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.**
- Ambitious plans to expand technical education are heavily reliant on employers and may not have considered the specific requirements of engineering. It will be even harder to deliver industry placements in this time of economic volatility and social distancing. Our dependency on international staff and students in higher education, particularly in engineering, also makes the UK vulnerable to the terms of departure from the EU – and this is more worrying in light of the pandemic. **We must analyse these impacts on the education system and ensure it is fit to cultivate the skills needed for the UK, now and into the future.**

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.

Hilary Leevers

Dr Hilary Leevers
Chief Executive
EngineeringUK

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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. Worse, this limited knowledge is often distorted; not only is engineering seen as difficult, complicated and dirty, it is often also considered a man's profession.

Our findings show young people often doubt their **ability to succeed** in STEM. For example, 62% of 16 to 17 year olds in the UK felt that subjects like science and maths were more difficult than non-STEM subjects. Swathes of research show that girls in particular perceive their capability in STEM as unrealistically low – a striking finding, given that girls outperform boys in most STEM subjects at GCSE and A level.

A lack of **knowledge about relevant STEM educational pathways** can also discourage young people from pursuing engineering careers. In 2019, just 39% of young people aged 14 to 16 said they 'know what they need to do next in order to become an engineer' – and this figure has remained fairly static over time.

The degree to which young people possess the requisite knowledge, attitudes and capability to pursue STEM – that is, their '**STEM capital**' – is often derived from their parents. 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

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62%

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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 C 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-EBacc 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.

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.

Many STEM teachers are not specialists in the subjects they teach. Only 63% of physics teachers and 78% of maths teachers have relevant post-A level qualifications.

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 3.0%). Entries went down for maths and further maths (down 6% and 10%, 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 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.

74%

FE colleges struggle to attract sufficiently qualified engineering teachers. 74% of college principals rank it as the most difficult subject to recruit for.

Women and people from minority ethnic backgrounds remain severely underrepresented in engineering-related apprenticeships.

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 apprenticeships 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 to 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%), engineering and manufacturing (8%) and ICT (20%). Those from minority ethnic backgrounds made up 5% of starts in construction and 8% in 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

The UK's departure from the EU could have a significant impact on the HE sector and, in particular, for subjects like engineering and technology where a significant proportion of students are international.

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.

has not changed significantly in 5 years. In Wales, the proportion of women on engineering-related apprenticeships has increased each year since 2014 to 2015 and is now 8%.

Engineering-related apprenticeships were more popular in **Northern Ireland**, comprising 61% of total participants. However, women were again underrepresented, making up just 7% of all engineering-related participants.

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.

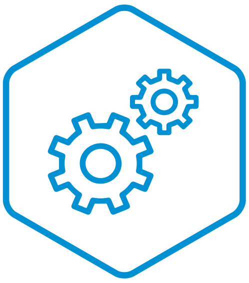
Since 2009 to 2010, there has been a 5% decrease in engineering and technology at postgraduate taught level. This is particularly concerning given that overall HE postgraduate taught entries rose by 16% over the same period.

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



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.

30%

Engineering and technology fares well 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%).

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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.

1 - Harnessing the talent pool

62.2% of young people aged 16 to 17 in the UK feel that subjects like science or maths are more difficult than others.

In 2019, only 23.5% of 11 to 19 year olds had heard about engineering careers from careers advisors.

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 deterrent 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. Even though they outperform boys in most STEM subjects, girls may be opting for less 'risky' subjects in which they think they are more likely to do well.

Teacher expectations and possible bias could be accentuating diversity problems in STEM. Students decide which subjects to study after GCSE based on predicted grades assigned by their teachers, but only around 16% of these are accurate.

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. Engineering 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.

All hands are on deck in attempts to harness the talent pool and promote STEM education to tomorrow's engineers.

