on vocational qualifications (most of these are one to 2 weeks).9,9 This placement aims to give students a more practical grounding in their chosen subject.

### 5 key elements to a T level

- **Technical qualification**, including the core content and occupational specialisms
- **Industry placements**
- **Occupational-specific requirements**
- **Employment, enrichment and pastoral care**
- **English, maths and digital skills**

Students will receive a separate grade from A* to E for the core component of each occupational specialism, shown as a pass, merit or distinction. These individual grades will make up one overall grade, ranked as a pass, merit, distinction or distinction*

In keeping with the drive to give technical education ‘parity of esteem’ with academic education, T level students who achieve a pass or above will receive UCAS points and will be able to apply for universities (although not all universities use the UCAS tariff as part of their entry requirements). Those attaining the highest possible grade (distinction*) will receive UCAS points equivalent to 3 A*s at A level. A T level distinction earns the same UCAS points as 3 As at A level, a merit earns the same as 3 Bs, and so on.

However, it remains to be seen whether all universities will accept T level students onto their courses. Of the 22 Russell Group universities that responded to an enquiry by TES magazine, 16 indicated that they had not yet finalised their policy on T levels.9,9,9

If T levels are to be taken seriously as an alternative to A levels, the engineering community must use their influence and partnership with higher education institutions to ensure universities recognise these qualifications and hold them in sufficiently high esteem, so that where appropriate, T level students can progress onto HE engineering courses.

**Figure 3.6** T level routes, pathways and start dates

<table>
<thead>
<tr>
<th>Route</th>
<th>Pathway</th>
<th>Start date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agriculture, environmental and animal care</strong></td>
<td>Animal care and management</td>
<td>Sep 2023</td>
</tr>
<tr>
<td><strong>Business and administration</strong></td>
<td>Management and administration</td>
<td>Sep 2022</td>
</tr>
<tr>
<td><strong>Care services</strong></td>
<td>Care services</td>
<td>Apprenticeship only</td>
</tr>
<tr>
<td><strong>Catering and hospitality</strong></td>
<td>Catering</td>
<td>Apprenticeship only</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td>Design, surveying and planning</td>
<td>Sep 2020</td>
</tr>
<tr>
<td><strong>Creative and design</strong></td>
<td>Cultural heritage and visitor attractions</td>
<td>Sep 2023</td>
</tr>
<tr>
<td><strong>Digital</strong></td>
<td>Digital production, design and development</td>
<td>Sep 2020</td>
</tr>
<tr>
<td><strong>Digital support and services</strong></td>
<td>Digital business services</td>
<td>Sep 2021</td>
</tr>
<tr>
<td><strong>Education and childcare</strong></td>
<td>Education</td>
<td>Sep 2020</td>
</tr>
<tr>
<td><strong>Engineering and manufacturing</strong></td>
<td>Engineering, design and development</td>
<td>Sep 2020</td>
</tr>
<tr>
<td><strong>Health and science</strong></td>
<td>Healthcare science</td>
<td>Sep 2021</td>
</tr>
<tr>
<td><strong>Hair and beauty</strong></td>
<td>Hair, beauty and aesthetics</td>
<td>Sep 2023</td>
</tr>
<tr>
<td><strong>Healthcare science</strong></td>
<td>Science</td>
<td>Sep 2021</td>
</tr>
<tr>
<td><strong>Legislation, finance and accounting</strong></td>
<td>Legal</td>
<td>Sep 2022</td>
</tr>
<tr>
<td><strong>Legal, finance and accounting</strong></td>
<td>Accountancy</td>
<td>Sep 2022</td>
</tr>
<tr>
<td><strong>Sales, marketing and procurement</strong></td>
<td>Marketing</td>
<td>Apprenticeship only</td>
</tr>
<tr>
<td><strong>Sales, marketing and procurement</strong></td>
<td>Procurement</td>
<td>Apprenticeship only</td>
</tr>
<tr>
<td><strong>Transport and logistics</strong></td>
<td>Transport</td>
<td>Apprenticeship only</td>
</tr>
<tr>
<td><strong>Transport and logistics</strong></td>
<td>Logistics</td>
<td>Apprenticeship only</td>
</tr>
</tbody>
</table>

Source: Figure taken from DfE. ‘T level action plan 2019’, 2019.

3.34 DfE. ‘Introduction to T levels’ [online], accessed 01/04/2020.
3.35 City and Guilds. ‘T level extended work placement research’, 2018.
Engineering-related T Levels

After completing a T level, students will have several options. These include skilled employment, an apprenticeship or higher education. The Institute for Apprenticeships and Technical Education (IfATE) has published occupational maps for each route, detailing the possible occupations associated with each mode of study for each pathway (including grouping specific occupations within clusters). Of the 15 T level routes, the largest occupational map is associated with engineering and manufacturing. IfATE, highlighting the large number of apprenticeship standards on offer in these sectors. This could mean that the standards developed by employers in this area are particularly narrow and align to very specific sets of skills or occupations within engineering.

T level routes in construction

Routes into construction will be among the first T levels to be delivered in 2020 (Figure 3.7). We will roll out each route by September 2021, albeit by a limited number of providers.

3.41 IfATE. ‘Occupational map: Engineering and manufacturing’ [online], accessed 09/04/2020.

3 – Further education and apprenticeships

3.39 IfATE. ‘Occupational map’ [online], accessed 09/04/2020.
3.41 IfATE. ‘Membership of T level panels for 2020 and 2021 delivery’, 2018.
The breadth of knowledge T levels seek to cover – as opposed to the specialist depth of apprenticeships – is proving to be particularly appealing for industry. Of the employers surveyed in the First 46 report,1 44 the proportion of employers responding that they would value breadth of knowledge most highly for a vacancy in their organisation was over double the number that would most value depth of knowledge (46% compared with 22%). Similarly, a survey of manufacturing employers conducted by Make UK,2 45 which found that 43% of those surveyed would prefer T level students to have a breadth of knowledge in general engineering and manufacturing concepts, rather than deep, specialist knowledge. 46 Views from providers appear to be similarly positive, with a report by the National Foundation for Educational Research (NFER) on how provider organisations are preparing to deliver the first 3 T levels noting that “providers and sector representatives are broadly supportive of the move to introduce T levels”, with one provider describing them as “an incredibly exciting opportunity”.47 Moreover, when asked why they were interested in delivering T levels, providers commonly cited the focus on meeting employers’ needs. This is very promising, given government’s commitment to putting employers at the heart of technical education and the importance of close collaboration between industry and providers for delivery. 3.4.1 T level industry placement One component of T levels where industry involvement is particularly essential is the 45-day industry placement requirement. So it is perhaps unsurprising that this has been the source of extensive collaboration between employers and providers. Although views vary, in general employers and providers both appear to see the benefits of the 45-day industry placement requirement and recognise the need for learners to gain experience in industry. A 2018 DfE report into employer engagement and capacity to support T levels placed significant weight on the role of engineering and manufacturing employers and construction employers comprised one quarter of total respondents – noted this overall support, with the length of placement viewed by employers as “sufficient to enable the young person to settle in, understand the business and undertake industry-relevant work of value to both employers and learners”.48 That being said, it was clear in the report that some sectors and industries expected to be less able to take on placements than others, with specific legal and regulatory requirements cited by engineering and manufacturing employers. For example, employers surveyed from this sector noted the need to provide constant workplace environments due to the age of most T level students. Some engineering and manufacturing employers also pointed out that certain types of work – often requiring specific conditions – were limited to licenced or otherwise approved persons and required specific professional memberships, which could make it difficult to bring in young employees on a short-term basis.49,50

Just under a third of manufacturers would be willing to offer a T level industry placement in its current form. 51

Similar sector-specific concerns have been voiced via other channels. In a survey of employers and training providers conducted by City and Guilds,45 for example, those working within construction and engineering and manufacturing were most likely to report barriers to work placements for young people.46 Half of training providers that delivered construction and engineering and manufacturing qualifications indicated the same, noting sector-specific barriers to industry placements, such as the highly technical nature of the role or legal requirements.

According to research by MakeUK, just one third of manufacturers surveyed reported that they would offer a T level student a placement in its current form, with 21% indicating they would not do so but would consider it if it was more flexible. 43,52 Chief among their concerns was the need to juggle work placement delivery with business needs (53% of respondents). Manufacturers were also concerned that industry placements could lead to a reduction in other school engagement activities, such as careers fairs and factory visits, due to the significant time and cost they already devoted to these ventures.43,52 If T level work placements are to succeed in the engineering sector, the professional bodies could examine the restrictions on certain roles due to regulatory frameworks and decide whether there may be scope to create specialist opportunities for new, young employees. This could make the entire workplace process smoother and increase availability for T level students. Awareness of T levels The extent to which employers are aware of T levels has also received significant attention. Research conducted by CIPO in 2018 found that just 40% of employers had heard of T levels prior to being surveyed. Of those who had heard of them, the majority rated their level of knowledge as fairly poor (46%) or very poor (18%).43

Even as recently as October 2019, after a £250,000 branding campaign, a report by the Institute of Engineering and Technology (IET) found that just 28% of engineering companies surveyed knew of this requirement. Even more worrying is that upon learning this was the case, less than 2 in 3 companies reported to offer placements (59%) and under half (43%) said they intend to offer industrial placements.43,52

3.4 – Higher technical qualifications

Alongside T levels, the government is actively working to raise the profile of what is now known as higher technical education (HTE) – T levels and 5 qualifications that enable learners to work in skilled trade roles, demanding higher skills than covered at T level.

Although there is clear demand in the labour market for those with Level 4 or 5 qualifications, the UK’s higher technical education system currently lags behind nations such as Germany and Canada. Currently, only 10% of adults aged 18 to 65 in the UK hold a level 4 or 5 qualification as their highest. This compares with, for example, 20% of adults in Germany and 34% in Canada. The absolute numbers of students studying for such qualifications in 2016 to 2017 was under 200,000, compared with 2 million working towards a level 3 or level 6 qualification.53

However, CBI has predicted that in 5 years’ time, almost half of all employment will be in high skill and technical roles, suggesting level 4 or 5 qualifications will be in high demand.54 Already, the advantage of taking this further qualification is clear, with those achieving a level 4 or 5 qualification by 23 more likely to have a higher median wage and be in sustained employment by 26 compared with those who had achieved a level 3 qualification.54

In response to the clear demand for these levels of skills within the STEM sector,55 the government has announced the creation of new institutes of technology. These are employer-led institutions that will offer higher level technical education (that is, levels 4 and 5) in collaboration with FE providers and universities.56

By April 2020, 12 institutes of technology had been announced. The majority of these will focus on engineering-related subject areas (see Figure 3.9). It is hoped that with the range of employers associated with these new institutes, students, industry and institutions across the country will have the opportunity to pursue STEM at the higher technical level and equip themselves with the skills required for their local areas.

Although the renewed government focus on higher technical education is encouraging for the engineering sector, successful delivery is dependent on recognising and addressing both opportunities and challenges specific to the engineering context. In its response to the DfE’s consultation on HTE, Education for Engineering (E4E), the body through which the engineering profession offers coordinated advice on education and skills policy, recommended that:

- the DfE work closely with Engineering Council and professional engineering institutions to establish the key set of knowledge, skills and behaviours of engineering occupations that should form the basis of standards
- the Engineering Council be involved in the qualification recognition process, due to its current role in regulating the profession overall
- caution is taken when considering work based learning or placements as an essential part of HTE, due to their reliance on the UK’s economic fortunes and the significant resourcing already being asked of employers in the delivery of apprenticeships and degrees, which are already a well-established, recognised qualification

It also noted the importance of addressing ‘cold spots’ in terms of access to training, noting that the institutes of technology that have been announced are largely based in cities, which might be difficult for students living in rural areas to access.

3.5 – Teaching in the further education sector

Recruitment and retention issues in the school system are widely known, with DfE’s stated number one priority being to “recruit, develop, support and retain teachers”.44 But there has been arguably less focus on issues relating to teaching in the FE sector. Nevertheless, these do exist and are likely to become increasingly prominent with the renewed focus on technical education, especially given the increased teaching hours that will be required for T levels.56 For the UK’s technical education system to thrive, it is vital that instructors, lecturers, teachers and assessors within the sector are fully equipped to teach students the skills required for the future.

In many ways, the talent pool for teaching in the FE sector is even smaller than that for secondary schools, because many colleges and training providers are looking for teachers with industry experience. Of the 12 institutes of technology that have been announced, just 17% have teaching qualifications, highlighting the pressure these new institutions will be under to train staff. Consequently, the potential for recruiting from industry, which is critical for the delivery of T levels, will be limited.

Results from the DfE’s 2018 College Staff Survey into the expectations and requirements of new entrants into the FE workforce suggest that 30% of respondents who had not been in FE for at least five years would be willing to offer a T level qualification in order to teach in an FE institution, but potential candidates may be asked to study for a qualification after taking up their post, depending on the institution.

3.5.1 – Further education and apprenticeships

74% of college principals said engineering and manufacturing was the most difficult subject to recruit teachers for.
Moreover, these challenges appear particularly acute in relation to engineering teachers (and, to a lesser extent, construction and digital teachers). An overwhelming 88% of FE college principals reported engineering and manufacturing to be a difficult vocational subject for which to recruit skilled teaching staff. Even more striking is that just under 3 in 4 (74%) reported engineering and manufacturing to be “the most difficult to recruit in”, making it the highest ranked subject in this category.

In part, these challenges may be driven by the sheer number of teachers required in engineering and manufacturing and related areas. As Figure 3.10 shows, construction and engineering teaching and manufacturing rank second and third respectively in terms of number of staff teaching in colleges.

This may prove to be particularly difficult in a sector such as engineering, where there is a natural tension between teaching and addressing the wider skills shortages in industry. Those able to teach these higher level engineering qualifications are often the same people who are in demand to fill engineering roles within industry.

This tension is reinforced by disparities in remuneration. A research report looking at which professions were similar to FE teaching reported that FE recruitment and retention pressures were strongly associated with pay differentials. It also noted that these were “greatest in a number of areas identified by the Government as strategic national key to the UK’s growth prospects, specifically construction, planning and the built environment, engineering and manufacturing technologies and ICT”. This is borne out in salary data, where the median average salary for an engineering professional in 2019 is £41,912, which is around £10,000 more than that of an engineering teacher in FE.

Such disparities have clear implications for retention, with the college staff survey reporting that 42% of teachers who had a job offer outside FE were leaving due to pay. This is worrying, given the significant reforms underway in the technical education sector. Both DfE and the Education and Training Foundation (ETF) have responded to the issue with potential policy solutions to attract more teachers into vocational training.

I decided to retrain as a teacher to give students the chances I had in life to better themselves and their careers through education.

The change to teaching from engineering is initially daunting, but confidence comes quickly as you get used to the classroom. The job is very quickly much more rewarding, and you will spend a lot more time talking to people and getting to know them. It's an excellent job if you have a good team of like-minded educators who want to help people. I also found that the experienced teachers were more than happy to share experiences and disseminate advice.

In terms of your lifestyle, the institution and your role in it will be the overriding factor. Most teachers I've met do work at home and do extra hours, but some manage to keep it all at work – it's down to you and the organisation to get the work-life balance you're after.

Teaching technical engineering elements is the easiest part of the job – the surrounding topics, such as including professional ethics and the effects of technology on society, can be the challenge!

We need to have an open and honest dialogue with people joining teaching if they're going to be retained. The bulk of the job is in the classroom, but you will be spending a lot of time doing admin and helping students to get the work life balance you're after.

Case study – Why I decided to retrain as an FE teacher

Jamie East, Course Leader, National College for Nuclear (formerly an industrial engineer)

I decided to retrain as a teacher to give students the chances I had in life to better themselves and their careers through education.

The change to teaching from engineering is initially daunting, but confidence comes quickly as you get used to the classroom. The job is very quickly much more rewarding, and you will spend a lot more time talking to people and getting to know them. It's an excellent job if you have a good team of like-minded educators who want to help people. I also found that the experienced teachers were more than happy to share experiences and disseminate advice.

In terms of your lifestyle, the institution and your role in it will be the overriding factor. Most teachers I've met do work at home and do extra hours, but some manage to keep it all at work – it's down to you and the organisation to get the work-life balance you're after.

Teaching technical engineering elements is the easiest part of the job – the surrounding topics, such as including professional ethics and the effects of technology on society, can be the challenge.

We need to have an open and honest dialogue with people joining teaching if they're going to be retained. The bulk of the job is in the classroom, but you will be spending a lot of time doing admin and helping students to get the work life balance you're after.
Initiatives for FE teachers

In a bid to address issues of teacher recruitment and retention in FE, DfE has recently embarked on a range of initiatives, including:

- **Tackling Teaching Further**, a national initiative to attract experienced industry professionals with expert technical knowledge and skills to FE, which is being managed by ETF and aims to recruit 150 new teachers across 2 rounds of funding. This programme will be particularly relevant within the engineering sector as the subjects that are being targeted in the first instance are the first T level routes and other STEM areas.

- **T level Professional Development (TLPD)**, which aims to "ensure teachers and trainers have the teaching skills, subject knowledge and confidence needed to deliver a high-quality T level programme from the outset." While this offer is focused on those teachers delivering new T level qualifications, it applies to any provider offering any of the new T levels, so it hoped the training will benefit the entire teaching workforce. The ‘professional development needs analysis’ will be done by a team of professional development advisers who “visit organisations and institutions who are confirmed to deliver T levels on a termly basis, advising them and gathering feedback that informs the development of providers’ professional development plans”.

- The introduction of ‘knowledge hubs’, which include the industry insight aspect of the TLPD offer. This activity will ensure that teachers and trainers have the teaching skills, subject knowledge and confidence needed to deliver T levels, and the hubs will focus on embedding industry-standard practices within the T level teaching specification. In an engineering subject context, it is imperative that those teaching the subject are well-versed in the most up-to-date practices, especially as the sector evolves in the process of the fourth industrial revolution, and more and more specialist knowledge will need to be embedded in the programmes.

- **Initial Teacher Education (ITE) bursaries**, which are financial incentives to attract high-quality individuals into the teaching profession in the FE sector.

These bursaries vary depending on subject taught. Prospective engineering and manufacturing teachers will have £26,000 available to them to train within the FE sector – among the highest rates available.

The difference between a framework and a standard

**Framework:** Apprenticeship frameworks are ‘qualification based’, meaning that learners are continually assessed throughout the apprenticeship by studying different units and ticking them off as they go. There is no overall end assessment, so there is no confirmation of whether the learners can actually perform the job they are training for. **Standard:** A standard is an occupational profile, which includes a list of duties and the skills, knowledge and behaviour that an apprentice needs to have learned by the end of their apprenticeship. Learning happens throughout the entire apprenticeship, with an end-point assessment to determine whether the student can carry out the job.

Apprenticeship standards are developed by groups of employers called trailblazers, with the intention that they have a role to play in disseminating information about the influence of professional engineering institutions means that they have a role to play in disseminating information about the benefits of teaching to their members. In addition, where possible, they can assist in developing ways to share up-to-date industry knowledge with engineering teachers.

3.6 – Apprenticeship reforms

In sections 3.1 and 3.2 we outlined the different types of technical education and showed that apprentices make up a large proportion of learners in the FE sector in England (see Figure 3.1 in section 3.2). In addition to the vocational qualification reforms in FE, there have been extensive reforms to the apprenticeship system, which have significantly impacted both engineering apprentices and employers.

**Apprenticeship standards**

The first large change came with the introduction of apprenticeships in England only in October 2013 to replace the old style of apprenticeships called frameworks. These have since been phased in gradually.

This represents an increase from 2017 to 2018. In 2018 to 2019, standards accounted for 40% of apprenticeships starts in construction, planning and the built environment, 46% in engineering and manufacturing technologies apprenticeships, and 67% in information and communication technology. Although these figures are encouraging, employers within the engineering sector will need to work closely with route panels to ensure sufficient availability of apprentice standards, because after 31 July 2020, all new apprenticeship starts must be on standards.

**The apprenticeship levy**

The other major change to the apprenticeship system was the introduction of the apprenticeship levy, which came into effect in April 2017 to "help deliver new apprenticeships and support quality training by putting employers at the centre of the system." The levy is a tax on employers charged at 0.5% of an employer’s total salary bill, but only affects companies with an annual salary bill of over £3 million. Employers can access their funds through an online apprenticeship service and it must be used exclusively on apprenticeships. Unspent levy funds are used to support existing apprentices and pay for apprenticeship training for smaller employers. Unlike apprenticeship standards, the apprenticeship levy applies across all of the UK, and discussion about the levy in the devolved nations can be found in section 3.8.

The levy was positioned by George Osborne as a key mechanism to achieve the target set by government in 2015 to reach an additional 3 million apprenticeship starts in England by 2020. However, figures suggest that the levy is not currently incentivising starts in the way intended and in June 2019, the Education secretary Damian Hinds signalled to the Commons Education Select Committee that the £3 million target was unlikely to be achieved.

In 2018, Chancellor Phillip Hammond announced a number of changes, primarily to address employer concerns around flexibility. These included levy transfers, which allowed larger employers to transfer unused funds to those in their supply chain, and reducing the rate that smaller employers had to pay for their apprentices. However, the reaction from employers suggests that these changes may not have been sufficiently far-reaching.

**Use of levy funds**

In the first year of the apprenticeship levy, employers were only using a small proportion of available funds, according to a 2019 National Audit Office (NAO) report which stated that in 2017 to 2018 there was a £400 million underspend in the apprenticeships budget. The government received £2.01 billion from Treasury to spend on apprentices, but only £268 million was spent by levy-paying employers on apprentices, with the remainder spent on pre-levy training, non-levy apprenticeships and maintaining the apprenticeship programme and service.

Given that by 2019 to 2020 the funding available for investment in apprenticeships in England will have risen to over £2.5 billion, this means that employers are only drawing upon 9% of the available funds.
Employers in engineering, and across all industries, said the time constraints associated with hiring apprentices posed the biggest challenge.

Early evidence indicated that employers were not taking advantage of the apprenticeship levy. However, a 2018 survey from the Open University found that, in general, employers felt the process of accessing levy funding through their online apprenticeship service account was easier than they thought it would be. Indeed, 29% agreed it was “clear and straightforward”, compared with just 15% who said it was “confusing and hard to understand”. 3\(^\text{rd}\) While this was expected to be the most time-consuming constraint to accessing funds requiring, with 30% of employers saying it took longer than expected and 18% agreeing that the administration required a drain on management time.

A survey by the Institute of Directors also found that, despite understanding of the levy system, the extra administrative burden on employers was a factor in hiring apprentices. Among those surveyed who did not hire apprentices, 27% cited administration costs or “time constraints” as the main reason for not doing so. This was in the context of 51% of employers currently paying the levy. Indeed, 9% of employers thought the levy system was “bing too confusing to bother with”. 3\(^\text{rd}\) 20% said the levy funds available to them to train new and existing staff.

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Although apprentices are employees, they are primarily students, and must have dedicated time to learn.

The 2012 Richard Review, which led to many of the apprenticeship reforms in England, identified off-the-job training as a crucial component of apprenticeships. It stated that “off-the-job... gives the apprentice safeguarded time away from their job to ensure they can do substantial training. It can give them a peer group of different apprentices and a wider perspective, experience other than their employer is inputting to the transferability.”

Central to this argument is the need for employers to recognise that although apprentices are employees, they are first and foremost students and must have dedicated time to learn. The 2012 Richard Review, which led to many of the apprenticeship reforms in England, identified off-the-job training as a crucial component of apprenticeships. It stated that “off-the-job... gives the apprentice safeguarded time away from their job to ensure they can do substantial training. It can give them a peer group of different apprentices and a wider perspective, experience other than their employer is inputting to the transferability.”

Off-the-job training in other countries – a comparison

Apprenticeships in other countries also tend to include a set amount of time completing ‘off the job’ training:
- In the widely hailed German Vocational Education and Training system (also called the dual training system), trainees spend part of their time at a company and the remainder at specialist vocational schools where they obtain theoretical knowledge for their occupation of choice, often for weeks or months.
- Typically, apprentices in Germany spend at least one day per week (20% of their time) completing off-the-job training.
- In the Netherlands, apprentices spend one day per week (20% at ‘school’ and 4 days in the company).
- In Belgium, apprentices spend one to 2 days per week (20% to 40%) at ‘school’ and 3 to 4 days per week at the company.
- In other countries apprentices spend significantly more time in off-the-job training in Sweden, for example, 50% of apprentices’ time is spent undertaking classroom-based vocational education.

There seems to be a lesson to be learned from other countries, which is that successful apprenticeship programmes are generally characterised by a formal system in which apprentices spend dedicated time in good quality training and development. Key to this is the full support of industry. So it is perhaps revealing that employers in England have reacted to this 20% off-the-job training with some concern, particularly in relation to its perceived rigidity and the potential for misinterpretation.

- A 2019 CBI report on improving the apprenticeship levy called the 20% off-the-job training requirement “a blunt and inflexible policy tool”, however well intentioned”, and noted that “there are significant inconsistencies in the way the 20% rule is interpreted, applied and measured... there remains a significant amount of confusion among employers.”
- A recent report by the Institute of Student Employers noted employer concerns that the off-the-job training requirement has been interpreted differently by different providers and prevented existing staff from taking part in apprenticeships.

Furthermore, a recent National Audit Office report reinforced the view that inconsistencies abound, noting that many apprentices are not currently spending at least 20% of their time doing off-the-job training and highlighting this as a major risk to the apprenticeship programme as a whole.

EngineeringUK held a focus group with its corporate members to explore the challenges and opportunities faced by employers in expanding the supply of apprenticeships and the impact of reforms. The results suggested that similar concerns are held within the engineering and manufacturing industries. Engineering firms that took part noted the use of apprenticeships to retain existing workers and raised questions around whether the levy is having its intended effect for engineering companies.

The 20% off-the-job training requirement was a key concern, with several engineering employers feeling that the requirement ought to be made more flexible or even reduced.

The degree to which 20% off-the-job training was required was, it was felt, dependent on the nature of the apprenticeship and the skills and competency required.

Similar concerns were raised by manufacturing employers taking part in a MakeUK survey, with 39% of levy-paying manufacturers surveyed indicating that the off-the-job training requirement was the most up to barrier to taking on more apprentices, because it required sufficient staffing capacity to cover apprentices while they were away from their normal duties.

It’s possible that this reluctance may be due, in part, to a view that apprentices are primarily employees – not students – as well as a (mis)perception that off-the-job training cannot take place in the workplace. Seeking to dispel myths surrounding this requirement, the government has clarified that off-the-job training can take place in the workforce, as long as the apprentice is learning new knowledge, skills and behaviours, and completing tasks that are “away from the apprentice’s normal working duties.”

To ensure the success of the apprenticeship programme and increase the numbers of apprentices in the engineering pipeline, the government must make clear both the necessity of and the rationale behind the 20% off-the-job training requirement. In addition, engineering employers should recognise the benefits that this additional training will provide.

3.105 German Federal Ministry of Education and Research. ‘The German vocational training system’ [online], accessed 20/02/2020.
3.111 NA Group. ‘Further education and apprenticeships’, 3 – Further education and apprenticeships

3.7 – Apprenticeship trends in England

Reforms to the apprenticeship system have had a major impact on the number of apprenticeship starts. This can be seen most acutely in the drop in starts seen in the fourth quarter of 2016 to 2017, just after the apprenticeship levy came into place (Figure 3.13).

The introduction of the apprenticeship levy caused a drastic reduction in overall apprenticeship starts.

Figure 3.13 suggests that the introduction of the levy caused a dramatic immediate change in the behaviour of employers and learners. As a result, it’s difficult to determine whether the impact will be long-lasting.

The 2018 to 2019 data shows that apprenticeship starts have picked up slightly from their lowest point in 2017 to 2018, but the figures are still far below those observed in 2016 to 2017 and earlier, before the levy was introduced. Provisional start data for 2019 to 2020 indicates another slight drop in starts. The ‘cumulative starts’ line indicates that the government has failed to reach its target of 3 million starts by 2020.

In the academic year 2018 to 2019, there were 103,620 engineering-related apprenticeship starts overall, which is an increase of 3.6% from 2017 to 2018. Numbers dropped by 10.3% between 2016 to 2017 and 2017 to 2018 after the introduction of the levy, but the drop was smaller than it was for apprenticeships overall (a decline of 24.1% across all sector subject areas). This means that in 2018 to 2019, engineering-related starts made up a higher proportion (26.3%) of all starts than before the apprenticeship levy was introduced (Figure 3.14).

About the data: apprenticeships

In this section, we refer to ‘engineering-related apprenticeships’, which are apprenticeships in the construction, planning and built environment, engineering and manufacturing technologies, and information, communication and technology (ICT) sector subject areas. Data is presented separately for each sector subject area in certain figures. Full breakdowns are available in the Excel resource.

In England, there are at least 3 levels of apprenticeship: intermediate (level 2), advanced (level 3) and higher (levels 4 to 7). Higher level apprenticeships include all apprenticeships at levels 4 and above. However, level 6 and 7 apprenticeships are specifically called ‘degree apprenticeships’, because the apprentice will achieve a full degree upon completion. For more detailed information about levels of qualification in England and the UK please see Figure 1.2 in Chapter 1.

Starts, achievements and achievement rates

Apprentice starts – this is the number of learners who started an apprenticeship in the listed academic year. It is an indicator that provides timely apprenticeship statistics and is the metric most commonly used by government and other stakeholders to analysed the success of the apprenticeship programme.

Apprenticeship achievement – this is the number of learners who successfully completed an apprenticeship in the academic year. But due to the different lengths of time taken for different apprenticeship programmes, numbers of achievements cannot be compared directly with starts.

The two indicators measure different aspects of apprenticeships. In this section we will primarily provide analysis on apprenticeship starts. This is because starts provide the most up to date information on the make-up of apprentices and how the picture is changing in the rapidly-developing FE landscape. Often it is not necessary to include both metrics, because achievements tend to show a similar picture as starts but with a delay, which is not appropriate given the introduction of the levy.

Where relevant, results will also be presented for apprenticeship achievements. More detailed data on both indicators is available in the accompanying Excel resource.

Apprenticeship achievement rates – this measures the proportion of people who completed their apprenticeship within the academic year out of all those who were due to do so. This is different from the overall number of apprenticeship achievements, which does not take into account when the learner started their apprenticeship or whether they completed it by their planned end date.

Published DfE data does not allow analysis of apprenticeship achievement rates by both sector subject area and personal characteristics such as gender and ethnicity, so it is not possible to present engineering related achievement rates by those characteristics.
Over the 5 year period up to the academic year 2018 to 2019, the number of engineering-related apprenticeship starts decreased by 4.7%. However, due to the overall decrease in apprenticeship starts (down 21.3% over 5 years), engineering’s share increased by 4.7 percentage points since 2014 to 2015, which bodes well for the sector in the future. The fact that this proportion has been broadly stable between 2017 to 2018 and 2018 to 2019 may indicate a sustained increase in the relative attractiveness of engineering-related apprenticeships.

**Apprenticeship levels**

There has been a large variation by sector subject area and level, with all sector subject areas – both engineering-related and other – seeing a large increase in higher level apprenticeship starts and a steep decline in intermediate level apprenticeship starts (Figure 3.15). In 2018 to 2019, there were 22,530 starts in construction, planning and the built environment, 59,970 in engineering and manufacturing technologies, and 21,110 in ICT. ICT apprenticeship starts observed the largest 5-year increase across all levels (34.8%) (see Figure 3.15). Conversely, there was a 19.0% decrease within the engineering and manufacturing sector subject area.

Due to the introduction of the apprenticeship levy in 2016 to 2017, and reflecting the fact that trends in apprenticeship achievements broadly follow the same pattern as starts, achievements across all engineering-related subjects have decreased dramatically over the past year, with a total of 55,080 in 2018 to 2019. This represents a drop of 16.7% from 2017 to 2018 (Figure 3.15).

In 2018 to 2019, there was a 52.3% increase in engineering-related apprenticeship starts at levels 4 and above.

The drop in intermediate level apprenticeship starts was most pronounced within the engineering and manufacturing sub-sector, where there was a 46.9% decrease over the past 5 years. The largest drop was observed between 2016 to 2017 and 2017 to 2018 after the introduction of the levy.

Across all engineering-related sector subject areas, there has been a 62.2% increase in higher level starts over a 5-year period, compared with a 36% decrease in intermediate starts. At higher level, the number of starts increased more in engineering-related subjects than the average across all subjects. At intermediate level, there was a fall in the numbers of engineering starts, but it wasn’t as great as the drop seen across all sector subject areas.

This shift to higher level starts is primarily due to the introduction of apprenticeship standards, which has increased the number of higher apprenticeships available. Indeed, of the 227 engineering-related standards approved for delivery, 37% are level 4 and above. Furthermore, of those engineering-related apprenticeships with starts in 2018 to 2019, just 6% of frameworks were at level 4 and above, compared with 31% of apprenticeship standards.

This is because historically, apprenticeships tended to be pitched at a lower level of learner, but the introduction of standards is seen as both an increase in quality of apprenticeships at all levels and an overall shift towards higher level apprenticeships to upskill the UK workforce.

Along with the increased focus on higher technical qualifications in STEM, the engineering sector should welcome this upskilling. The 2017 Employer Skills Survey found that manufacturing was the sector with the second highest proportion of its workforce lacking full proficiency. Technical education is one way to address this skills gap.

**Degree apprenticeships**

The rise in higher apprenticeship starts has not been equal across each level. Degree apprenticeships, in particular, have seen a steep increase in popularity since the introduction of the levy (Figure 3.16).
6 In the construction, planning and the built environment sector, degree apprenticeships are more popular than level 4 and 5 apprenticeships, accounting for 62.0% of all higher starts in 2018 to 2019. They have increased by 94.4% in the past year alone. The increase in degree apprenticeship starts in engineering-related areas was lower than across all sector subject areas – both in the past year (65.8% for engineering-related compared with 100.7% for all areas) and over a 5 year period. However, degree apprenticeship starts comprised a larger proportion (40%) of all higher level starts in engineering-related areas in 2018 to 2019 than they did for all sector subject areas (29%).

What is a degree apprenticeship?

In recent years, there has been a policy drive towards degree apprenticeships, which were announced as a concept in late 2014. A degree apprenticeship combines aspects of both higher and vocational education, and is designed to test occupational competence and academic learning. This can be through a fully-integrated degree programme (co-designed by employers and HE institutions) or a degree plus a separate test of professional competence. Due to the integrated degree, degree apprenticeships were expected to prove highly attractive to students who may be concerned about the debt inherent in a student loan that they are likely to have to take out to fund a university degree.

This level of apprenticeship may be particularly relevant to the engineering sector, with a 2019 Universities UK report on the future of degree apprenticeships suggesting that these qualifications will be crucial in addressing the engineering skills shortage.136 Analysis of DfE data shows that in 2018 to 2019, 5 of the 10 degree apprenticeships with the highest number of starts were in engineering-related areas (Figure 3.17).

With established employers such as Rolls-Royce137 and the RAF138 now providing degree apprenticeships that guarantee employment in the engineering sector and progression opportunities upon completion, it’s not surprising that these new types of qualifications are becoming increasingly popular. Engineering employers should take note and seek to understand more about the skills gained by those successfully completing one of these degrees and the benefits they may provide in addition to a traditional undergraduate degree. Figure 3.17 shows that there were 623 students starting a civil engineering degree apprenticeship in 2018 to 2019, which is 11.2% of the number of civil engineering first degree entrants into higher education (see Figure 4.5 in Chapter 4 for more detail). Although this is still a low proportion, degree apprenticeships have only existed for 5 years. The data suggests that they will cement their place even more firmly in the education landscape, with provisional 2019 to 2020 DfE data showing a further increase in engineering-related degree apprenticeship starts.

However, the reaction to degree apprenticeships within the FE sector has not been unanimously positive. This is due to the high numbers of starters on management courses and the “rebadging of existing graduate schemes into apprenticeships”, as highlighted in the 2017 to 2018 annual Ofsted report.139 David Hughes, chief executive of the Association of Colleges, has also raised this as a concern, stating that “apprenticeships are for young people entering the labour market… rather than giving people who are already privileged in the system more skills that probably would have been funded differently by employers in the past”.140 Figure 3.17 shows that in 2018 to 2019, the most popular degree apprenticeship starts were the senior leader master’s level apprenticeship and the chartered manager degree, which would suggest that these concerns are not unfounded.

Gender

In engineering-related areas, the demographic makeup of apprentices has not changed significantly over the past 5 years, despite government commitments to increase numbers of apprentices from diverse backgrounds.141 The engineering sector in particular suffers from a lack of diversity, with women making up just 12% of the current engineering workforce.142 Those from minority ethnic backgrounds also comprise 9% of the workforce.143 Chapter 3 shows that girls are underrepresented in key STEM subjects at A level and Chapter 4 shows that the same holds true for higher education. However, within FE the problem is particularly acute, with apprentices starting engineering related courses being even less diverse. Across all 3 engineering-related sector subject areas together, there has been an increase in the female share of apprenticeships since 2014 to 2015. However, in engineering and manufacturing technologies the proportion has not improved since 2015 to 2016. There were a far higher proportion of women starting ICT apprenticeships than the other areas: the proportion of women has risen by 9.9 percentage points since 2016 to 2017, but women still made up less than 20% of ICT apprentice starts in 2018 to 2019 (Figure 3.18).
The fact that just 7.9% of engineering and manufacturing technologies starts were by women in 2018 to 2019 is particularly stark when you consider that women accounted for half (50.1%) of overall apprenticeship starts in 2018 to 2019. Female underrepresentation is similarly apparent in the construction industry, where only 15% of those working in the sector are women. It is particularly acute among those studying related apprenticeships – just 6.4% were women in 2018 to 2019. Despite the current levels being extremely low, it is promising that the proportion of female construction apprenticeship starts has risen by 4.2 percentage points since 2014 to 2015.

The proportion of women starting engineering and manufacturing technologies apprenticeships has not increased since 2015 to 2016.

The low share of apprenticeships starts by women in engineering-related areas in 2018 to 2019 shows that concerted efforts to increase the number of women taking up engineering3.130 have had limited success in the technical education sector. This is further evidenced by the fact that the proportion of female engineering and manufacturing technologies apprentices has not risen significantly since 2014 to 2015, with the level hovering between 7% and 8% across the entire 5 year period.