1.1 – Introduction

STEM skills are more important than ever for the UK's economic prosperity. This is particularly true at a time of increasing international competitiveness, fast-paced technological change and uncertainty concerning European politics, migration, free movement and trade. For at least 2 decades, UK government and industry have expressed growing concerns about the shortage of people with the qualifications and experience needed to fill vacancies in crucial sectors such as engineering.[1.1] This skills crisis threatens the UK's ability to keep pace with other nations and to prepare for the challenges associated with major political changes, including Brexit.

Many entrants to the UK's engineering workforce come directly from education, highlighting the need to grow the potential talent pool via educational pathways. The engineering sector includes many diverse and varied occupations. These need technical expertise and subject-specific knowledge which can, arguably, only be gained through formal education.

The skills crisis in engineering is being driven by the growing and ever-changing needs of the sector, coupled with the tendency of young people to opt out of STEM qualifications. In addition, there is a concern that the education system doesn't always ensure young people are 'work ready'. Some employers have questioned graduates' 'employability' in terms of both adequate subject-specific knowledge and the relevant 'soft skills' needed to succeed in the workplace.[1.2]

The UK government has pledged to address the skills crisis via commitments set out in the industrial strategy (2017) and the STEM skills strategy in Scotland (2019), for example. Efforts have included establishing a dedicated STEM and Digital Skills Unit within the Department for Education (DfE) in England, targeted campaigns such as the Year of Engineering and the introduction of new technical qualifications. But addressing this issue is going to be a long-term endeavour and we are yet to see any sustained upward trend in the take-up of STEM qualifications.

> **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 of around £10,000 a year more than the UK workforce as a whole.[1.3] 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 workforce can improve performance through, for example, increased creativity and innovation.[1.4] 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 low participation caused by young people failing to attain the prerequisite 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.[1.5] 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 90.0% achieved A* to C/9 to 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 59.6% 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 have 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 than for STEM 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.

1.1 House of Commons, Committee of Public Accounts. 'Delivering STEM skills for the economy', 2018.
1.2 UniversitiesUK. 'Supply and demand for higher-level skills', 2015.
1.3 MAC. 'Full review of the shortage occupation list', 2019.
1.4 EngineeringUK. 'Social mobility in engineering', 2018.
1.5 Banerjee, P. A. 'Does continued participation in STEM enrichment and enhancement activities affect school maths attainment?', Oxford Rev. Educ., 2017.

Figure 1.1 Average GCSE and A level attainment in STEM and non-STEM subjects (2018/19) – England, Wales and Northern Ireland

	GCSE		A level	
	Avg % attaining A* to A/9 to 7	Avg % attaining A* to C/9 to 4	Avg % attaining A* to A	Avg % attaining A* to C
STEM	25.5%	71.7%	27.7%	72.1%
Maths and physics only	30.1%	75.3%	34.5%	73.1%
Non-STEM	24.1%	71.4%	25.4%	77.4%
All subjects	**24.6%**	**71.5%**	**26.0%**	**76.0%**

Source: JCQ. 'GCSE (Full Course) Results, Summer 2019' data, 2019.
Subjects included as STEM are additional science, additional science (further), biology, chemistry, computing, construction, design and technology, economics, engineering, ICT, mathematics, mathematics (additional), mathematics (further), mathematics (numeracy), physics, science, science (double award), statistics, other sciences, other technology.
To view this table by nation and with numbers sat, see **Figure 1.1** in our Excel resource.

Differences in attainment may, however, be one reason why some groups are underrepresented in STEM education. For example, lower average GCSE grades among socioeconomically 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 educational stages.[1.6] 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 these subjects at A level. And, as we explain in **Chapter 3** and **Chapter 4**, even fewer progress on to engineering apprenticeships or degrees. Differences in choice (and the reasons behind them) are therefore of key importance – over and above differences in attainment – when it comes to participation in STEM.

Differences in attainment may be one reason why some groups are underrepresented in STEM education, but this doesn't tell the full story.