EngineeringUK’s 2019 Engineering Brand Monitor may shed some light on why female representation is so low within engineering. The survey showed that it is possible girls have a pre-conceived idea about what an engineering apprenticeship encompasses, with girls aged 11 to 19 being more likely than boys to think engineering is ‘dirty, messy or greasy’. However, there was no statistically significant difference between girls and boys in terms of whether they would choose a vocational or academic route into engineering, which indicates that the gender difference in engineering apprenticeships may lie within the subject matter itself, rather than the vocational nature of apprenticeships.

The Institute of Mechanical Engineers (I MechE) published a report on female engineering apprentices in 2018, which suggested that a significant minority (35%) of these students were mistakenly identified as not being likely to be interested in engineering-related careers, leading them to end up discovering engineering as a ‘later option’ in the educational pipeline.3.129 These young women had particularly negative views of schools’ careers advice, and the research suggested that focussed messaging should be targeted at girls in schools at later stages, “emphasising messages likely to resonate with the values, attitudes and broad interests of female students”.

It is clear, then, that far more could be done to encourage women into engineering at each stage of education, and it is imperative that any pre-existing stereotypes are not reinforced. It is also crucial to ensure that women feel comfortable undertaking an engineering apprenticeship once they have successfully secured one.

Case study – Perspectives from a female engineering apprentice

Heather Came, 1st year apprentice, Flybe Training Academy, Exeter

Becoming an engineer has been a passion of mine for a long time. Having come from an academically oriented school, I realised that a practical job would suit me best. My main reason for wanting to become an engineer is because engineering consists of a variety of skills. You never know what you’ll be challenged with next, which keeps you constantly engaged. Another appeal is that the industry is constantly developing and progressing. Therefore, it will always be required. Engineers created everything around us and will continue to do so, which is why they will always be in demand.

Engineering has been, for a long time, a male dominated industry. I am the only woman in my class, which can sometimes be isolating, and at times I do feel that I am treated differently because of my gender. This can be disheartening and a considerable confidence knock. However, I am not deterred by these factors, and I think that more women should be encouraged to join the engineering sector to address the imbalance.

Becoming an engineer allows you to make a difference and contribute towards future innovations. The satisfaction of turning a piece of material into an item with a purpose or being able to fix something previously broken and to see it working again, either on your own or as part of a team, is priceless.

On a positive note, the increased numbers of apprenticeship starts at higher levels across all sector subject areas (Figure 3.15, page 85) may increase the overall proportion of women in engineering-related apprenticeships. This is because a far greater proportion of women were on higher level engineering-related apprenticeships than lower levels (Figure 3.19).

In 2018 to 2019, women were much more likely to start higher level engineering-related apprenticeships than lower levels.

Figure 3.19

Female apprentices as a share of engineering-related sector subject area starts by level (2018/19) – England

<table>
<thead>
<tr>
<th>Level</th>
<th>Construction, planning and the built environment</th>
<th>Engineering and manufacturing technologies</th>
<th>Information and communication technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced</td>
<td>14.8%</td>
<td>18.4%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Higher apprenticeship</td>
<td>22%</td>
<td>24.8%</td>
<td>13.6%</td>
</tr>
<tr>
<td>Intermediate apprentices</td>
<td>15.8%</td>
<td>13.6%</td>
<td>13.6%</td>
</tr>
<tr>
<td>18-19 year olds</td>
<td>17.2%</td>
<td>19.1%</td>
<td>13.6%</td>
</tr>
<tr>
<td>Intermediate</td>
<td>17.2%</td>
<td>19.1%</td>
<td>13.6%</td>
</tr>
<tr>
<td>All sector subject areas</td>
<td>15.0%</td>
<td>18.0%</td>
<td>13.6%</td>
</tr>
</tbody>
</table>

This is true across all sector subject areas, but the difference was particularly noticeable in both construction, planning and the built environment, and engineering and manufacturing technologies. Women accounted for 18.4% of all higher level construction starts, compared with just 2.2% of intermediate and 8.9% of advanced starts.

The fact that women were more likely to take up higher level engineering apprenticeships may mean that the gender disparity in engineering-related areas will improve in future, as the shift towards apprenticeships at level 4 and above continues.

Engineering-related achievements by women

In 2018 to 2019, there were 3,730 engineering-related apprenticeship achievements by women, making up 6.8% of the total.

This varied by sector subject area, with just 3.1% of construction, planning and the built environment achievements by women, 6.2% of engineering and manufacturing achievements, and 14.3% of ICT achievements.

This represented an increased share from 2017 to 2018 levels for construction, planning and the built environment (up by 1.0 percentage point), but a decrease for engineering and manufacturing (down 1.2 percentage points) and ICT (down 0.2 percentage point).

Ethnicity

Figure 3.20 shows that the proportion of apprenticeships starts by minority ethnic students in both construction (5.4%) and engineering and manufacturing (7.9%) was extremely low in 2018 to 2019. This compares with 12.5% of all apprenticeship starts, showing that engineering lags behind other areas in attracting students from minority ethnic backgrounds.

*Engineering-related achievements by women (2018/19)*

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Construction, planning and the built environment</th>
<th>Engineering and manufacturing technologies</th>
<th>Information and communication technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction, planning</td>
<td>15.6%</td>
<td>17.2%</td>
<td>7.1%</td>
</tr>
<tr>
<td>Engineering and manufacturing</td>
<td>11.4%</td>
<td>11.4%</td>
<td>7.9%</td>
</tr>
<tr>
<td>Information communication</td>
<td>9.1%</td>
<td>9.1%</td>
<td>7.9%</td>
</tr>
<tr>
<td>All sector subject areas</td>
<td>14.2%</td>
<td>14.2%</td>
<td>7.9%</td>
</tr>
</tbody>
</table>

In 2018 to 2019, women were much more likely to start higher level engineering-related apprenticeships than lower levels.
Students from minority ethnic backgrounds were better represented in ICT, comprising 19.1% of all starts in 2018 to 2019, which was a 1.8 percentage point rise from 2017 to 2018, and an increase of 4.1 percentage points on 2014 to 2015 figures.

While construction, planning and the built environment and engineering and manufacturing have slightly improved their take up by students from minority ethnic backgrounds (increasing by 1.2 percentage points in both subject areas since 2014 to 2015), these rises were in line with those observed across apprenticeships more widely (1.8 percentage points increase). This means that neither has increased its relative attractiveness to students from minority ethnic backgrounds compared with other areas.

This is in stark contrast to the high proportion of engineering and technology students in higher education (HE) from minority ethnic backgrounds, which is explored in more detail in Chapter 4. Apprentices and higher education students are different, but those responsible for technical education in the engineering sector could look to HE to try to understand how to improve take up by students from minority ethnic backgrounds, as they are overrepresented in HE.

The proportion of engineering and manufacturing apprenticeships starts by minority ethnic students is, however, in line with employment in the engineering sector. Of those working in engineering occupations within the engineering sector, just 8.5% are from minority ethnic backgrounds. 1.126 This means that the ethnic make-up of engineering and manufacturing apprentices broadly reflects the wider underrepresentation of minority ethnic people within the engineering workforce in the UK.

There was also some variation in the levels at which apprentices from minority ethnic backgrounds were likely to start. In construction, planning and the built environment and ICT they were more likely to start higher level apprenticeships (9.5% and 21.1% of all starts respectively). However, in the engineering and manufacturing technology subject area, minority ethnic students were more likely to start on lower level apprenticeships (9.6% of all intermediate starts).

In 2018 to 2019, students from minority ethnic backgrounds were more likely to start lower level apprenticeships in engineering and manufacturing technologies than their white peers.

This is particularly concerning for engineering and manufacturing, given that across all subject areas, those from minority ethnic backgrounds were more likely to start higher level apprenticeships. The reduction in intermediate level engineering and manufacturing starts in 2018 to 2019 (Figure 3.15) exacerbates this issue. Any further decline in lower level starts could be problematic for those from minority ethnic backgrounds, because they will have fewer apprenticeships to choose from, and for engineering and manufacturing as a whole as it may reduce diversity.

**Figure 3.21** Minority ethnic apprentices as a share of engineering-related sector subject area starts by level (2018/19) – England

<table>
<thead>
<tr>
<th>Sector subject area</th>
<th>Higher apprentices</th>
<th>Advanced apprentices</th>
<th>Intermediate apprentices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction, planning and the built environment</td>
<td>44%</td>
<td>9.5%</td>
<td>9.5%</td>
</tr>
<tr>
<td>Engineering and manufacturing technologies</td>
<td>9.6%</td>
<td>6.9%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Information and communication technology</td>
<td>16.7%</td>
<td>18.9%</td>
<td>21.1%</td>
</tr>
</tbody>
</table>

**Engineering-related apprenticeship achievements by those from minority ethnic backgrounds**

In 2018 to 2019, there were 7,550 engineering-related apprenticeship achievements by those from minority ethnic backgrounds, making up 6.9% of all achievements.

There was a large variation in achievements by sector, with minority ethnic students accounting for 13.9% of those in ICT, 6.1% in engineering and manufacturing and 4.2% in construction, planning and the built environment.

The proportion of such achievements by minority ethnic students in each subject area has declined compared with the year before, with percentage point decreases of 0.1 for construction, planning and the built environment, 0.3 in engineering and manufacturing, and 2.6 for ICT.

**Figure 3.22** Engineering-related apprenticeship starts by age group (2014/15 and 2018/19) – England

<table>
<thead>
<tr>
<th>Subject area</th>
<th>2014/15</th>
<th>2018/19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction, planning and the built environment</td>
<td>29.5%</td>
<td>25.1%</td>
</tr>
<tr>
<td>Engineering and manufacturing</td>
<td>33.4%</td>
<td>25.1%</td>
</tr>
<tr>
<td>Information and communication technology</td>
<td>34.3%</td>
<td>35.2%</td>
</tr>
</tbody>
</table>

**Figure 3.22** Engineering-related apprenticeship starts by age group (2014/15 and 2018/19) – England

### Engineering-related apprenticeship achievements by those from minority ethnic backgrounds

In 2018 to 2019, there were 7,550 engineering-related apprenticeship achievements by those from minority ethnic backgrounds, making up 6.9% of all achievements.

There was a large variation in achievements by sector, with minority ethnic students accounting for 13.9% of those in ICT, 6.1% in engineering and manufacturing and 4.2% in construction, planning and the built environment.

The proportion of such achievements by minority ethnic students in each subject area has declined compared with the year before, with percentage point decreases of 0.1 for construction, planning and the built environment, 0.3 in engineering and manufacturing, and 2.6 for ICT.

**Figure 3.22** shows that apprentices in engineering-related areas tend to be much younger than apprentices in general. In 2018 to 2019, nearly half (48.9%) of construction apprentices and 40.2% of engineering and manufacturing technologies apprentices were under 19, compared with just one quarter (24.8%) of apprentices from all sector subject areas. And whereas nearly half (45.7%) of all apprentices were 25 or over, only one quarter (25.5%) of engineering and manufacturing, and 17.3% of construction apprentices were.

Despite apprentices in engineering-related areas being younger than the overall cohort, there has been a shift over time. Now, a far higher proportion of apprenticeship starts in both ICT and construction, planning and the built environment are older learners than in previous years. In construction and ICT, there were increases of 7.7 and 10.1 percentage points respectively in the share of apprenticeship starts by people aged 25 and over between 2014 to 2015 and 2018 to 2019.

The age profile of those starting engineering and manufacturing apprenticeships has seen less change. There has, however, been a minor shift, with slightly more starts by those aged under 25 (a 3.8 percentage point increase overall) and fewer starts by those aged over 25.

This finding is particularly relevant in the context of the broader apprenticeship landscape. There are widespread concerns that the apprenticeship levy has caused employers to rebadge existing training as apprenticeships and convert their existing graduate and trainee and professional development programmes into apprenticeships. 1.126

However, the comparatively young age profile of engineering and manufacturing apprentices could indicate that many of those undertaking apprenticeships in the sector are at the start of their career rather than existing engineers. This is encouraging, given the need to attract more students into the engineering pipeline.

The increased share of older learners starting construction and ICT apprenticeships is likely to be due to the rapid expansion of higher level apprenticeships, and the increase in starts in both advanced and higher level apprenticeships (Figure 3.15), which tend to be undertaken by older learners.
Although London had the highest number of engineering employees, it had the second lowest proportion of engineering and manufacturing technologies apprenticeship starts.

There was a large variation in engineering related apprenticeships starts by region, with the North West accounting for the highest proportion of construction starts (16.2%). The South East accounted for the highest proportion of engineering and manufacturing technologies starts (15.7%), and London had the highest proportion (17.6%) of ICT apprenticeship starts (Figure 3.23).

We might expect the number of engineering related apprenticeships to reflect the number of engineering jobs available in each region and the proportion of the overall employment in each region that is within the engineering footprint. Analysis of InterDepartmental Business Register (IDBR) data\(^\text{134}\) shows that the highest number of engineering employees – according to the Engineering Footprint explained in the 2018 EngineeringUK report\(^\text{135}\) – are located in London and the South East. So it is therefore surprising that London has the second lowest proportion of engineering and manufacturing technologies apprenticeship starts (6.2%) and the lowest proportion of construction starts (7.0%). It may be that the majority of these London-based roles are professional engineering roles and therefore not suited to engineering apprentices. However, there may be scope to increase the number of engineering related apprenticeships available for students in the capital.

When noting the location of apprenticeships starts, it is important to consider potential ‘cold spots’ where it may be difficult for prospective learners to find a suitable apprenticeship. The Higher Education Commission (HEC) recently released a report on degree apprenticeships suggesting that apprenticeship cold spots – areas where students have to travel a long distance to find an opportunity – are likely to be in areas of overall employment cold spots, meaning that social mobility issues are amplified.\(^\text{136,137}\) The report recommended that “disadvantaged young people, especially from educational and employment cold spots, should be eligible for maintenance support in line with the support offered to university students, so that they can access degree apprenticeships ‘on their doorsteps and around the country’”.

Apprenticeships and social mobility

Because apprenticeships are undertaken by people from a broad age range, it is impossible to use the measures of disadvantage that are applicable to young people at school. Instead, the Index of Multiple Deprivation (IMD) is used to categorise apprenticeships into ‘deprivation quintiles’ based on where they live.\(^\text{138}\)

Figure 3.24 shows the proportions of engineering-related apprenticeship starts by those from the lowest deprivation quintile (quintile 1, representing the most deprived areas). If apprenticeship starts were distributed equally across each IMD quintile and level of study, we would expect to see 20% of starts by those in the most deprived areas. Percentages higher than 20 mean, therefore, that those from deprived areas are overrepresented, with the converse also being true.

With the introduction of T levels (at level 3) and the shift towards higher level apprenticeships, it is important that those from the most disadvantaged backgrounds don’t get left behind, facing a lack of available training at appropriate levels. It will also be crucial to ensure those from the most deprived areas are encouraged to pursue engineering apprenticeships at level 3 and above, as they are currently underrepresented at higher levels.

Apprenticeship achievement rates

Since 2014 to 2015, apprenticeship achievement rates have fallen, both in engineering-related sector subject areas and across all apprenticeships. In engineering-related areas, achievement rates were highest for intermediate ICT apprenticeships (82.1% achievement rate) and lowest for higher level ICT apprenticeships (52.6%).

3.137 Taken from the Ministry of Housing, Communities and Local Government, the Index of Multiple Deprivation is ‘the official measure of relative deprivation in England’ and is part of a suite of outputs that form the Indices of Deprivation (IoD).
In construction, planning and the built environment, and in engineering and manufacturing, advanced level apprenticeships had the highest achievement rates (74.1% and 74.0% respectively) – something that was also seen when all sector subject areas were considered together. The difference in achievement rates between levels were more pronounced for construction, planning and the built environment, and ICT, than it was for all sector subject areas.

The drop in achievement rates over the past year, and indeed 5 years, is due to the introduction of apprenticeship standards, which have far lower achievement rates than the old apprenticeship frameworks.

### 3.8 – Apprenticeship trends in Scotland, Wales and Northern Ireland

Up to this point, this chapter has exclusively covered apprenticeships and technical education in England, as the reforms primarily affected England. Skills and apprenticeship provision are devolved to the individual nations of the UK. Scotland, Wales and Northern Ireland elected to continue with apprenticeship frameworks instead of introducing apprenticeship standards, and meeting the demands of employers through the existing apprenticeship qualifications. 3.145 However, the apprenticeship levy does apply across all nations of the UK, with each devolved administration receiving a proportionate share of the funds.

Scotland

Skills Development Scotland (the body in charge of Scottish Apprenticeships) will continue to fund apprenticeship training in Scotland and the Scottish government will receive the Scottish share of the apprenticeship levy (£239 million in 2019 to 2020). 3.145

Scotland recently introduced an ‘apprenticeship board’, which ensures there is a demand-led, responsive and adaptive work based learning system for the employers and the Scottish economy. 3.145 This board means that there are some similarities with the English system (which has the Institute for Apprenticeships and Technical Education).

While England introduced a target of 3 million apprenticeship starts by 2020, the Scottish government set an ambition of reaching 30,000 apprenticeship starts annually by 2020. 3.146

There are 3 main types of apprenticeship available in Scotland: 3.146

- Foundation apprenticeships – to help young people gain real-world work experience while still at school. Young students take these apprentices in S4 or S5 (the equivalent of years 10 and 11 in England and Wales, when students would be studying for GCSEs – see Chapter 1 for more detail on education levels in different UK nations).
- Modern apprenticeships – for employers to develop their workforce by training new staff and upskilling existing employees. These apprenticeships are open to anyone over the age of 16, with the funding provision restricted to 24 year olds.
- Graduate apprenticeships – providing work based learning up to Master’s degree level for new and existing employees. These apprenticeships are primarily taken by those already in the workplace.

These different types of provision ensure that all learners are catered for within the technical education sector in Scotland and aim to attract increasing numbers of young people and professionals alike, including those studying engineering.

In Scotland, engineering-related apprenticeships accounted for 34.3% of all starts in 2018 to 2019. This section will discuss modern apprenticeships only, as Skills Development Scotland publishes data only on modern apprenticeships and they provide the closest comparison to the apprenticeships discussed in the England section.

In Scotland, there were 9,353 engineering-related apprenticeship starts in 2018 to 2019. These made up a higher proportion of overall starts than they did in England, with 34.3% of all starts in 2018 to 2019 on engineering-related apprenticeships (compared with 26.3% in England).

### Figure 3.27 – Engineering-related apprenticeships as a share of all apprenticeship starts over time (2014/15 to 2018/19)

Scotland

In Scotland, there were 9,353 engineering-related apprenticeship starts in 2018 to 2019. If these rates continue, there will be large swatches of apprentices in engineering-related areas who either fail to complete their course at all or spend far longer doing so than is necessary. This could be a significant blow to the engineering pipeline at a time when a skilled workforce is crucial.

In terms of gender disparity, Scotland performs worse than England. Just 3.8% of all engineering-related starts in Scotland were by women in 2018 to 2019. Furthermore, that share has not changed significantly since 2014 to 2015. While the absolute number of women taking up engineering apprenticeships in Scotland has risen, this has been in line with the increase in apprentices overall – proportionally the percentage of apprentices who are women has remained relatively static.

The picture is similar for engineering apprenticeship achievements in Scotland. In 2018 to 2019, just 3.2% of these were by women, compared with 37.7% of all apprenticeship achievements. 3.145

Apprenticeship achievement rates in Scotland

In 2018 to 2019, engineering-related frameworks in Scotland had a 78.2% achievement rate, compared with 76.5% for all apprenticeships. This represented a decrease of 3.7 percentage points from 2017 to 18. However, engineering-related achievement rates in Scotland were higher than in England, where the achievement rate in engineering-related areas was only 71.5% (see Figure 3.25).

There was a minor difference by gender, with an average achievement rate of 78.8% for women in engineering-related areas, and 73.2% for men. 3.145

Not only are there gender differences between Scottish and English engineering apprentices, but the age profile differs too. A lower proportion (16.0%) of Scottish engineering apprentices were aged 20 to 24 than in England, and there were more adult apprentices in Scotland (Figure 3.29).
In Wales, there were 5,175 engineering-related apprenticeship starts in 2018 to 2019, an 6.7% increase since 2014 to 2015. There was a large rise in both engineering-related and overall apprenticeship starts between 2016 to 2017 and 2017 to 2018, which meant that the 2018 to 2019 numbers were significantly lower than the previous year. As a share of overall starts, engineering-related apprenticeships have decreased over a 5-year period, so that in 2018 to 2019 they made up 19.9% of the overall cohort – a lower share than in both England and Scotland.

In contrast to England, where those aged 25 and over made up the highest proportion of apprentices overall, Scotland’s wider apprenticeship cohort tended to be younger. Engineering apprentices made up a large proportion (41%) of the entire 25 and over cohort and a higher proportion of all engineering apprentices fell into that age category. This could indicate that in Scotland, many people follow their path towards careers by studying an apprenticeship, either as a way of re-training or upskillling. The different types of apprenticeships available in Scotland also account for some of this difference, with older learners more likely to embark on graduate apprenticeships as opposed to modern apprenticeships.

Wales

In a similar manner to Scotland, the Welsh government will continue to administer its apprenticeships programme using the current Welsh apprenticeship provider network, and the Welsh government has stated that their approach to apprenticeships will be “driven by the needs of the Welsh economy and communities”.

The Welsh government has committed to increasing apprenticeships in skills shortage areas such as engineering. In 2017, the Welsh government committed to delivering 100,000 apprenticeship places by 2022 and recent evidence suggests it is on course to meet that target. In the 2017 policy plan, the government also committed to increasing the numbers of apprentices in ‘skills shortage areas’ such as engineering, and generally increasing STEM apprenticeships more widely. Welsh apprenticeship levels are in line with those in England, with slightly different naming conventions. Level 2 apprenticeships are called foundation, level 3 are simply called apprenticehips, and level 4 and above apprenticeships are called higher.

The decreased share may be due to the introduction and recent rise in take-up of higher level apprenticeships in Wales. The first higher apprenticeship starts in engineering-related areas were in 2017 to 2018, but these haven’t been taken up as much as higher level apprenticeships in other areas.

In 2018 to 2019, engineering-related apprenticeships accounted for 27.0% of foundation, 19.4% of apprenticeship and just 4.2% of higher starts in Wales. Overall numbers of higher starts remained low in Wales, whereas, a 2018 report by Estyn confirmed that the Welsh government plans to increase the number of higher apprenticeships in science, technology, engineering and mathematics by 2019. The landscape could therefore change significantly, with more higher level engineering-related starts in future.

While engineering’s share of all apprenticeship starts may be lower in Wales, the region has been more successful than England and Scotland in increasing engineering’s attractiveness to women. In 2018 to 2019, there were 390 engineering-related starts by women, accounting for 7.5% of the total numbers.

The absolute numbers involved were extremely low, but the increased share – and there has been a steady rise each year since 2014 to 2015 – indicates that Wales is moving in the right direction.

Apprenticeship achievement rates in Wales

In 2018 to 2019, 83% of learners in apprenticeships at all levels successfully completed their framework in engineering and manufacturing technologies. This was the same proportion as in 2017 to 2018 but a decrease of 4 percentage points since 2014 to 2015. For those on construction, planning and the built environment apprenticeships, 79% successfully completed their framework in 2018 to 2019. This represented a decrease of 3 percentage points on 2017 to 2018 figures but only a 1 percentage point decrease from 2014 to 2015.

While engineering’s share of all apprenticeship starts may be lower in Wales, region has been more successful than England and Scotland in increasing engineering’s attractiveness to women. In 2018 to 2019, there were 390 engineering-related starts by women, accounting for 7.5% of the total numbers.

Higher level engineering-related apprenticeship starts accounted for just 4.2% of all higher level starts in Wales in 2018 to 2019.
Northern Ireland

In Northern Ireland, sector subject figures are only published for those participating on apprenticeships, rather than starts or achievements. The levels of apprenticeship are similar to England, with higher level apprenticeships at level 4 and above. Its level 3 apprenticeships are similar to advanced apprenticeships in England and modern apprenticeships in Scotland. Northern Ireland also has level 2 apprenticeships, which are similar to foundation apprenticeships in Wales and intermediate apprenticeships in England. However, in Northern Ireland, some apprentices are also referred to as on a ‘level 2/3 apprenticeship’ if they are pursuing a level 2 qualification but are working towards a targeted level 3 outcome.

Encouragingly, engineering apprentices make up the majority of all participants on apprenticeships in Northern Ireland, with 5,412 of the 8,812 apprentices within engineering-related areas in 2019. The most popular engineering related apprenticeship across all levels was the ‘electrotechnical’ apprenticeship, with 1,497 participants in 2019.

In 2019, engineering-related apprenticeships accounted for 61.4% of all apprentice participants in Northern Ireland.

In Northern Ireland, just 6.8% of apprenticeship participants on engineering-related frameworks were women in 2019.

Table: Apprenticeship participation by framework, level and gender (2019) – Northern Ireland

<table>
<thead>
<tr>
<th>Framework</th>
<th>Level 2</th>
<th>Level 2/3</th>
<th>Level 3</th>
<th>All levels</th>
<th>Female Total</th>
<th>Total % Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>461</td>
<td>465 0.9%</td>
</tr>
<tr>
<td>Construction crafts</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>74 1</td>
<td>234 0.3%</td>
</tr>
<tr>
<td>Construction technical</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>32 2</td>
<td>32 0.0%</td>
</tr>
<tr>
<td>Electrical and electronic servicing</td>
<td>–</td>
<td>12</td>
<td>–</td>
<td>2</td>
<td>16 0.0%</td>
<td></td>
</tr>
<tr>
<td>Electrical distribution and transmission engineering</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>35</td>
<td>43 2.3%</td>
<td></td>
</tr>
<tr>
<td>Electrical power engineering</td>
<td>1</td>
<td>11</td>
<td>–</td>
<td>–</td>
<td>11 1.1%</td>
<td></td>
</tr>
<tr>
<td>Electrotechnical</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td>333</td>
<td>21</td>
<td>279</td>
<td>297</td>
<td>841 3.3%</td>
<td></td>
</tr>
<tr>
<td>Food manufacture</td>
<td>136</td>
<td>3</td>
<td>348</td>
<td>345</td>
<td>644 4.4%</td>
<td></td>
</tr>
<tr>
<td>Furniture production</td>
<td>1</td>
<td>24</td>
<td>–</td>
<td>1</td>
<td>31 6.5%</td>
<td></td>
</tr>
<tr>
<td>Heating, ventilation, air conditioning and refrigeration</td>
<td>–</td>
<td>38</td>
<td>–</td>
<td>1</td>
<td>60 0.3%</td>
<td></td>
</tr>
<tr>
<td>IT user</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>15 0.0%</td>
<td></td>
</tr>
<tr>
<td>IT and telecoms professional</td>
<td>6</td>
<td>23</td>
<td>–</td>
<td>12</td>
<td>106 17.0%</td>
<td></td>
</tr>
<tr>
<td>Land based service engineering</td>
<td>–</td>
<td>5</td>
<td>–</td>
<td>–</td>
<td>30 0.3%</td>
<td></td>
</tr>
<tr>
<td>Light vehicle body and paint operations</td>
<td>–</td>
<td>–</td>
<td>11</td>
<td>–</td>
<td>46 0.0%</td>
<td></td>
</tr>
<tr>
<td>Mechanical engineering services (plumbing)</td>
<td>1</td>
<td>235</td>
<td>–</td>
<td>57</td>
<td>473 0.4%</td>
<td></td>
</tr>
<tr>
<td>Print production</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>21 0.0%</td>
<td></td>
</tr>
<tr>
<td>Printing industry</td>
<td>2</td>
<td>28</td>
<td>–</td>
<td>–</td>
<td>28 0.1%</td>
<td></td>
</tr>
<tr>
<td>Vehicle body and paint</td>
<td>–</td>
<td>71</td>
<td>–</td>
<td>3</td>
<td>46 0.0%</td>
<td></td>
</tr>
<tr>
<td>Vehicle fitting</td>
<td>–</td>
<td>8</td>
<td>–</td>
<td>–</td>
<td>8 0.0%</td>
<td></td>
</tr>
<tr>
<td>Vehicle maintenance and repair</td>
<td>1</td>
<td>143</td>
<td>6</td>
<td>288</td>
<td>625 1.6%</td>
<td></td>
</tr>
<tr>
<td>Vehicle parts</td>
<td>–</td>
<td>4</td>
<td>3</td>
<td>15</td>
<td>34 0.3%</td>
<td></td>
</tr>
<tr>
<td>All engineering related frameworks</td>
<td>157</td>
<td>1,745</td>
<td>36</td>
<td>1,133</td>
<td>5,412 6.8%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,009</td>
<td>3,465</td>
<td>108</td>
<td>1,278</td>
<td>8,012 26.5%</td>
<td></td>
</tr>
<tr>
<td>Engineering-related apprenticeships as a share of all frameworks</td>
<td>15.6%</td>
<td>50.4%</td>
<td>33.3%</td>
<td>88.7%</td>
<td>61.4%</td>
<td></td>
</tr>
</tbody>
</table>


Notes:
- This table shows that in 2019, 61.4% of all apprentice participants on engineering-related frameworks were women in 2019. This is a far greater share than for England, Scotland or Wales, and is likely to reflect the types of vocational training available. It may be a function of the strong emphasis the Northern Irish government has placed on cultivating STEM skills through, for example, their 2011 ‘Success through STEM’ strategy. More recently, results from the Northern Irish 2019 skills barometer – which allows the government to assess where there may be skills shortages and direct policy and funding accordingly – identified professional, scientific and technical, ICT, and manufacturing among the sectors with the highest forecasted growth projections, suggesting this focus is set to continue.

That said, while engineering-related apprenticeships appear to be far more popular in Northern Ireland than the rest of the UK, the underrepresentation of women is clearly an issue. The proportion of female participants on all engineering-related frameworks was just 6.8%, similar to in England, Scotland and Wales. However, unlike the rest of the UK, the proportion of all apprentice participants who were women in Northern Ireland was also relatively low, at just 28.8%.

In Northern Ireland, the most popular engineering-related frameworks were those related to engineering. This is a far greater share than for England, Scotland or Wales, and is likely to reflect the types of vocational training available. It may be a function of the strong emphasis the Northern Irish government has placed on cultivating STEM skills through, for example, their 2011 ‘Success through STEM’ strategy. More recently, results from the Northern Irish 2019 skills barometer – which allows the government to assess where there may be skills shortages and direct policy and funding accordingly – identified professional, scientific and technical, ICT, and manufacturing among the sectors with the highest forecasted growth projections, suggesting this focus is set to continue.

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In electrotechnical, the most popular engineering-related frameworks in Northern Ireland (representing 17.0% of all apprenticeships in the nation), just 0.5% of participants were women, which is particularly concerning given the relatively large numbers enrolled. There were also several engineering-related frameworks with no women participating. Across all levels, apprentices in heating, ventilation, air conditioning and refrigeration, light vehicle body and paint operations, and land based service engineering were exclusively men – though it must be noted that numbers within these frameworks were small overall (60 or less). Other engineering-related areas such as ‘food and manufacture’ fare better in terms of female representation, though women remain a minority (44.0% of the total participants in 2019).
Technical education: collaboration to create lasting change

Understandably, the government wishes to see economic and social growth across the country, and technical education is a key part of this ambition. However, the issue is that technical education in further education is an area that has seen constant change for a long time, ranging from minor tweaks to wholesale shifts, and currently we are in a period of exceptionally wide-reaching change. It is hard to argue against technical education being a key player in a drive towards greater levels of productivity and social mobility, but it is difficult to understand how exactly we can adapt it to fit the purpose more effectively.

The current technical education (TE) landscape is complex. This is not surprising, given that TE is attempting to solve a number of problems for a significant number of people and businesses. In order to understand how wide a lens TE currently has, it is useful to outline some of its ambitions:

- helping those without work to find employment
- supporting small businesses to grow
- helping large business fill skills gaps and succession planning
- retro-fitting literacy, numeracy, digital and other skills for employees who are failing to progress and wish to
- improving productivity and social mobility across the UK

The current round of changes within TE are very clearly employer-led. This could be a natural reaction to TE previously expected to drive forward wider changes to the UK economy. Many of these employers are fully committed to delivering the changes to TE, but don’t have the capacity or wherewithal to combine student training, development of technical content and successful maintenance of their own businesses. There seems to be a lack of evidence suggesting an individualised approach can realise these wider ambitions. There should therefore be more centralised coordination, an individualised approach can realise these wider ambitions.

Technical education is addressing a range of complex issues. We need clear metrics to determine whether we are solving the problems we identified.

An employer-led system

Individual employers may perceive a training need within their company, which might be shaped by a range of factors, most of which are likely to concern the growth and continued existence of the business. Currently, the UK government’s approach to TE expects employers to address UK productivity and social mobility issues by creating new content for technical courses, which is extremely difficult without having an overarching strategic view.

Within engineering, key sector bodies are working together to understand skills needs - this must set an example for industry more widely across the UK.

In the engineering sector in particular, 90% of businesses have fewer than 10 people, meaning that they simply cannot be expected to drive forward wider changes to the UK economy. Many of these employers are fully committed to delivering the changes to TE, but don’t have the capacity or wherewithal to combine student training, development of technical content and successful maintenance of their own businesses.

There are real concerns that some T levels (all of which sit at level 3) will not allow seamless progression to an apprenticeship and that T levels could be viewed as the ‘poor cousin’ of apprenticeships. A T level student will have a strong and broader knowledge base, but will not be able to claim any skills or competence, whereas the apprentice will have the knowledge that is required as well as the skills and the behaviours, making them the ‘whole package’. This is a current example of how developing strands of TE in isolation is profoundly unhelpful.

It is counterproductive to develop individual strands of technical education in isolation from each other.

Organisations within engineering have attempted to address this challenge, with EngineeringUK publishing ‘demand tables’ to analyse where particular employment and skills gaps may lie in future. Furthermore, the recent publication of the ‘Perkins review revisited’ by the Royal Academy of Engineering signalled several possible avenues that the sector should be aware of. For example, the report outlined that there will be particular demand for high integrity welders and systems engineers. These findings can, and should, be incorporated into the engineering TE landscape, and the work of key bodies with a holistic view must set an example for other sectors in the UK.

T levels and apprenticeships

The government initially intended T levels to achieve a parity of esteem with A levels, but seemingly failed to consider their direct relationship with apprenticeships. It is hard to reconcile the two programmes, with ISATE’s routes not aligning with current sector subject areas and – despite the development with occupations in mind – neither mapping easily across to standard industrial classification (SIC) and standard occupational classification (SOC) codes.

There are real concerns that some T levels (all of which sit at level 3) will not allow seamless progression to an apprenticeship and that T levels could be viewed as the ‘poor cousin’ of apprenticeships. A T level student will have a strong and broader knowledge base, but will not be able to claim any skills or competence, whereas the apprentice will have the knowledge that is required as well as the skills and the behaviours, making them the ‘whole package’. This is a current example of how developing strands of TE in isolation is profoundly unhelpful.

It is counterproductive to develop individual strands of technical education in isolation from each other.

What would success look like?

Criticising policy is often easy, but it is important that we focus on solutions. There are no quick-fix answers, but there are certainly ways to address issues.

We need to take a deep breath and look at the whole of TE to see what it is that we appear to be creating. Once we have a shared understanding of what is being created, we need to decide if that is what we need (as opposed to want).

Do we need legions of successful managers gaining level 7 Master’s?

Do we want to exclude those without academic attainment from accessing in-work training?

Can we see a correlation between the identified skills gaps in a sector and where funding is actually being spent?

Right now, this is not really possible as we cannot map these things to each other. And there are no metrics to judge ‘success’ in terms of productivity gains or social mobility, let alone whether we have confidence that skills gaps have been appropriately identified and then mapped to actual provision.

TE is attempting to solve a complex range of issues for both individuals and business. Such problems are best resolved by creating strong bonds between what credible sources are telling us we need and what TE is providing. All stakeholders need to be part of the development of the solutions and we need clear metrics to determine if what we are doing is solving the problem that was identified in the first place.

The problems belong to all of us and we should share the responsibility for creating the solutions. The insistence on viewing a problem from a single perspective is the root of many problems and issues in TE.

Whatever is put in place needs the continued engagement of stakeholders, appropriate levels of funding and oversight. Obviously there are limitations and we won’t be able to rely on government funding to resolve all, nor should we. But together, perhaps we could ensure that the funding that is available goes where it is needed most and will yield the greatest return in the long run.

Teresa Frith, Senior Skills Policy Manager, Association of Colleges

3.155 EngineeringUK. ‘Demand tables’ [online], accessed 24/03/2020.
3.156 EngineeringUK. ‘Demand tables’ [online], accessed 24/03/2020.
There are many ways in which the HE population is becoming more diverse. There have been increases in the proportion of HE entrants from: outside the UK (25.5%); minority ethnic backgrounds (25.6%); and low participation neighbourhoods (12.6%). The proportion of disabled students has risen to 12.6%, and although the overall figures have changed for several years, the gender make-up of students remains mixed, with 57.2% being women.

Trends in diversity in engineering and technology have largely mirrored those observed in the wider student population. However, engineering and technology students in the UK are less diverse than the overall student population in several ways, a fact that will be discussed in detail later in this chapter. Specifically, disabled students and women are particularly underrepresented. The gender disparity among engineering students is reflected in the engineering workforce, with women making up just 12.6% of those working in engineering occupations in the UK.4

This finding is particularly concerning given that in HE overall, and in STEM subjects, women are overrepresented. In 2018 to 2019, over half of STEM students (52.4%) were women.4

While those from minority ethnic backgrounds are well represented in engineering HE (29.9% of engineering and technology entrants to HE, compared with just 8.0% of all students and 14.5% of the population in England and Wales)4,5,6,7 the proportion of minority ethnic people working in engineering occupations (9.0%) is low.4 The overall proportion of engineers that come from low socioeconomic backgrounds (24%) is also low.