About the data

The data used in this chapter comes from the following sources:

EngineeringUK Engineering Brand Monitor (EBM): The EBM is a repeated cross-sectional online panel survey. The annual survey asks young people aged 7 to 19, members of the general public and STEM secondary school teachers about their perceptions, understanding and knowledge of STEM and engineering. Fieldwork for the 2019 survey took place between January and March, with a total sample of over 5,000 across the UK. Post-hoc weighting based on known characteristics of the population drawn from Office for National Statistics estimates was used to make the pupil and public surveys nationally representative.

Office for National Statistics (ONS) Labour Force Survey (LFS): The LFS is a UK-wide, nationally representative survey of around 40,000 households per quarter. This chapter uses LFS data from the third quarter (July to September) of 2019. The main aim of the LFS is to enable analyses of point-in-time measures and changes over time concerning various aspects of the UK labour market. The LFS uses calibration weighting using a population weighting procedure.

Centre for Longitudinal Studies (CLS) Next Steps (LSYPE1): The Next Steps survey, previously known as the Longitudinal Study of Young People in England (LSYPE), is a major longitudinal study that has followed the lives of around 16,000 people in England since 2004, when they were in Year 9. Cohort members are interviewed annually, collecting information on their educational and labour market experiences. Analyses of Next Steps data apply calibration weights, correcting for both the survey design and non-response.

Department for Education (DfE) Our Future (LSYPE2): The Our Future survey, also known as the second Longitudinal Study of Young People in England (LSYPE2), began in 2013 and is one of the largest studies of young people ever commissioned. It follows a nationally representative sample of over 13,000 young people who were aged 13 to 14 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.

1.6 Banerjee, P. A. 'A systematic review of factors linked to poor academic performance of disadvantaged students in science and maths in schools', Cogent Educ., 2016.

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[1.7] (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 exams 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 options, 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).[1.8] 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 Highers, which are equivalent to AS levels, and Advanced Highers, 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 option is increasingly common due to the continuing expansion of the education sector and a trend of 'credential inflation'[1.9] 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.

1.7 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 stage of their education. Maintained schools are required to follow the national curriculum, but academies and independent schools can choose not to.
1.8 Some students in Scotland will instead sit National 4 qualifications, which are less academically advanced.
1.9 Credential inflation occurs when increasing numbers of people gain qualifications (for example with educational expansion). This increase in the number of people with similar credentials results in a lower return in the labour market, leading more people to pursue higher qualifications to secure a competitive advantage.

Figure 1.2 Overview of the UK education system

AGE 4-11	AGE 11-16	AGE 16-18
Primary education (Key stage 1-2)	**Lower secondary education** (Key stage 3-4)	**Upper secondary and further education** (Key stage 5)
	Maintained schools, academies, grammar schools, independent schools, technical colleges, studio schools	School sixth forms, further education colleges, sixth-form colleges, training providers

Compulsory education Northern Ireland and Scotland

Level 1	Level 2		Level 3
· GCSE D-G/3-1 · Functional Skills (ENG) · Essential Skills Qualifications (NI/WAL) · Vocational and Technical Qualifications	· GCSE A*C/9-4 · Functional Skills (ENG) · Essential Skills Qualifications (NI/WAL) · Vocational and Technical Qualifications	· Intermediate/ Foundation Apprenticeship (ENG/WAL) · Traineeship (NI) · Functional Skills (ENG) · Essential Skills Qualifications (NI/WAL) · Vocational and Technical Qualifications	· Apprenticeships · Vocational, Technical and Professional Qualifications · GCE AS/A Level · T levels · International Baccalaureate

Level 1-3	Level 4	Level 5	Level 6	Level 7
· National 1-3 · National Progression Awards (NPA) · National Certificate	· National 4 · Scottish Vocational Qualifications (SVQ) · NPA · National Certificate	· National 5 · Modern Apprenticeship · SVQ · NPA · National Certificate	· Modern Apprenticeship · Foundation Apprenticeship · NPA · National Certificate · Professional Development Award (PDA) · SVQ	· Higher National Certificate · Certificate of Higher Education · Modern Apprenticeship · PDA · SVQ · Scottish Baccalaureate · Advanced Higher

England, Wales and Northern Ireland · Scotland

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 nation differences.