The reasons for these differences are widespread. As Chapter 1 discusses, they are often the result of systemic issues within the education system that take place far earlier along the education pipeline than university. Nevertheless, those responsible for delivering engineering courses in HE must do their utmost to ensure that all students – and particularly those from underrepresented groups – have equal opportunities to succeed. OfS took over responsibility for regulating university ‘access agreements’ from the Office for Fair Access (OFFA). These access agreements required HE providers that wanted to charge more in tuition fees normally to pay £9,000 – to set out exactly how they would sustain or improve access, student succession and progression among people from underrepresented and disadvantaged groups.

Regardless of the existing efforts, it is clear that widening participation must go beyond simply targeting young people in the lead-up to their degree choices as to whether to progress to higher education, and if so, where and what they will study. As discussed in Chapter 1, many of the barriers that stop young people from progressing into STEM studies (or indeed, engineering more generally) are rooted in much earlier experiences that shape their motivations, capability and opportunities. The rationale for increasing the diversity of engineering and technology and making better use of the wealth of different courses to choose from at over 100 different institutions. In 2018 to 2019, there were 2.38 million students studying at UK HE institutions. The HE sector contributed £21.5 billion to UK GDP in 2014 to 2015, according to a report by Oxford Economics for Universities UK.4,5 Furthermore, the sector supported more than 940,000 jobs,6 making it an integral part of both the education system and the country as a whole.

The large decline in engineering and technology participation varied widely by level of study. Over the past 10 years, engineering and technology entries have increased at first degree undergraduate and postgraduate taught level (by 5.6% and 10.4%, respectively), have declined at other undergraduate and postgraduate taught level (by 55.5% and 49.3%, respectively) and remained fairly static at other undergraduate level. In contrast, the decline in postgraduate taught engineering and technology entrants has taken place in the context of overall postgraduate taught entries rising – a potential cause for concern.

In terms of students from low participation neighbourhoods, there were lower proportions of entrants into engineering and technology degrees (11.3%) than across all of HE generally (12.6%) in 2018 to 2019. Moreover, there have been only marginal increases in these figures since 2014 to 2015, indicating a continued challenge within engineering.

Compared with the overall HE population, engineering and technology had a low proportion of disabled entrants in 2018 to 2019, at just 7.5% in contrast to 12.0% of the wider student cohort. Such underrepresentation highlights the need for widening participation efforts to ensure reasonable adjustments are made to remove barriers to study.
For those from underrepresented groups, we must increase participation and retention in HE, as well as ensure parity in employment outcomes.

In HE, increasing participation, improving retention and completion, and working towards parity in employment outcomes for those from underrepresented groups will be paramount in bringing about true innovation within the sector.

The tables in this chapter consist of data from the Higher Education Statistics Agency (HESA) student record, covering the 2018 to 2019 academic year. HESA counts the academic year (reporting period) as 1 August 2018 to 31 July 2019. The HESA data lets us look at different cohorts of students, including:

- **Entrants**: students who are recorded as being in the first year of their degree. The course does not have to be their first course in HE. (For example, entrants to postgraduate courses will often have completed an undergraduate degree)
- **Students**: all students (including entrants) registered at a reporting HE provider who follow courses that lead to the award of a qualification(s) or HE provider credit, excluding those registered as studying wholly overseas.

Qualifiers: those who obtained a HE qualification in the HESA reporting period, including qualifications awarded from dormant, writing-up or sabbatical status.

The majority of this chapter reviews analysis of entrants because this gives the most up-to-date view of the HE landscape and allows comparisons between the overall population of students and engineering and technology entrants.

Not all students who enter HE will complete their degree. Drop-out rates vary between groups, so the composition of qualifiers differs from that of entrants. We have included analysis and tables on qualifiers in our Excel resource, which are signposted in this chapter.

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47 CfDP. ‘Diversity and inclusion at work: facing up to the business case’, 2019.
48 UK Government. ‘Transition period’ [online], accessed 02/02/2020.
49 The Guardian. ‘UK is home of more than 21,000 non-academic staff’ [online], accessed 04/02/2020.
53 Bfi. ‘How students are financing higher education and training’. Student_utopia.org.uk.

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4.4 Higher education   4 – Higher education

4.23 Many of the HE sector have voiced concerns that Brexit could lead to a potential reduction in student numbers and staff, as well as the loss of EU research funding.\(^{4.11}\) This could have a significant bearing on the UK economy, as HE is estimated to contribute £14.4 billion in education related ‘exports’, which is two-thirds (67%) of the total educational exports.\(^{4.12}\) These ‘exports’ mainly comprise tuition fees and expenditure on living costs while in the UK by non-UK domiciled students. EU students contribute almost £2.7 billion of this total. Educational exports also include revenue that UK HE institutions receive from offshore campuses and distance learning programmes (transnational education activities).\(^{4.20}\)

The effect of a reduction in EU and international student numbers, if this does transpire, is far from being limited to the immediate income they represent in the form of educational exports. It also has a bearing on the talent pool for the UK, especially in sectors such as engineering that are experiencing skills shortages. The potential reduction in international student numbers is of particular concern for engineering and technology, where they comprise a significant proportion of those studying the subject, especially at postgraduate level. In fact, with 12,465 students from the EU enrolled into engineering and technology related courses in the UK in 2018 to 2019, the subject is one of the most popular STEM subjects studied here by EU students, second only to biological sciences.\(^{4.24}\) With the shortfall of graduate level engineers already estimated to be between 37,000 and 59,000,\(^{4.25}\) a decline in students studying engineering and technology at UK universities poses a further threat to successfully addressing the skills shortage.

4.24 Higher Education and Research Act

By far the most significant legislative change to impact the HE sector in the last year was the implementation of the Higher Education and Research Act (HERA).

The Act was split into 4 parts, each with a different purpose, namely:\(^{4.26}\)

- Establishing a new body called the Office for Students (OfS) and giving it responsibility for regulating the English HE sector
- Updating and changing previous legislation on student financial support and complaints procedures
- Introducing a new body called UK Research and Innovation (UKRI), which takes responsibility for regulating and funding research
- Addressing various administrative issues, such as joint working and data sharing between OfS and UKRI

Although OFTT officially closed in April 2018,\(^{4.27}\) all of its duties have been subsumed by OfS. The change in title reflects numerous other changes due to growing recognition that simply funding more students from under-represented backgrounds into higher education is not enough, especially when they have worse non-continuation rates and outcomes than other students overall, with the image following them long after they have left higher education\(^{4.28}\), according to a recent paper from the Higher Education Policy Institute.\(^{4.10}\)

OfS superseded the Higher Education Funding Council of England (HEFC) as the main regulator of English HE and is responsible for holding universities to account for the quality of teaching they provide.\(^{4.29}\)

For the United Kingdom to have a thriving, productive and competitive engineering sector, there must be enough people in the workforce to ensure the demand for crucial new infrastructure and technology can be met. In addition, we need a workforce that is diverse enough to bring about true innovation within the sector.

4.29 About the data
4.2 – Engineering and technology in higher education

In the UK HE system, engineering degrees fall under the broad subject group of engineering and technology, within which there are 10 separate engineering subjects and 8 technology subjects (see Figure 4.3).4-6 The broad range available allows students wishing to embark on an engineering degree to fully assess which type of engineering would be suitable for them, given their preferences and career ambitions.

There are excellent options in the UK for students choosing to study engineering here, including 3 of the top 20 universities in the world for engineering, according to the Times Higher Education World University Rankings.1,9 This puts the UK on an extremely competitive footing globally and is undoubtedly a significant factor for the many international students who choose to take undergraduate and postgraduate engineering courses in England, Scotland, Northern Ireland or Wales.

Engineering student numbers

As Figure 4.1 shows, over the last decade there has been a small but steady growth in the number of HE students who have chosen to study engineering and technology, although this has plateaued over the past 3 years. Although the numbers of engineering and technology students fell in the academic year 2012 to 2013 when tuition fees increased, the decline was relatively marginal compared with the drop seen in overall student numbers. And by 2015 to 2016, more students were studying engineering and technology than before the tuition fee increase, whereas total student numbers have not recovered in the same way. However, the picture looks somewhat different when we consider engineering’s share of all student entries over time (Figure 4.2).

Looking at the past 10 years, the proportion of all HE entrants who have chosen to study engineering and technology has remained relatively steady, but in recent years that share has been slowly decreasing. This drop is slightly more pronounced for postgraduate taught entrants, with a 1.1 percentage point decrease over the past 5 years. This is worrying, given the increased efforts by many bodies to boost the attractiveness of engineering.

The UK government has made a concerted effort to encourage more young people to take up STEM subjects in all educational pathways. This includes university study, with initiatives including incentives for higher education institutions (HEIs) to offer STEM courses. The OfS, for example, provides funding for high-cost subjects where the tuition fee alone is not enough to meet the full costs of delivery; these include laboratory-based science, engineering and technology subjects.1,4

Engineering subjects

Most engineering and technology courses available in the UK focus on a particular area of engineering, which means students will specialise from an early stage in their studies. However, there are some courses – such as general engineering – where undergraduates can choose their specialism later in their studies. This lets them leave their options open until they know more about potential career choices.

The options available fall into 2 categories: engineering and technology. The subjects available are displayed in Figure 4.3.

4.36 HESA. ‘Categories of onward data use’ [online], accessed 15/04/2020.
4.37 There are 19 subject groups in the UK HE system, 9 of which are classed as STEM.
4.38 Times Higher Education. ‘Best universities for engineering degrees 2020’ [online], accessed 22/01/2020.
4.39 OfS. ‘Supporting STEM subjects’ [online], accessed 22/01/2020.
4.40 These are the engineering subject according to the Joint Academic Coding System (JACS) codes. With the introduction of the Higher Education Classification of Subjects (HECoS) codes, the engineering areas may change.
Case study – Airbus Global University Partnership Programme

Suzanne Baltay, University Relations, AGUPP

The Airbus Global University Partnership Programme (AGUPP) is a structured university network designed to meet rapidly evolving business needs. Its overall aim is to ensure a better exchange of insights with universities on the future skills and competency needs of Airbus, and to enable faster integration of these needs into relevant academic and training programmes. AGUPP collaboration activities are designed to help students develop their technical expertise, business understanding, innovation and skills in emerging sectors (such as internet of Things, additive manufacturing, augmented reality, artificial intelligence and robotics) to better prepare the workforce of the future.

AGUPP engages creatively with universities beyond the traditional route of supporting research activities. This allows us to bring together students with Airbus technical expertise and ignite curiosity and innovation in both groups. By collaborating, students learn how effective real diversity of background and approach can be in delivering engineering solutions.

The ‘Drone Dash’ activity run at the University of Bristol is a great example of how this works. Here, Airbus set students the challenge of designing, building and flying a drone to complete a simulated rescue mission in 48 hours. The students had one day to design, build and program their drone and a system to pick up objects of varying weights and complexity. On the second day, the drones were deployed in a safe flying arena to ‘rescue’ the objects, with a prize for the quickest and most innovative solutions to any problems they encountered. It was a very popular and dynamic event.

Through this and other activities, Airbus can reach a wide audience, engage directly with students and raise its profile among a student population that may not consider Airbus as a first choice employer for their discipline. By working with our experts, students get to know Airbus, giving them a greater insight into the Airbus community and allowing them to imagine their future with us. Furthermore, the enthusiasm and ‘can-do’ approach of the students has proved to be highly inspirational to our engineers, who have found they can learn from the digital generation.

Within these principal subjects, students can choose from many further areas of study, allowing them to specialise even more than they would if they chose to study a broader engineering option.

The system of classification for undergraduate degrees is the Joint Academic Coding System (JACS). This is soon to be replaced by a new coding system called the Higher Education Classification of Subjects (HECoS), meaning that the established engineering subject areas may change.43

Some of the current engineering degree codes have ties to the UK Standard Occupational Classification (SOC) codes with professional engineering.44 This means students can be sure there are specific jobs related in a concrete way to their degree choices, which many other traditional STEM areas do not benefit from.

In addition, many engineering courses have strong ties to industry and even to particular employers, so students on these courses could have an inherent advantage in terms of transitioning into the labor market. For instance, some engineering courses offer a ‘sandwich year’ as part of their course, giving undergraduates invaluable experience of working for an engineering company before finishing their degree. This has advantages for both students and employers. Students gain in understanding of what an engineering role entails and improve their employability prospects. At the same time, an employer can assess whether they want to take on a particular student when they complete their degree.

4.3 – Engineering and technology students by level of study

About the data

In this chapter, we focus on 4 different levels of education and on engineering students across different subjects compared within each of these levels. The different levels of study are defined by HESA and refer to the content of each course. The levels that are considered are:

- first degree undergraduates
- other undergraduates
- postgraduate taught
- postgraduate research

Undergraduates are students participating in programmes of study leading to qualifications at first or foundation degree level, or a range of HE diplomas and certificates (levels 4 to 6 of the national qualifications framework). In most of the analysis, undergraduates have been disaggregated into first degree undergraduates and other undergraduate students.

- First degrees – taken by students with no prior degree-level qualification in the subject. May include eligibility to register to practice with a health or social care or veterinary regulatory statutory body.

- Other undergraduate – includes qualification aims equivalent to and below first degree level including, but not limited to: Professional Graduate Certification in Education, foundation degrees, diplomas in HE, Higher National Diploma (HND), Higher National Certificate and Diploma of Higher Education. Several other qualifications also fall within this category, and it is a complex landscape that interacts with the further education sector, especially the Higher Technical Qualifications described in Chapter 3.

Postgraduate courses lead to higher degrees, diplomas and certificates, and usually require a first degree as an entry qualification. Taught and research courses differ in terms of their content, with the former having a high proportion of lectures, seminars and tutorials and the latter being mainly based on independent research.

It is worth noting that these degree levels closely follow – but not fully aligned with – qualification levels. As Figure 4.4 shows, while the vast majority of postgraduate research entrants are studying for PhD (doctorate) level qualifications, just 1 in 10 are working toward a Master’s. There are also first degree entrants (24.8% of entrants) who are studying for a master’s level qualification. These students are studying on MEng courses, where they attain a master’s qualification at the end of 4 years of engineering study.

There are differences – for example by gender and socioeconomic status – between students enrolled on each of these different qualification types. The roles they can undertake in the engineering sector upon finishing their degrees may vary according to their highest level of study. While the 4 HESA qualification levels don’t map directly to the qualification levels covered in Chapter 1, it is possible to establish the breakdown of engineering students by both HESA level of study and UK qualification (see Figure 4.4).

4.4 – Higher education

Machanical engineering students made up over a quarter of all first degree engineering entrants in 2018 to 2019.

First degree undergraduate entrants

In 2018 to 2019, 37,200 students started first degree engineering and technology courses. Of these, the most commonly studied subject was mechanical engineering, which was chosen by over one quarter (25.5%) of all first degree engineering entrants (see Figure 4.5). This is the largest engineering degree choice by a significant margin, at 9.2 percentage points above electronic and electrical engineering (16.3%).

4.5 – Higher education

Chemical and process engineering

Figure 4.4 Engineering and technology HE entrants by level of study and qualification (2018/19) – UK

<table>
<thead>
<tr>
<th>Qualification level</th>
<th>Postgraduate research</th>
<th>Postgraduate taught</th>
<th>First degree</th>
<th>Other undergraduate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctorate (level 8)</td>
<td>90.3%</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Masters (level 7)</td>
<td>9.7%</td>
<td>100.0%</td>
<td>24.8%</td>
<td>–</td>
</tr>
<tr>
<td>Bachelor’s (level 6)</td>
<td>–</td>
<td>74.1%</td>
<td>6.4%</td>
<td>–</td>
</tr>
<tr>
<td>Below degree level</td>
<td>–</td>
<td>–</td>
<td>1.1%</td>
<td>93.6%</td>
</tr>
<tr>
<td>Total</td>
<td>4,720</td>
<td>17,445</td>
<td>36,615</td>
<td>4,795</td>
</tr>
</tbody>
</table>

Source: HESA. ‘HESA student record 2018/19’ data, 2020. Totals and percentages presented in this figure exclude engineering and technology students studying at 3 universities in the UK (Falmouth University, University of Worcester and London South Bank University), which opted out of providing detailed data on individuals outside the HE sector and regulatory bodies in the academic year 2018 to 2019.

Qualification levels 6, 7 and 8 refer to qualifications levels in England, Wales and Northern Ireland only.

At 64,245, the number of HE entrants across all levels to engineering and technology has remained fairly static over the last year.

In 2018 to 2019, there were 64,425 entrants into engineering and technology courses, which represented a less than 0.1% increase on the previous year. First degree undergraduate entrants made up the largest proportion (57.7%), followed by postgraduate taught entrants (27.2%), other undergraduate entrants (7.7%) and postgraduate research entrants (7.4%).

4.6 – Higher education

At 64,245, the number of HE entrants across all levels to engineering and technology has remained fairly static over the last year.

<table>
<thead>
<tr>
<th>Subject area</th>
<th>First degree undergraduate entrants</th>
<th>Postgraduate taught</th>
<th>Postgraduate research</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace engineering</td>
<td>9.3%</td>
<td>–</td>
<td>–</td>
<td>9.3%</td>
</tr>
<tr>
<td>Chemical, process and energy engineering</td>
<td>7.9%</td>
<td>–</td>
<td>–</td>
<td>7.9%</td>
</tr>
<tr>
<td>Engineering subjects</td>
<td>25.5%</td>
<td>–</td>
<td>–</td>
<td>25.5%</td>
</tr>
<tr>
<td>Electronic and electrical engineering</td>
<td>16.3%</td>
<td>–</td>
<td>–</td>
<td>16.3%</td>
</tr>
<tr>
<td>General engineering</td>
<td>15.9%</td>
<td>–</td>
<td>–</td>
<td>15.9%</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>15.0%</td>
<td>–</td>
<td>–</td>
<td>15.0%</td>
</tr>
<tr>
<td>Production and manufacturing engineering</td>
<td>3.1%</td>
<td>–</td>
<td>–</td>
<td>3.1%</td>
</tr>
<tr>
<td>Other engineering subjects</td>
<td>2.5%</td>
<td>–</td>
<td>–</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

Source: HESA. ‘HESA student record 2018/19’ data, 2020. Due to small numbers on courses, students studying ‘Broadly based programmes within engineering and technology’, ‘Naval architecture’ and ‘Others in engineering’ are grouped into ‘All other engineering subjects’.

Technology subjects includes the 6 separate principal subjects within technology detailed in Figure 4.5.

4.7 – Higher education

At 64,245, the number of HE entrants across all levels to engineering and technology has remained fairly static over the last year.

4.8 – Higher education

At 64,245, the number of HE entrants across all levels to engineering and technology has remained fairly static over the last year.

**References:**

4.1 HESA. ‘JACS 3.0: Detailed (four digit) subject code’ [online] accessed 15/04/2020.
4.2 HESA. ‘The Higher Education Classification of Subjects (HECoS)’ [online]: accessed 22/01/2020.
4.3 The UK SOC codes include: 2312, Civil engineers; 2313, Mechanical engineers; 2314, Electrical engineers; 2315, Design and development engineers; 2107, Production and process engineers.
First degree entrants over time

Overall, there has been an increase in engineering and technology first degree entrants. There has been a 5.6% rise since the academic year 2009 to 2010 (and there was also a large increase between 2006 to 2007 and 2009 to 2010). However, there has only been a 0.3% rise since 2011 to 2012. At the same time period, general and aerospace engineering have both also seen a rise in uptake, whereas there has been a decline in the numbers of first degree entrants opting for electronic and electrical, and chemical, process and energy engineering.

As can be seen in Figure 4.6, there has been an upward trend in the take-up of mechanical engineering at first degree level for some time. Over the last 10 years, it has steadily gained popularity relative to the other engineering disciplines, overtaking electronic and electrical engineering as the most popular engineering discipline in 2011 to 2012.

Since 2012 to 2013, there has been a 24.8% increase in the number of mechanical engineering first degree entrants. In this same time period, general and aerospace engineering have both also seen a rise in uptake, whereas there has been a decline in the numbers of first degree entrants opting for electronic and electrical, and chemical, process and energy engineering.

The number of students entering technology subjects at first degree level has decreased by 61.4% in the past 10 years, and 18.3% in the past year alone.

Case study – Perspectives from an engineering student

Jamie McKane – 4th year student, Mechanical Engineering, University of Bristol

My decision to study mechanical engineering came from a strong interest in maths and a determination to follow on and apply this knowledge in a useful and innovative way. Ultimately, it is the prospect of sitting down in future with a team of talented people to design pioneering products and solutions that excites me about the discipline.

I decided to study engineering at a fairly late stage and wanted to keep my options open, so decided that the mechanical course at Bristol was the broadest available. Subsequently, I have found this to be the right decision as my deepest interests during my time here have been mechatronic systems and control. Also, the mechanical (and aerospace) course is more heavily focused on mathematics than the civil course, which suits my skillset better. The course at Bristol has introduced me to new and difficult challenges, such as coding and finite element analysis.

Sometimes the workload is tough, but the coursework often involves writing a detailed technical report, which will prepare me well for professional projects in the future. Although I’m unsure of exactly what I’ll do after my degree or which company I will work for, I would like to work in the research and development department of an engineering company. The ability of engineers to do something in a novel and creative way is something I admire and would love to be a part of.

Diversity is something often lacking in engineering cohorts at university and unfortunately I would say this is the case for Bristol. The majority of students on my course are men from White or East Asian backgrounds and so more should be done to encourage women and those from other minority ethnic backgrounds into the field.
Other undergraduate entrants over time

As Figure 4.8 shows, since 2009 to 2010 there has been a sharp drop in other undergraduate entrants across all engineering disciplines (down by 5.5%) with a decrease of 8.3% in just one year, since 2017 to 2018. The decline has been starker in mechanical engineering and technology courses, but the number of other undergraduate entrants on general, electronic and electrical, aerospace and civil engineering have all decreased significantly in the past 10 years.

The decline in engineering and technology other undergraduate entrants reflects a broader trend of falling numbers at this level. In the last 5 years alone, the number of other undergraduate entrants in HE overall has declined by 25.0% (from 155,740 in 2014 to 2015 to just 116,850 in 2018 to 2019).

In the academic year 2018 to 2019, there were 17,535 postgraduate taught entrants, a 12.7% increase compared to the previous year. This is a similar trend to that seen in first degree entrants. The increased popularity of mechanical engineering across both levels could indicate a shift in attitudes towards the types of courses and occupations that students are likely to choose in the future.

Postgraduate taught entrants

Within universities in the UK, there are numerous postgraduate taught engineering courses available. The majority of these courses come in the form of a taught master’s (MSc) course, where students are likely to have a research element included in their studies, as well as attending lectures, seminars and tutorials. A postgraduate taught degree often follows a similar structure to an undergraduate degree and is used to bridge the gap between a bachelor’s degree and a PhD (research) degree. In addition to further study, many engineering postgraduate taught courses meet the qualification requirements to become a chartered engineer.4,5

In the academic year 2018 to 2019, there were 17,535 postgraduate taught entrants to engineering and technology subjects, with civil engineering (18.9% of entrants) and electronic and electrical engineering (18.9% of entrants) being the most popular choices, followed by mechanical engineering (15.5% of entrants). It is interesting to note that students are more evenly distributed across disciplines at this level, given that across all of HE, postgraduate taught entries have risen by 15.6% over the same period.4,6

In the past 10 years, there has been a 4.9% decrease in postgraduate taught entrants to engineering and technology courses, compared to a 15.6% increase for all HE subjects.

Figure 4.10 shows that there have been fluctuations in the number of postgraduate taught entrants into engineering courses over time. In particular, there has been a large decline in the number of electronic and electrical entrants since 2009 to 2010 (a decrease of 26.3%). This was, however, preceded by a large increase between 2007 to 2008 and 2008 to 2009, and there has been a gradual increase in popularity again since 2016 to 2017, with entrant numbers rising each year.

Conversely, there has been a steady increase in numbers of mechanical engineering entrants since 2012 to 2013, from just 1,095 in 2012 to 2013 to 2,725 in 2018 to 2019 – a 40.8% increase. This is a similar trend to that seen in first degree entrants. The increased popularity of mechanical engineering across both levels could indicate a shift in attitudes towards the types of courses and occupations that students are likely to choose in the future.

Postgraduate taught entrants over time

Overall, the number of entrants on engineering and technology postgraduate taught courses has decreased by 4.9% since the academic year 2009 to 2010, but the figure of 16,445 in that year was a peak, with large increases in each preceding year from 2005 to 2006. In the last year to 2018 to 2019 we have seen a 21% increase. Nevertheless, this is worrying for the engineering sector, especially given that across all of HE, postgraduate taught entries have risen by 15.6% over the same period.4,6
Postgraduate research entrants

At 4,740 in 2018 to 2019, the number of students entering engineering and technology courses at postgraduate research level is lower than all other qualification levels. This is the case across HE more generally and reflects the fact that some students choose not to progress to the next qualification level. However, for those who do choose to pursue engineering education up to the highest level, there are clear benefits in terms of remuneration. Longitudinal Educational Outcomes (LEO) data shows that there is a significant premium, in respect of earnings, placed on those with PhD qualifications compared with master’s level degrees.4.4 Median earnings for UK domiciled engineering students who graduated with a master’s level (level 7) degree in 2014 to 2015 were £35,800 per year 3 years after graduating, compared with £37,800 for those with a PhD (level 8).4.5

Since 2009 to 2010 there has been a 10.4% increase in the number of postgraduate research entrants to engineering and technology courses, but in the past year the number did not increase significantly.

The majority of the rise over the last 10 years came from entrants to general engineering courses, which has seen a larger increase (33.0%) overall than other postgraduate research engineering subjects, although numbers fell by 3.7% between 2017 to 2018 and 2018 to 2019.

There has been a reduction in entrants to electronic and electrical engineering courses across all levels. Interestingly, the number of professional electronics and electrical engineers in the labour market has slightly increased since 2011 to 2012.4.6 So the fall in students isn’t necessarily due to any decreased labour demand.

Across all levels of study, the number of entrants to electronic and electrical engineering courses has decreased over the past 10 years.

In contrast to postgraduate taught and undergraduate entrants, where specialist engineering subjects make up the largest proportion of students, the most common postgraduate research degree for engineering and technology postgraduate research entrants in 2018 to 2019 was general engineering (27.3%). This is perhaps contrary to what we might expect, as students tend to specialise more as they continue along the educational pipeline. However, it’s possible that the specialist and industry focused nature of specific engineering subjects lend themselves better to moving on into employment in the relevant field, whereas those studying general engineering may be more inclined to pursue research.

Postgraduate research entrants over time

Overall, the number of entrants to postgraduate research degrees in engineering and technology has risen by 10.4% since 2009 to 2010, but in the year to 2018 to 2019 there was just a 0.2% increase.

The gender disparity in HE has remained steady since the academic year 2009 to 2010, with women making up between 56.1% and 57.2% of the population each year. There are many possible reasons for this. Several sources have cited the difference in educational attainment in secondary school between girls and boys as a leading cause.4.6 Chapter 2 showed that this is still very much the case in 2018 to 2019, with girls outperforming boys in the majority of school subjects, including STEM areas.

Given their performance in STEM subjects at secondary school, it is curious, then, that girls are so underrepresented in engineering and technology courses at university. What is it exactly about engineering that is preventing girls from applying? The trend does not show any signs of stopping. The most recent data available from UCAS covering the full 2019 cycle indicates that there were 1.56 million applications from women, compared with 1.17 million applications from men to all subjects and courses in higher education.4.6 This is in stark contrast to engineering and technology, where there were just 32,865 applications from women (19.5%) and 168,240 applications from men.4.6

At 20.7%, the proportion of engineering and technology entrants that were women in 2018 to 2019 was the highest it’s ever been (up 4.8 percentage points from 2010 to 2011).

4.4 The LEO data links education, tax and benefits data to chart the transition of graduates from higher education into the workplace.


There has, however, been a minor improvement in terms of the proportion of female engineering and technology entrants across all levels of study, with women making up 20.7% of all engineering and technology entrants in the academic year 2018 to 2019 (Figure 4.13). It is promising that the figures from 2018 to 2019 figures for female entrants into engineering and technology HE are the highest on record, which represents an increase of 4.8 percentage points since 2010 to 2011. This may be indicative of concerted efforts to improve gender diversity within engineering over the past 10 years and the introduction of targeted messaging through various campaigns to increase the representation of women in STEM more generally.

However, the rise in female entrants to engineering and technology subjects has not been fast enough. Women are still severely underrepresented in engineering and technology, and if the current trend continues, engineering and technology HE level will not achieve gender parity for at least another 3 decades.

Subject comparison

While there is a known gender disparity across many STEM areas, it is particularly acute in engineering and technology. Out of the 19 broad subject areas in HE, engineering and technology ranks second to last in terms of female representation and only marginally higher than computer science (20.7% of engineering and technology entrants across all levels were women in 2018 to 2019 compared with 20.3% of computer science entrants). Even within engineering there are major differences in female representation by subject and level of study. For example, women make up a far larger proportion of engineering and technology entrants at undergraduate level (28.1% of postgraduate taught and 26.5% of postgraduate research) compared with just 17.6% of first degree entries and 12.6% of other undergraduate entrants (Figure 4.14).

This is encouraging as it suggests that the experience of studying undergraduate engineering does not put women off from pursuing further study in the subject. Notably, the difference in proportions of female entrants between undergraduate and postgraduate degrees was larger for engineering and technology than it was for STEM, and also larger than for all subjects combined. Several universities have recognised the importance of attracting women onto postgraduate engineering courses, with the University of Manchester identifying collaboration, offering a fully funded PhD specifically for exceptional female engineering candidates.4, 4.1

The engineering subject with the largest number of first degree entrants – mechanical engineering – also had the lowest proportion of female entrants in 2018 to 2019, with women making up just 10.8% of entrants. Chemical, process and energy engineering was the most popular first engineering degree chosen by women (12.7% of female entrants in 2018 to 2019) and this subject seemed to remain popular up to postgraduate levels.

As a whole, engineering and technology fared far worse than STEM overall for female representation across all levels of study, as shown in Figure 4.14. In STEM subjects, women accounted for just over half of all first degree entries at first degree level (51.3%), 58.8% of postgraduate taught entries and 46.0% of postgraduate research entries. It is true that of the 6 subjects with the lowest proportions of female entrants in 2018 to 2019, 5 were STEM areas, showing that the issue is not unique to engineering. Nevertheless, computer science and engineering and technology fare far worse than the other STEM areas. Interestingly, subjects allied to medicine – a STEM area – have the highest proportion of female first degree entrants of all subjects, demonstrating that it is not necessarily STEM as a whole that struggles to attract women.

There are several possible reasons for the underrepresentation of women in engineering and computer science, both at university and in the sector itself. One is that the lack of visible role models may cause women not to pursue careers in these areas. However, the role that adding female role models who are women graduates and are working in these areas can play cannot be understated.

The importance of role models and female role models in particular, is a subject that we have been advocating for over the past few years and which we are further exploring. It may be that the problem is more systemic, with women simply not choosing STEM subjects, or it may be that women who have chosen STEM subjects are being turned off by the culture and systems within institutions.

There is a need for greater diversity in both terms of gender and ethnicity, as well as in the culture and norms of the sector. It is essential that engineering and technology is an area for everyone and that the sector is an attractive one for women and other disadvantaged and underrepresented groups. It is not just a question of attracting more women; the sector needs to be much more inclusive and welcoming to women, and the sector needs to be more diverse in its make-up.

The case study that follows is an example of a university that has been successful in attracting and retaining women in engineering and technology in the last few years, through the use of targeted initiatives and initiatives that are aimed at making the sector more inclusive and welcoming to women.

Case study – FemEng society at University of Glasgow

Penny Morton, President, FemEng, University of Glasgow

FemEng is a network that aims to promote and support women in engineering by connecting women in the School of Engineering at the University of Glasgow. The group has several focuses including: outreach work with schools; networking events with industry professionals; mentoring schemes; discussion panels; social activities; and postgraduate events.

FemEng successfully pioneered ‘FemEng in Rwanda’, the University’s first student-led learning project in collaboration with the University of Rwanda. This initiative brought together female engineering students at both universities with the common goal of encouraging more high school girls in Rwanda to pursue further STEM education. This project led to an increase of over 100% in engineering applications to the University of Rwanda. Following on from this success, we have recently launched ‘FemEng in Malawi’.

FemEng membership and activities are open to everyone and we are pleased this year to have welcomed several male members and students from all STEM backgrounds, not just engineering. FemEng believes it’s important for a diverse range of voices to be included in the discussion around the gender imbalance in engineering.

The FemEng network will continue to grow through school and industry visits, and collaboration with supporting organisations such as Equate Scotland, Athena SWAN and the Women’s Engineering Society. Furthermore, the society will continue to work closely with industry and is exploring the possibility of expanding the mentoring scheme to include industry mentors. This aims to reduce the large proportion (73%) of women who qualify with a degree in a STEM subject but choose to leave the industry within the first 10 years of graduating.4.1

FemEng will continue to strive to encourage diversity and inclusion while working further in the coming year towards ensuring our society is welcoming to the LGBTQ+ community.

5.4 – Engineering and technology students by ethnicity

Within the United Kingdom as a whole, the ethnic make-up of the population has changed significantly over the past 30 years, which has been reflected in the make-up of both school students (in 2018 to 2019, 27% of pupils in state-funded schools were from minority ethnic backgrounds) and university students. Indeed, those from minority ethnic backgrounds are actually overrepresented in HE (Figure 4.16).

About the data

Throughout this section, we will provide analysis to compare those from White ethnic backgrounds with those from minority ethnic backgrounds, who include Black students, Asian students, Mixed ethnicity students and those indicating their ethnicity as Other. While EngineeringUK recognises the limitations of this, it is a widely used approach to identify high level patterns of difference in relation to ethnicity.

Furthermore, within the White ethnicity category there are different nationalities and backgrounds that may also have different bearings upon results, but in the context of analysing ethnicity, we feel it is appropriate to group these together.

In cases where there is a large variation in outcomes between those from different ethnic groups we will highlight this in the text. Further information on more detailed ethnicity breakdowns can be found in the Excel resource.

All analysis by ethnicity is necessarily restricted to UK domiciled students in HE, because the HESA record doesn’t capture the ethnic groups of international students.

Participation

Despite the fact that just 0.9% of engineering professionals were from minority ethnic backgrounds,4.6 29.9% of UK domiciled entrants to engineering and technology courses were from minority ethnic backgrounds in the academic year 2018 to 2019, showing that there is much potential to increase the diversity of the engineering workforce.

Over the last 10 years, there has been an 8.6 percentage point increase in engineering and technology entrants from minority ethnic backgrounds.

It also means that engineering and technology entrants were more diverse in terms of ethnicity than the overall student population. This has been the case for the past 10 years, with the proportion of those from minority ethnic backgrounds in engineering and technology courses rising steadily since 2010. Indeed, the proportion of entrants from minority ethnic backgrounds has increased by almost 9 percentage points since 2009 to 2010.

All minority ethnic groups have observed an increase in proportions of engineering and technology entrants. The increase varies, however, with a 5.1 percentage points rise in the proportion of engineering entrants from Asian backgrounds, compared with a more modest increase of 0.7 percentage point for Black students. This rise in entrants from minority ethnic backgrounds has meant that proportions of White engineering entrants have decreased at a faster rate than for the overall student population.

Figure 4.16

UK domiciled engineering and technology entrants over time by ethnicity (2009/10 to 2018/19) – UK

There was a higher proportion of women achieving a 1st or 2:1 degree in engineering and technology than men, with a 5.5 percentage point difference between the 2 groups.

Subject comparison
Compared with the overall HE cohort, a higher proportion of minority ethnic students entered engineering and technology courses across all levels of study in 2018 to 2019, with the exception of other undergraduate degrees. The same is true when compared with the overall STEM cohort (Figure 4.17).

The proportions of entrants from minority ethnic backgrounds was the same for engineering and technology first degrees and postgraduate taught courses (32.5% of all entrants). However, there was a far lower proportion of entrants from minority ethnic backgrounds starting other undergraduate degrees (10.6%) and a slightly lower proportion starting postgraduate research degrees (25.1%). This trend is true for all subjects in HE, but the disparity between other undergraduate entrants and all other levels of study for engineering subjects is particularly stark.

With 32.5% of first degree entrants from minority ethnic backgrounds in 2018 to 2019, engineering and technology is one of the most ethnically diverse subject areas in HE, behind only medicine and dentistry, business and administrative studies, and law.4,5,6 Just 27.8% of STEM first degree entrants were from minority ethnic backgrounds and 26.7% of all first degree entrants.

Chemical, process and engineering had the highest proportion (45.3%) of first degree entrants, postgraduate taught entrants (49.1%) and postgraduate research entrants (33.6%) from minority ethnic backgrounds. When considered alongside the fact that it had the highest proportion of women (Figure 4.14, section 4.4), this shows it is extremely diverse compared with other engineering areas. However, at other undergraduate level there were no entrants from minority ethnic backgrounds into chemical, process and energy engineering courses.

The relative popularity of engineering and technology among those from minority ethnic backgrounds – particularly men – has been discussed in wider research. For example, a study by the Runnymede Trust shows that engineers ranked second in terms of job choices for pupils from Mixed, Bangladeshi, Black Caribbean and Black African backgrounds.7,8 Notably, however, this was only among boys from these backgrounds. Across all ethnic groups surveyed, girls did not include engineering in their top 5 job choices, suggesting there is an interplay between gender and ethnicity in subject and career choices.