AGE 18+

Compulsory education England and Wales

Further and higher education

Universities, university colleges, further education colleges, higher education institution, alternative providers

Postgraduate education

Universities, university colleges, further education colleges, higher education institution, alternative providers

Level 4	Level 5	Level 6	Level 7	Level 8
· Higher Apprenticeship · Vocational, Technical and Professional Qualifications · Higher National Certificate · Certificate of Higher Education (WAL)	· Foundation Degree · Higher Apprenticeship · Diploma of Higher Education · Vocational, Technical and Professional Qualifications · Higher National Diploma	· Bachelor's Degree · Degree Apprenticeship (ENG) · Higher Apprenticeship · Professional Graduate Certificate in Education · Vocational, Technical and Professional	· Master's Degree · Higher Apprenticeship · Degree Apprenticeship (ENG) · Postgraduate Certificate in Education · Vocational, Technical and Professional	· Doctoral Degree · Vocational, Technical and Professional Qualifications · Degree · Apprenticeship* · Higher Apprenticeships*

Level 8	Level 9	Level 10	Level 11	Level 12
· Higher National Diploma · Diploma of Higher Education · Technical Apprenticeship · Higher Apprenticeship · PDA · SVQ	· Bachelor's/ Ordinary Degree · Graduate Diploma · Graduate Certificate · Graduate Apprenticeship · Technical Apprenticeship · PDA · SVQ	· Bachelor's Degree (Hons) · Graduate Diploma · Graduate Certificate · Professional Apprenticeship · Graduate Apprenticeship · PDA · SVQ	· Master's Degree · Postgraduate Diploma · Postgraduate Certificate · Professional Apprenticeship · Graduate Apprenticeship · PDA · SVQ	· Doctoral Degree · Professional Apprenticeship* · PDA

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.

Engineering-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.[1.10]

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, since it is difficult 'or even structurally impossible'[1.11] 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,[1.12] 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.[1.13]

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.

Figure 1.3 Highest educational qualification among those in engineering occupations (2019) – UK

Highest educational qualification	Working in engineering occupations (%)
Degree or equivalent	33.9%
A level equivalent or above	39.4%
GCSE grades A*-C or above	15.5%
Other qualification	7.1%
No qualification	4.1%

Source: ONS. 'Quarterly Labour Force Survey, July to September 2019' data, 2019.

Among those in engineering occupations[1.14] 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

Main degree subject area	Working in engineering occupations (%)
Engineering	23.4%
Mathematical sciences and computing	20.2%
Architecture and related studies	10.2%
Business and financial studies	9.3%
Physical/Environmental sciences	8.7%
Arts	6.1%
Social studies	5.0%
Biological sciences	4.6%
Mass communications and documentation	2.2%
Humanities	2.2%

Source: ONS. 'Quarterly Labour Force Survey, July to September 2019' data, 2019.
Subject areas with a proportion of less than 2% have been omitted.

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 stages, 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 science at GCSE level in England, for example, the depth of material covered can vary. For example, pupils can elect to take additional numeracy-based GCSEs, 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).[1.15]

Students who take triple science at GCSE are more likely to remain in STEM education at later stages than those who do not.[1.16] 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.[1.17] 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.[1.18] And the pre-requisites for