EngineeringUK’s Engineering Brand Monitor provided further evidence to show that there is a relationship between ethnicity and potential career choices.9,10 Among students aged between 11 and 19, those from a minority ethnic background were more likely to pick ‘doctor’ or ‘lawyer’ as their top job choice, whereas those from White backgrounds were more likely to pick ‘vet’, or ‘childcare/education’. Given that medicine and dentistry along with law have the highest proportions of entrants from minority ethnic backgrounds, this indicates that school level career choices may well extend through to university.11,12

Figure 4.17
UK domiciled HE entrants from minority ethnic backgrounds by subject area, principal subject and level of study (2018/19) – UK

First degree undergraduate Postgraduate taught Postgraduate research

<table>
<thead>
<tr>
<th>Principal subject</th>
<th>Minority ethnic (%)</th>
<th>Minority ethnic (%)</th>
<th>Minority ethnic (%)</th>
<th>Minority ethnic (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical, process and engineering</td>
<td>35</td>
<td>45.3%</td>
<td>35</td>
<td>0.0%</td>
</tr>
<tr>
<td>Aerospace engineering</td>
<td>32.5</td>
<td>39.6%</td>
<td>35</td>
<td>6.6%</td>
</tr>
<tr>
<td>Electronic and electrical engineering</td>
<td>35</td>
<td>34.0%</td>
<td>49</td>
<td>5.2%</td>
</tr>
<tr>
<td>All other engineering subjects</td>
<td>35</td>
<td>32.4%</td>
<td>49</td>
<td>4.4%</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>35</td>
<td>31.6%</td>
<td>49</td>
<td>3.7%</td>
</tr>
<tr>
<td>General engineering</td>
<td>35</td>
<td>31.3%</td>
<td>49</td>
<td>3.7%</td>
</tr>
<tr>
<td>Mechanical engineering</td>
<td>35</td>
<td>30.9%</td>
<td>49</td>
<td>3.7%</td>
</tr>
<tr>
<td>Technology subjects</td>
<td>35</td>
<td>21.1%</td>
<td>49</td>
<td>3.7%</td>
</tr>
<tr>
<td>Production and manufacturing engineering</td>
<td>35</td>
<td>17.9%</td>
<td>49</td>
<td>3.6%</td>
</tr>
<tr>
<td>All engineering and technology</td>
<td>35</td>
<td>20.4%</td>
<td>49</td>
<td>3.6%</td>
</tr>
<tr>
<td>All STEM</td>
<td>35</td>
<td>20.2%</td>
<td>49</td>
<td>3.6%</td>
</tr>
<tr>
<td>All subjects</td>
<td>35</td>
<td>19.4%</td>
<td>49</td>
<td>3.6%</td>
</tr>
</tbody>
</table>


Due to small numbers on courses, students studying ‘Broadly based programmes within engineering and technology’, ‘Naval architecture’ and ‘Others in engineering’ are grouped into ‘All other engineering subjects’. ‘Technology subjects’ includes the 8 special principal subjects within technology detailed in Figure 4.13.

Totals and percentages calculated in this figure exclude engineering and technology students studying at 3 universities in the UK (Falmouth University, University of Worcester and London South Bank University), which opted out of providing detailed data to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019.

To view a more detailed breakdown of HE entrants by subject area, ethnicity and level of study, see Figure 4.17 in our Excel resource. Figure 4.17 also includes comparisons for all university subjects.

Minority ethnic students are also more likely to study STEM at school and HE level than their White peers, though this is not necessarily the case for all ethnic groups. While Indian, Pakistani and ‘other’ ethnicity students are more likely to study STEM A levels than students from different ethnic backgrounds, there are particularly low levels of uptake by Black African and Caribbean students.4,13

Studies show that young people from minority ethnic backgrounds tend to have higher aspirations – both educationally and occupationally – than their White British peers, which is linked to subject choice.

One possible reason minority ethnic students may be more likely to study STEM subjects in school and HE could be related to parental and student attitudes and behaviours. A number of studies indicate that both young people from minority ethnic backgrounds and their parents generally have higher educational and occupational aspirations than their White peers, and have linked these to both subject choice and educational achievement.1,14,15

It may seem that if pupils hold on to their early career aspirations up until university, the future of engineering HE will be characterised by an even wider ethnic diversity, which one may expect to feed through to a more diverse workforce. Unfortunately, despite the high proportions of those from minority ethnic backgrounds in HE, employment outcomes vary widely between White and minority ethnic students.

EngineeringUK’s 2018 State of Engineering report showed that among full time UK domiciled engineering and technology leavers who graduated in 2016, nearly two-thirds (65.6%) of White graduates had secured full-time employment, compared with less than half (48.6%) of minority ethnic graduates.4,13,16

Attainment
The proliferation of students from different ethnic backgrounds entering into the UK HE system is a positive trend, but research shows there is a large difference in how they experience HE, in terms of retention, outcomes and progression.4,17

There are stark differences between ethnic groups in terms of retention. Black Caribbean students are far more likely not to continue with their HE studies than White and Asian students.4,18,19 The degree class they achieve also differs. The proportion of students from minority ethnic backgrounds across all of HE achieving a first or upper second class degree is lower than their White peers, regardless of entry qualifications. Given the difference isn’t explained by factors such as age, gender, course or prior attainment, OFS suggests that this may be explained by factors such as institutional structures and curriculum.4,17

There are similar issues when looking at degree attainment specifically for engineering and technology qualifications. Of those qualifying from first degree engineering and technology courses in 2018 to 2019, 89.5% of White students achieved a first or upper second class degree, compared with 73.7% of students from minority ethnic backgrounds (Figure 4.18).

Figure 4.18
UK domiciled engineering and technology first degree qualifiers by degree class and ethnic group (2018/19) – UK

First class honours
43.7%
29.5%
Upper second class honours
39.8%
46.2%
Lower second class honours
14.1%
21.5%
Third class honours/pass
2.3%
4.7%

White minority ethnic


Percentages in this chart are calculated using total UK domiciled engineering and technology qualifications from higher education in 2018/19. Percentages in this chart are calculated using total UK domiciled engineering and technology qualifications from higher education in 2018/19. Percentages in this chart are calculated using total UK domiciled engineering and technology qualifications from higher education in 2018/19.


4.81 Ibid.


4.85 Ibid.

4.86 Ibid.

4.87 For a full analysis of degree class by ethnicity please view Figure 4.18 in our Excel resource.

Reasons for the ethnicity attainment gap are not fully understood, but there are a number of initiatives in place to try to understand it more fully and to address it. A 2019 report by Universities UK suggested that collecting and disseminating more granular data on attainment and ethnicity could inform targeted interventions. 4.10 This recommendation has since been echoed by the Higher Education Policy Institute in a 2019 paper, which suggested that “each university will have to take an evidence-based approach to tackling the BME attainment gap.”

Engineering and technology students from minority ethnic backgrounds were much less likely than White students to achieve a 1st or 2:1 degree (9.8 percentage point difference).

4.6 – Engineering and technology students by socioeconomic status

Within the United Kingdom, students from disadvantaged backgrounds have been shown to have worse outcomes in educational attainment and in later life, both in terms of employment and earnings. 4,9,4,10 This is discussed in detail in Chapter 1 in terms of STEM education at secondary school level, which is vital for attracting those from different socioeconomic backgrounds onto engineering and technology HE courses.

Case study – The SESTEM project at University of Reading

Dr Billy Wong, Associate Professor in Widening Participation, University of Reading

The Student Experience in STEM degree (SESTEM) project is a 3-year longitudinal qualitative research study based at the University of Reading (from 2018 to 2021) that aims to better understand the experiences of undergraduate STEM students from minority ethnic backgrounds.

The SESTEM project focuses on minority ethnic students in STEM degrees, where there is a narrower degree outcome gap than for non-STEM subjects. The Equality Challenge Unit has speculated that differences in assessment types between STEM and non-STEM degrees might be responsible for this narrower gap. 4,41

By understanding students’ experiences, views and reflections over time, we aim to build empirical and contextual evidence to support the University’s aspiration to eliminate the ethnicity degree outcome gap. Data analysis is currently underway. However, we have already made the following recommendations, which have informed and supported existing and future practices:

- Welcome Week should include a dedicated session on equality and inclusion to highlight diversity at university and the importance of mutual respect and understanding. The aim is to provide the appropriate vocabulary for all undergraduates, including a refresher day for returning students.
- Staff training and development should have a clear focus on diversifying the curriculum, with examples from research in STEM teaching and learning. There should also be mandatory staff workshops on racial and ethnic awareness.
- Consider compulsory and timetabled tutorials to reduce stigma for students to seek support and ask for help.
- There must be a strong and continuous campaign to raise the profile of the university’s commitment to racial, ethnic and cultural equality.

About the data

The majority of analysis relating to socioeconomic status within this chapter uses POLAR4, a measure of university attendance based on the areas where students live. It uses a geographical unit called the middle layer super output area that usually consists of around 5,000 to 7,000 residents in England and Wales, 146 and is used to report on small area statistics.

The POLAR4 data reports on students who began their studies between the academic years 2009 to 2010 and 2013 to 2014.

The measure has been derived by ranking areas by participation rate and splitting these into 5 quintiles, each of which represents one fifth of the young population. 147 In this section, students are defined as being from a low participation neighbourhood if they live in an area that falls into quintile 1 (the 20% of areas with the lowest participation in the country).

POLAR4 is commonly used by the HE sector as an indicator of access to university across the country and a young person’s socioeconomic background. However, this measure has recognised limitations.

There are, for example, known issues of accuracy in cities, where there can be a huge variation in housing in the same middle layer super output area. As a recent report by NEON on HE access by disadvantaged White students noted: “London has less than 13 Low Participation Neighbourhood areas which means that many students from the capital from lower socioeconomic groups are hidden from view.” 4,47 Similarly, a research paper by academics from Sheffield Hallam University suggested that: “Low participation neighbourhoods have a questionable diagnostic value, with more disadvantaged families living outside them than within them.” Additionally, POLAR4 does not take other individual or household measures of socioeconomic status into account, such as household income or parental education status. Moreover, socioeconomic class and disadvantage is a complex and multifaceted concept, and participation in HE is just one indicator of this.

We use POLAR4 data in this chapter as a proxy for socioeconomic status, because it is the socioeconomic indicator in the HESA data with the highest coverage (compared with other indicators outlined below) and it is the measure used by the Office for Students to investigate disadvantage.

There are other indicators in the HESA data that allow an examination of socioeconomic status:

- Parental education: this measure asks whether any of their parents or legal guardians have any HE qualifications
- Socioeconomic status (SES): this measure asks students under 21 to provide information on the occupations of their parents (or other guardians or carers), which HESA uses to derive the National Statistics Socio-economic Classification (NS-SEC) 148 of their parents (based on standard occupational codes). For students over 21, it asks for their own NS-SEC using the same classification, so these students have been excluded from this analysis because this does not provide a measure of social background

These measures also have limitations. For example, there is a high degree of missing information in the SES variable across those both under and over 21, and from non-UK domiciled students in the parental education variable. We have touched on these measures in this section.

Coverage

Due to a recent change in the licensing of postcode data for Northern Ireland, it is not possible to assign students from Northern Ireland into a POLAR4 quintile because HESA is unable to provide aggregated postcode data for the region. For that reason, students from Northern Ireland are excluded from POLAR4 analysis. Because it is a measure based on UK areas, data on non-UK domiciled students is also excluded. Those with unknown POLAR4 status are also excluded.

4.10 RM RaEng, ‘UK UG Engineering Students’ demographics and qualifications: from admissions through progression to graduation’. forthcoming.
4.12 ONS: ‘ Low participation by area [dataset], accessed 02/02/2020.
Figure 4.19 outlines the proportions of engineering and technology entrants in HE by socioeconomic status since the academic year 2014 to 2015. There has been little change in the make-up of entrants from low participation neighbourhoods in that time, with only 11.3% of entrants in the academic year 2018 to 2019 coming from the areas of the UK with the lowest HE participation.

If HE participation was equal across the different POLAR4 quintiles, we would expect to see around 20% of entrants coming from the areas of lowest participation. The fact that just 11.3% of entrants into engineering and technology courses were from these areas shows that as a subject, there is still some way to go to bring about equality. However, the figure is not dissimilar to the UK HE system as a whole, for which the proportion of entrants from the lowest participation neighbourhoods sits far below where it should – in 2018 to 2019 just 12.6% of entrants into HE were from POLAR4 quintile 1.

This shows that although engineering does not fare well, it is a systemic problem across the HE system, where there is a low proportion of students from low participation neighbourhoods across all degree subjects.

Looking at other socioeconomic measures, entrants into HE engineering and technology courses in 2018 to 2019 were more likely than the overall HE population to have parents in managerial, administrative and professional occupations (57.3% and 53.4%, respectively). Despite these figures, there is cause for optimism. Although those from low participation neighbourhoods are underrepresented in HE, their entry rates have been increasing year on year: UCAS data shows that in the 2018 to 2019 academic year, the proportions of those living in POLAR4 quintile 1 areas that entered HE stood at 21.0%, up from 19.7% in 2017 to 2018. 4.31 As a consequence, the ‘entry gap’ between those from the lowest participation neighbourhoods and the highest has been decreasing. Nevertheless, there still remains a sizeable difference, with students in POLAR4 quintile 5 being 2.26 times more likely to enter HE than students in quintile 1 in 2018 to 2019. 4.32

The gap on entry is more acute at institutions with high entry tariffs. Young people from the areas of highest participation (POLAR4 quintile 5) were 5.27 times more likely than those from POLAR4 quintile 1 to enter these institutions. This gap has decreased significantly since 2009 to 2010 when it was 8.41, but it is still a stark reminder of the disparity seen at the most ‘selective’ institutions. 4.33

There was also a large discrepancy between the different levels of study, with those from low participation neighbourhoods more likely to start an ‘other undergraduate’ degree than other levels in 2018 to 2019. Among engineering and technology other undergraduate entrants, 17.4% were from low participation neighbourhoods, compared to just 10.6% of first degree and postgraduate taught entrants, and only 9.1% of postgraduate research entrants.

This underlines the point raised in section 4.3 about the difference between these types of students and both first degree undergraduates and postgraduates, and that the decline of ‘other undergraduate’ courses in HE may have negative ramifications for those from disadvantaged backgrounds.

There were also large discrepancies between the different levels of study, with those from low participation neighbourhoods more likely to start an ‘other undergraduate’ degree than ‘first degree and postgraduate taught’ entrants, and only 9.1% of postgraduate research entrants.

Subject comparison

Engineering and technology fares worse than STEM overall in terms of entrants from low participation areas into first degrees and postgraduate taught courses, as well as falling below the overall average for HE. Just 10.6% of engineering and technology first degree entrants were from low participation neighbourhoods, compared with 13.6% of STEM first degree entrants and 13.0% of all first degree entrants (Figure 4.20).

There are other factors which could explain the underrepresentation of young people from lower participation areas into engineering and technology courses. These include the different nature of each engineering and technology sector, the different funding landscapes, STEM related subjects being ‘selective’ and the different types of HE providers. This is illustrated in Figure 4.20, which shows the ‘selective’ nature of different HE sectors and the different funding landscapes for each subject area.

The difference in proportions from low participation neighbourhoods between first degree and other undergraduate entrants is much larger for engineering and technology courses (6.8 percentage points difference) than it is for all subjects (2.4 percentage points difference). This shows that for engineering and technology – more so than for other subject areas – other undergraduate courses are the preferred option for those from disadvantaged backgrounds who may not be ready to undertake a full first degree.
Only 7.5% of engineering and technology entrants to Russell group universities were from low participation neighbourhoods.

Figure 4.21 UK domiciled engineering and technology HE entrants from low participation neighbourhoods by mission group (2018/19) – UK

University Alliance
14.6%

Other
11.1%

Millenium Plus
11.1%

All mission groups
11.5%

Build HE
9.2%

Russell Group
7.5%

94 Group
7.0%

Source: HESA. HESA student record 2018/19 data. 2020. Percentages presented in this figure exclude engineering and technology students studying at 7 universities in the UK (Falmouth University, University of Worcester and London South Bank University), out of providing detailed data to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019. Universities listed as ‘Other’ were those not included in any of mission groups listed in the figure.

Figure 4.21 shows there is a large discrepancy in the proportions of engineering and technology entrants from low participation areas that attend different types of universities. They account for only 7.0% of students attending the 94 Group – a now defunct group of smaller, research focused universities including the University of East Anglia and Lancaster university – and 7.5% of Russell Group entrants. By comparison, they make up 14.2% of entrants to universities in the University Alliance mission group, which describes itself as “the voice of professional and technical universities” and its universities as institutions that “work with industry to … train the workforce of tomorrow.”

The contrast in the composition of the entrants to different mission groups is interesting, especially given that University Alliance group universities were the most popular among engineering and technology first degree qualifiers from advantaged and disadvantaged backgrounds appears to have narrowed in recent years. In the academic year 2018 to 2019, 77.1% of qualifications from low participation neighbourhoods received a first or upper second class degree (up 3.0 percentage points from the previous year), compared with 80.9% of those from other neighbourhoods.

However, it must be remembered that a good deal of academic selectivity has already taken place by this point, and work must be done to address such gaps not only in higher education, but also in earlier stages of STEM education. A 2016 study by Banejee, for instance, concluded that “there are a range of factors linked to underachievement of disadvantaged pupils in school science and maths” and a 2019 report by the Education Policy Institute highlighted that this attainment gap in maths persisted in 2018 – from early years education until the end of Key Stage 4 (GCSEs). Such gaps are likely to constrain young people’s educational and career trajectories – and, by extension, the degree to which we are able to harness the potential engineering talent pool.

About the data
Our disability analysis is drawn from the HESA student record, whilst asks students to indicate any physical or mental impairments that have a substantial and long-term adverse effect on their ability to carry out normal day-to-day activities. Students return this information on the basis of their own self-assessment and can choose not to disclose this information. From 2010 to 2011, new entrants to the student record were no longer able to be coded as information refused, information not sought or not known. As a result, this report uses the term ‘disabled students’ to refer to students whose HESA student record indicate they are disabled. ‘Non-disabled students’ is used to refer to students who are not indicated as disabled, or whose disability status is unknown by their institution.

Participation
Disabled students are clearly underrepresented within engineering and technology compared with HE as a whole, at just 7.5% in 2018 to 2019 compared with 12.0% across the HE student population (Figure 4.23).

4.156 The University Alliance – The voice of professional and technical universities [online], accessed 15/04/2020.


4.157 University Alliance. ‘The voice of professional and Technical universities’ [online], accessed 15/04/2020.
Given this, it is important that engineering and technology departments work to create a safe, inclusive environment where students feel able to disclose a disability. They also need to regularly assess what barriers – physical, procedural or social – may be preventing disabled students from participating and act to remove them or mitigate their effects.

Just 7.5% of engineering and technology entrants were disabled, compared to 12.0% of the overall HE population.

For instance, the Equality Challenge Unit (ECU) has highlighted the need to ensure that competence standards are non-discriminatory.4,119 (These standards outline the level of ability that a student must demonstrate on a course and are particularly common in competence-led professions such as engineering.) The ECU notes that where possible, reasonable adjustments should be made to ensure such standards are inclusive. For instance, the Engineering Council requires accredited HE programmes to include an “understanding of and ability to use relevant materials, equipment, tools, processes or products”. However, a student with a physical impairment may find it more difficult to use ‘relevant materials’ and a reasonable adjustment may be made to enable the student to be assessed in this area.

Subject comparison
Engineering and technology is among the lowest-ranked of all HE subject areas for entry by disabled students, with lower proportions than the overall STEM and HE averages (Figures 4.23 and 4.24).

Although engineering and technology has lower proportions of disabled entrants than HE in general, this varied considerably by subject. For example, just 6.8% of chemical, process and energy engineering first degree entrants were disabled, compared with 14.2% of those studying technology engineering.4,24 At higher levels of study, the proportion of students declaring a disability declines, suggesting there may be barriers to disabled students continuing on to advanced degrees, something that appears to be true across all subjects.