1.10 House of Commons, Committee of Public Accounts. 'Delivering STEM skills for the economy Forty-Seventh Report of Session 2017-19 Report, together with formal minutes relating to the report', 2018.
1.11 Raabe, I. J. et al. 'The Social Pipeline: How Friend Influence and Peer Exposure Widen the STEM Gender Gap', Sociol. Educ., 2019.
1.12 Iannelli, C. and Duta, A. 'Inequalities in school leavers' labour market outcomes: do school subject choices matter?', Oxford Rev. Educ., 2018.
1.13 Anders, J. et al. 'The role of schools in explaining individuals' subject choices at age 14', Oxford Rev. Educ., 2018.
1.14 Throughout this chapter, references to those in 'engineering occupations' denotes those with Standard Occupational Classification (SOC) codes that fall within the core and related engineering jobs as classified within EngineeringUK's engineering footprint. For more detailed information on the engineering footprint, see EngineeringUK's 2018 report 'The State of Engineering'.
1.15 Not all schools offer their pupils the opportunity to study triple science and there is evidence that young people from disadvantaged backgrounds are less likely to be given the choice. For more information, see: EngineeringUK. 'Social mobility in engineering', 2018.
1.16 EngineeringUK. 'Social mobility in engineering', 2018.
1.17 UCAS. 'Engineering & Technology Subject Guide', 2019.

engineering degree courses are off-putting for women in particular – for example, when UCL removed the requirement for maths and physics A levels for entry onto their engineering undergraduate degree courses, they saw a surge in enrolments among women.[1.19]

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 peers[1.20] 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.[1.21] Young people from disadvantaged backgrounds are also far less likely than their better off peers to start high quality apprenticeships.[1.22]

In engineering, we particularly need to fill vacancies in level 3+ occupations. Given that need, if those from disadvantaged backgrounds are underrepresented in higher-level apprenticeships[1.23] and academic STEM pathways, this may result in an 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 achieve parity of esteem with academic equivalents.

The aim must not simply be to funnel more young people into engineering careers via 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.

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.

1.3 – Facilitators and barriers in STEM educational choices

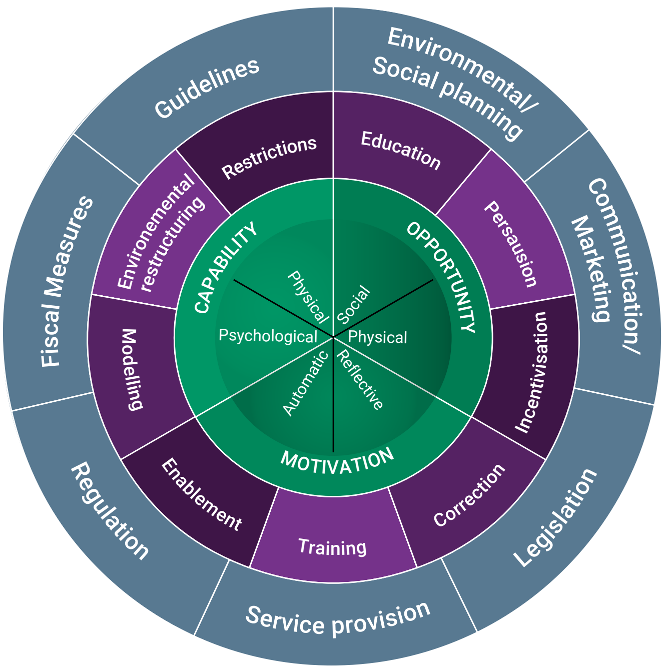
The range of factors that influence young people when making their educational choices is widely documented and the complexities of choice processes are well recognised. There is no 'one-size-fits-all' explanation.

However, these factors can generally be organised into the Capability, Opportunity, Motivation, Behaviour (COM-B) model.[1.24] This is a framework for understanding the processes, barriers and facilitators that help to shape an individual's behaviour.

Designed following a systematic review of behaviour change interventions and consultation with behaviour change experts, the model considers **B**ehaviour to be a function of an individual's:

- psychological or physical **C**apability to carry out the behaviour (for example their knowledge or skillset)
- **O**pportunity for the behaviour afforded by the physical and/or social environment (such as so cial support and availability of information)
- automatic and reflective **M**otivation to enact the behaviour, where automatic refers to their emotions and drives, and reflective refers to their planning and intentions

Figure 1.5 The COM-B model of behavioural change



Sources of behaviour · Intervention functions · Policy categories

Source: Michie, S., et al. 'The behaviour change wheel: A new method for characterising and designing behaviour change interventions'. Implement. Sci., 2011.

1.18 EngineeringUK. 'Social mobility in engineering', 2018.
1.19 Evening Standard. 'Women push for places on UCL engineering course after it dropped need for physics and maths A level' [online], accessed 31/03/2020.
1.20 CVER. 'Peer effects and social influence in post-16 educational choice', 2017.
1.21 NFER. '2019 Review of the Value of Vocational Qualifications', 2019.
1.22 Sutton Trust. 'BETTER apprenticeships', 2017.
1.23 QA. 'The Social Mobility Impact of Apprenticeships', 2019.
1.24 Michie, S. et al. 'The behaviour change wheel: A new method for characterising and designing behaviour change interventions', Implement. Sci., 2011.

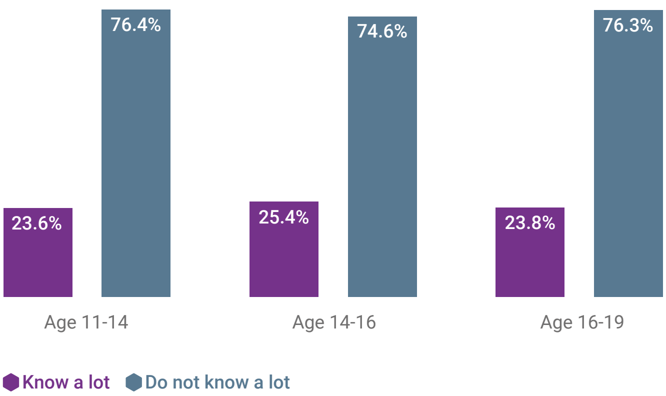
Such a framework can serve as a useful reminder that if we are to increase the engineering talent pool, it is not enough to increase just one set of factors, such as devoting our attention wholly to inspiration building. We must recognise that changes in behaviour are dependent on young people being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

This section will review evidence relating to the facilitators and barriers in STEM education choices, all of which can be understood in the context of the COM-B model.

Limited knowledge, misconceptions and narrow stereotypes

A widespread lack of awareness about engineering, including a limited of 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.

Figure 1.6 Knowledge of engineering careers among 11 to 19 year olds by age group (2019) – UK



Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: 'How much do you know about what people working in engineering do?' Percentages represent the proportions reporting they know '4 – quite a lot' or '5 – a lot' on a 5-point Likert scale, compared with the proportions reporting they know '1 – almost nothing', '2 – a little' or '1 – something'.
To view this chart by gender and ethnicity, see **Figure 1.6-1.6a** in our Excel resource.

Worse, their limited knowledge is often coloured by narrow and outdated stereotypes of the profession. The 'Draw an Engineer Test' (DAET) conducted in the US in 2004 highlighted the importance of images in communicating messages to young people and the potential damage that inaccurate or incomplete understandings can have on forming perceptions and influencing decisions.[1.25] As the study reports, "while the concepts are theoretical, the implications are concrete." Both preconceived misconceptions and 'conventional' understandings of engineers prevailed among students – a finding which is also borne out in the UK.[1.26]

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".[1.27] Previous studies have shown that young people typically consider their peers who favour science as being "less attractive, less popular and less socially competent" than those who favour the humanities.[1.28] This persistent 'hard hat' image of engineering can hinder young people's motivations to pursue a career in the profession.