The relative lack of disabled students into engineering and technology courses is likely to impact the future engineering workforce. This is a concern because attracting more disabled people at school can increase their willingness to apply to engineering, in addition to those outlined in the introduction. An article by the Institution of Mechanical Engineers described efforts made by the engineering company Fujitsu to increase the proportion of its workforce with a disability from 3% to 6% between 2014 and 2018, with the chair of Fujitsu UK outlining some of the specific ways in which disabled employees can add value to the company.4,118

• “Neuro-diverse employees often bring a different thinking style to projects, which helps innovation.”

• “People with dyslexia are often great at creative and visual thinking, problem solving and are outcome orientated.”

The article also comments on other benefits, including reaching more disabled students as they are more likely to engage with disabled employees.

Disabled employees bring a range of benefits to engineering employers, so we must encourage more disabled students into engineering and technology HE.

The ‘Equal Engineers’ podcast recently featured an interview with Simon Wilkins, a deaf engineer working for Bam Nuttall. In this, he discusses his time at Newcastle University and the support available as a student living with a disability.4,118 At university, he had Disabled Support Allowance... the support I had in place was a note-taker, interpreters for group meetings and discussions and also a radio aid”. However, Simon goes on to say that “Newcastle University hadn’t previously experienced having deaf students studying there, so I had to provide them with a lot of advice and guidance to ensure I had the correct support in place.”

Experiences such as this highlight the need to ensure reasonable adjustments are in place and the positive difference they can make to disabled students’ lives. Reasonable adjustments “remove or minimise disadvantages experienced by disabled people” and are applicable both within HE and the workplace.4,112

When disabled people do enter HE, they attain almost the same level of ‘good’ degrees as non-disabled students. In 2018 to 2019, there was only a marginal difference in the proportion of disabled (7.6%) and non-disabled (7.7%) engineering and technology qualifications achieving an upper second or first class degree. However, non-disabled students were more likely to achieve a first class degree than disabled students (37.3% compared with 34.9% respectively).4,122

4.8 – Intersectinality

So far, this chapter has examined differences in HE participation and attainment by individual characteristics, such as gender, ethnicity or socioeconomic class. However, young people’s identities are actually made up of a complex combination of such characteristics, which overlap and interact in ways that can have important consequences for their lives.

This ‘intersectinality’ is important because it can lead to multiple disadvantages for some groups. Research from the Social Mobility Commission in 2016 found large variations in HE participation by different characteristics. For example, just 13% of White British students from the lowest socioeconomic quintile attended university, compared with 66% of Chinese students and 53% of Indian students, both from the lowest quintile.4,123

The effects of intersectinality can also be seen in relation to STEM. Research by Codrii McMastler in 2017 showed that while both gender and socioeconomic background independently affect young people’s likelihood of studying STEM in HE, these characteristics also interact. Young women from lower socioeconomic backgrounds are less likely than both their male counterparts and their more advantaged female counterparts to pursue a STEM degree over other ‘high return’ subjects.4,124

There is growing acknowledgement within the sector that this issue must be addressed. In 2017, the Equality Challenge Unit sought evidence on the diversity of staff and students related to intersectinality, which led to the development of a suite of case studies from universities and FE colleges.4,116

Participation
Is there a need to investigate participation in HE – and participation in engineering more specifically – by multiple characteristics combined. This section will present an overview of patterns of intersectinality among engineering and technology HE students.
There were a lower proportion of women from White backgrounds starting engineering and technology degrees than there were among those from minority ethnic backgrounds.

Interestingly, the gender divide among engineering entrants is starker among White students, with women comprising just 16.4% of all White UK domiciled entrants in 2018 to 2019. The ethnic group whose entrants into engineering and technology degrees were most likely to be women was mixed, with 21.8% being women.

Although the percentage point differences between ethnic groups in the proportion of entrants who are female are modest (at a maximum of 5.4 percentage points difference), the figures are still noteworthy. Previous research has highlighted the possibility that the greater uptake of ‘high return’ subjects, including STEM subjects, among minority ethnic groups compared with their White peers could be reflective of a conscious attempt to guard against additional barriers in the labour market – minority ethnic students are less likely to be unenrolled after receiving their degree, for example.\(^{4.16}\) It could be that young women from minority ethnic backgrounds are particularly attuned to these barriers and the multiple intersecting disadvantages they might face in the labour market, and so opt to pursue high return STEM degrees at a greater rate than their White peers.

These findings show that it is important to consider both socioeconomic background and ethnicity when investigating participation in STEM in HE. Some research suggests there is a heightened drive and ambition among minority ethnic groups to pursue social mobility as a result of recent minority ethnicity graduates being second generation migrants whose parents experienced social demotion when they came to the UK.\(^{4.10}\) Minority ethnicity students, including those from lower socioeconomic backgrounds, could therefore be pursuing STEM education at a higher rate than their White counterparts in an attempt to enjoy the financial and wider benefits that STEM careers can offer.

In sections 4.4 and 4.5, we showed that there was an attainment gap between men and women, and also between White students and those from other ethnic backgrounds (Figure 4.15 and Figure 4.18). Figure 4.27 shows that there is an even more complex dynamic at play, with the attainment gap between men and women varying significantly between different ethnicities.

In particular, Black men tend to do significantly worse than Black women and the same holds true for Asian qualifiers. Just 64.6% of Black men taking engineering degrees achieved a first or upper second class award, compared with 76.4% of Black women, representing an attainment gap of 12.0 percentage points. This compares poorly with the overall gender attainment gap for UK domiciled engineering qualifiers of 5.1 percentage points (Figure 4.15).

It’s important to note, however, that the numbers of students making up some of these groups are quite low – in particular women from Mixed and Other backgrounds - but the results are still interesting and provide food for thought. These results are more notable when we compare them with the attainment of all UK domiciled HE qualifiers in 2018 to 2019 (Figure 4.28).

The gender attainment gap among all degree qualifiers was narrower in each ethnic group in 2018 to 2019 than for engineering and technology qualifiers. However, it is striking that actual attainment by engineering and technology graduates was higher than for students overall across the board. The fact that engineering and technology students tend to get a higher degree class regardless of ethnicity is encouraging, but for Black and Asian men in particular, results lag far behind women studying the same subject. Figures 4.25 to 4.28 show that despite the overarching differences observed in participation and attainment by different characteristics, in engineering and technology courses the picture is slightly more complex.

The engineering sector must be aware of the multiple identities that students may have and those in HE should seek to understand the implications of intersectionality when designing curriculums, recruiting students and providing the best possible education to any prospective entrants.

4.128 UK Government. ‘Destinations and earnings of graduates after higher education’ [online], accessed 22/04/2020.
In the academic year 2018 to 2019, 40.6% of all entrants to engineering and technology HE courses were from international backgrounds, whereas the equivalent figure for all HE entrants was 23.9%.

Since 2009 to 2010, the proportion of entrants from international non-EU domiciles into engineering and technology courses and across HE have both risen by 4.3 percentage points. However, in the past year there has been a 1.9 percentage point increase in engineering and technology entrants but a 0.2 percentage point decrease overall (Figure 4.31).

Interestingly, the proportion of other EU students entering engineering degrees has marginally decreased since 2009 to 2010, although the change has not been particularly noticeable. A further discussion around EU students and staff in engineering and technology subjects, and in STEM more widely, will be found in the thought piece from Universities UK on page 133.

**Level of study**

The breakdown of engineering students by domicile is according to the level of degree that they study, with those entering postgraduate courses far more likely to come from international backgrounds than those at undergraduate level.

Figure 4.30 displays the stark difference in domicile between different levels of HE study, with a large majority of both postgraduate taught and postgraduate research entrants in 2018 to 2019 heralding from outside the UK. Amongst postgraduate research students, 13.4% were from the EU, indicating that this may be a particular area of concern once the final rules concerning international students have been agreed with the EU.

In HE overall, there were higher proportions of international students at higher levels of study in 2018 to 2019, but the difference was particularly sizeable for engineering and technology students.\(^4\)

### Engineering and technology first degree qualifications by year

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Other EU (%)</th>
<th>Non-EU (%)</th>
<th>Total</th>
<th>Other EU (%)</th>
<th>Non-EU (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009/10</td>
<td>69,085</td>
<td>9.5%</td>
<td>28.1%</td>
<td>1,185,260</td>
<td>5.4%</td>
<td>13.6%</td>
</tr>
<tr>
<td>2010/11</td>
<td>68,060</td>
<td>9.6%</td>
<td>30.3%</td>
<td>1,145,435</td>
<td>5.7%</td>
<td>15.2%</td>
</tr>
<tr>
<td>2011/12</td>
<td>68,025</td>
<td>9.3%</td>
<td>28.3%</td>
<td>1,177,335</td>
<td>5.8%</td>
<td>15.5%</td>
</tr>
<tr>
<td>2012/13</td>
<td>61,945</td>
<td>9.1%</td>
<td>30.9%</td>
<td>972,255</td>
<td>5.8%</td>
<td>17.7%</td>
</tr>
<tr>
<td>2013/14</td>
<td>64,445</td>
<td>8.9%</td>
<td>32.0%</td>
<td>995,740</td>
<td>5.7%</td>
<td>18.0%</td>
</tr>
<tr>
<td>2014/15</td>
<td>65,910</td>
<td>8.5%</td>
<td>31.6%</td>
<td>988,890</td>
<td>5.8%</td>
<td>17.6%</td>
</tr>
<tr>
<td>2015/16</td>
<td>65,560</td>
<td>8.5%</td>
<td>30.0%</td>
<td>992,125</td>
<td>6.0%</td>
<td>17.6%</td>
</tr>
<tr>
<td>2016/17</td>
<td>64,440</td>
<td>9.0%</td>
<td>29.4%</td>
<td>1,013,445</td>
<td>6.2%</td>
<td>17.0%</td>
</tr>
<tr>
<td>2017/18</td>
<td>64,395</td>
<td>8.6%</td>
<td>30.5%</td>
<td>1,023,360</td>
<td>6.1%</td>
<td>18.1%</td>
</tr>
<tr>
<td>2018/19</td>
<td>64,380</td>
<td>8.2%</td>
<td>32.4%</td>
<td>1,047,530</td>
<td>6.0%</td>
<td>17.9%</td>
</tr>
</tbody>
</table>

### Engineering and technology first degree qualifications by level of study and domicile (2018/19) – UK

<table>
<thead>
<tr>
<th>Level of Study</th>
<th>Other EU</th>
<th>Non-EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>First degree</td>
<td>72.4%</td>
<td>20.9%</td>
</tr>
<tr>
<td>Other undergraduate</td>
<td>82.5%</td>
<td>6.7%</td>
</tr>
<tr>
<td>Postgraduate taught</td>
<td>72.9%</td>
<td>10.7%</td>
</tr>
<tr>
<td>Postgraduate research</td>
<td>81.5%</td>
<td>13.4%</td>
</tr>
</tbody>
</table>

### Engineering and technology first degree qualifications by domicile and (2018/19) – UK

**First class honours**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Other EU</th>
<th>Non-EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>First class</td>
<td>39.6%</td>
<td>47.4%</td>
</tr>
<tr>
<td>Upper second class</td>
<td>47.7%</td>
<td>39.7%</td>
</tr>
<tr>
<td>Lower second class</td>
<td>56.8%</td>
<td>38.5%</td>
</tr>
</tbody>
</table>

**Third class honours / pass**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Other EU</th>
<th>Non-EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third class</td>
<td>3.2%</td>
<td>7.1%</td>
</tr>
</tbody>
</table>

Further highlighting the disparity in outcomes, almost one third (31.8%) of engineering qualifiers from outside the EU achieved a lower second class or a third class degree, compared with just 19.5% of UK qualifiers and 15.8% of EU qualifiers. Prior attainment data on non-EU nationals is not available, but if we assume similar levels of inherent ability in both non-EU and EU (including UK) students, these findings may indicate that engineering and technology courses in the UK are not geared well towards those from non-EU countries. This may be related to language barriers, or possibly wider pastoral issues that will be crucial to address if the UK is to attract more students from outside Europe after the UK’s departure from the EU.

It is also notable that students from other EU countries were far more likely to obtain a first class degree in 2018 to 2019 (47.4% of qualifiers) than their UK and non-EU peers (29.6% and 29.7% of qualifiers respectively). This finding was also observed across HE more widely, but the gap was smaller, with 35.5% of all EU qualifiers achieving a first class degree, compared with 28.9% of UK and 21.9% of non-EU qualifiers.\(^4\)

Given that EU students are the most successful engineering and technology qualifiers, it will therefore be crucial to maintain the attractiveness of engineering to this group. This may help to ensure that a vital source of talented European engineers entering into the engineering workforce in the UK remains steady and is not impeded by Britain’s departure from the EU.

**Students from non-EU countries were far more likely to achieve lower degree classifications than both UK-domiciled students and other EU students.**

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The impact of leaving the EU on STEM and engineering higher education

Universities are international organisations by nature and UK institutions are no exception. They admit more international students than universities in any other country except the US.\(^{4.133}\) International staff make up nearly one third of all academics and over 55% of UK research publications are internationally co-authored.\(^{4.133}\)

The particular closeness of our links with European counterparts becomes apparent when these international metrics are broken down into EU versus non-EU components; for instance, 13 of the UK’s top 20 research collaboration partner countries are in the EU or European Economic Area (EEA).\(^{4.136}\) Against this backdrop, it is perhaps understandable that the UK university sector had profound reservations about the implications of the decision to leave the EU. It was feared that this rupture would decimate EU student numbers, reducing the diversity of our learning environments and stifling the talent pipeline; that it would lessen UK universities’ attractiveness to researchers looking to forge a career in knowledge creation; and that it would jeopardise the ability to collaborate on ground-breaking research projects with colleagues in the EU. Four years on from the referendum and several months following the UK’s formal withdrawal from the EU, we are now in a position to consider how well-founded these fears were, what the specific implications for STEM subjects have been and what the future may hold after the current ‘stand-still’ period comes to an end on 31 December 2020.

Student recruitment

Contrary to initial fears, EU student enrolment at UK universities has continued to rise steadily since the EU referendum in 2016. Taking a 5-year perspective, there were 124,590 EU students (excluding UK nationals) registered at UK universities in the academic year 2014 to 2015 and this grew to 143,025 in 2018 to 2019, an increase of 14.8%.\(^{4.133}\) In some ways this is not surprising, given that there was no change in EU student fee status during this time, so they continued to qualify for home fee status and access to the tuition fee loan. Most STEM subjects have outperformed this trend, albeit with more significant increases in some subject areas.

The outlook for EU student recruitment beyond the end of the transition period is unclear. At present, tuition fees for EU students have only been confirmed for 2020 to 2021 entry; these students will continue to benefit from home fee status for the full duration of their courses. Although it seems likely that EU students will eventually be moved on to the same footing as non-EU students, universities are asking the UK government to extend the status quo at least for the 2021 to 2022 academic year.

Of course, the sheer number of staff does not tell the whole story. In the Universities and Colleges Employers Association’s latest biennial report on the UK higher education workforce, published in November 2019, around one quarter of universities reported that they had experienced a moderate to significant impact on recruiting (23%) and retaining (26%) EU staff over the past 12 months, and a similar number expect this picture to get worse in the future. But it is about more than just attracting staff to relocate; using staff surveys, HR directors have also perceived a decline in EU staff wellbeing since the EU referendum. They reported that the political turbulence, media coverage of EU citizens in the UK and uncertainty over future access to EU research and mobility funding have all taken their toll on the EU workforce.

Share of total research income from EU government sources in 2017/18


4.135: ‘Civil engineering’.


4.139: ‘General engineering’.


4.135: ‘Civil engineering’.


4.139: ‘General engineering’.


Of EU staff

EU staff make up a substantial part of the university workforce and universities rely on them to teach future engineers and produce ground-breaking research. They represented 12.2% of all UK university staff in 2018 to 2019, accounting for 17.5% of staff on academic contracts and 7.0% of staff on non-academic contracts.\(^{4.137}\)

In terms of the composition of the overall international (non-EU) university community, EU academic staff make up a larger proportion of the total international workforce than EU students do of the international student cohort; 56.3% of all international academics are from the EU as opposed to 29.5% of international students. This proportion has continued to grow over the past 5 years, with EU staff numbers increasing in all STEM subject areas.

EU staff numbers decreased year-on-year between 2014/15 and 2018/19 in all but four subject areas, with the highest decrease in international mathematics, where EU staff numbers decreased by 32% over this period. The only STEM subject areas other than engineering and technology showing the smallest increase.

Australia, New Zealand, US, Canada, and Japan.\(^{4.136}\) This is because almost all students from these countries are classed as international, even if they are studying on a course delivered in the UK. In the wider international context, these figures are important: in 2018 to 2019, UK universities admitted 143,025 EU students in the academic year 2014 to 2015 and this grew to 173,940 in 2018 to 2019, an increase of 21.3%.

Of course, the sheer number of staff does not tell the whole story. In the Universities and Colleges Employers Association’s latest biennial report on the UK higher education workforce, published in November 2019, around one quarter of universities reported that they had experienced a moderate to significant impact on recruiting (23%) and retaining (26%) EU staff over the past 12 months, and a similar number expect this picture to get worse in the future. But it is about more than just attracting staff to relocate; using staff surveys, HR directors have also perceived a decline in EU staff wellbeing since the EU referendum. They reported that the political turbulence, media coverage of EU citizens in the UK and uncertainty over future access to EU research and mobility funding have all taken their toll on the EU workforce.

UK universities are unequivocal about how highly they value their international staff. To ensure that EU staff continue to feel welcomed in the UK, research community, universities are counting on the UK government to put forward policies to provide certainty for current and prospective European staff. One of the most important elements will be the future immigration system that will be put in place in January 2021 to replace EU free movement. The initial signs show some promise for STEM subjects; the new points-based system that the government has proposed prioritises STEM by offering more points for anyone holding a STEM doctorate, and all researchers will be eligible to apply for a Global Talent Visa, which will replace the current Tier 1 visa system.

EU research and mobility funding

UK universities have benefitted massively from EU programme funding for research and mobility in recent years. According to the HE Sa finance return for 2017 to 2018, 11.8% of total university research income for STEM subjects came from EU government sources, with some engineering subjects receiving an even higher proportion.\(^{4.138}\)

In addition to the financial dividends, access to these programmes brings substantial added value, such as the ability to collaborate with world leading counterparts from hubs of excellence that do not exist in the UK. This is why it is essential that the UK remains part of the next EU research programme, Horizon Europe, which kicks off in 2021.

2021 and beyond

To a large extent, the question of how UK university engineering faculties’ international make-up will evolve in coming years will depend on government policy in areas like tuition fee status and immigration. But in other areas, such as access to EU programmes, universities on both sides of the Channel are now looking to UK and EU negotiators to secure a future partnership which continues to facilitate university exchange and collaboration after the end of the stand-still period on 31 December 2020. Given the strong and widely acknowledged mutual benefit of a positive outcome for both sides, there is reason to be optimistic that a promising agreement can be achieved. However, this will rely on isolating these discussions from any negative fallout from wider trade negotiations.

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