These stereotypes are also often gendered. The view of engineering as a masculine profession is not uncommon,[1.29] which can serve to demotivate young women in particular from pursuing engineering careers. Among young people aged 11 to 19, 13% of girls who said they don't consider a career in engineering desirable indicated it was because engineering is not well suited to their gender. Responses included that engineering is "for boys" (girl aged 14 to 16) and that it is "hard for women" (girl aged 16 to 19). The 2019 EBM also found that parents of girls were less likely to recommend an engineering career to their children than the parents of boys.[1.30]

Inaccurate and incomplete knowledge about engineering careers can be off-putting for young people. With engineering lacking a presence in the curriculum, it is crucial that those within and outside the education sector make efforts to promote the profession by correcting misunderstandings and fostering a motivation to pursue STEM.

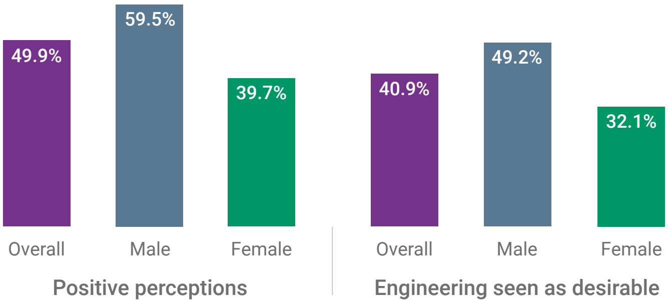
Perceptions of engineering

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.[1.31] This is significantly lower than for other areas of STEM: 68% 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.

1.25 Knight, M. and Cunningham, C. 'Draw an Engineer Test (DAET): Development of a tool to investigate students' ideas about engineers and engineering', ASEE Annual Conference Proceedings 2004.
1.26 EngineeringUK. 'Gender disparity in engineering', 2018.
1.27 EngineeringUK. 'Engineering Brand Monitor', 2019.
1.28 Taconis, R. and Kessels, U. 'How Choosing Science depends on Students' Individual Fit to 'Science Culture'', Int. J. Sci. Educ., 2009.
1.29 EngineeringUK. 'Gender disparity in engineering', 2018.
1.30 EngineeringUK. 'Engineering Brand Monitor', 2019.
1.31 Ibid.

Figure 1.7 Perceptions and desirability of careers in engineering among 11 to 19 year olds by gender (2019) – UK



Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: 'How positive or negative is your view on engineering?' Percentages represent the proportions reporting '4 - quite positive' or '5 - very positive' on a 5-point Likert scale, with 1 representing 'very negative' and 5 representing 'very positive'.
Q: 'How desirable do you believe a career in engineering to be?' Percentages represent the proportions reporting '4 – quite desirable' or '5 – very desirable' on a 5-point Likert scale, with 1 representing 'not at all desirable' and 5 representing 'very desirable'.
To view this chart by age group and ethnicity, see **Figure 1.7-1.7a** in our Excel resource.

Young people cited family, salary expectations and taking part in science-related activities outside school as being among the most positive influences on their perceptions of engineering, as shown in **Figure 1.8**.

Interestingly, over one quarter (27.4%) said that celebrities had a negative influence on their perceptions of engineering, perhaps indicating that some young people are put off engineering because it appears to be less glamorous or fashionable than other careers. 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".

Young people need more than just the motivation to pursue engineering as a career – they must also possess the capability and be offered the opportunity to realise this aspiration.

Figure 1.8 Positive and negative influences on the perceptions of engineering among 11 to 19 year olds (2019) – UK

	Positive influence on perceptions (%)	Negative influence on perceptions (%)
Family	57.6%	13.4%
Perceptions of salary	57.1%	16.1%
Science exhibitions/museums	56.2%	15.5%
Course tutors/lecturers/teachers	55.3%	14.3%
Engineering activities in school	55.3%	17.2%
Careers advisor coming into school	55.2%	13.6%
Science programmes on TV	55.0%	16.5%
Internet	54.6%	13.5%
Speakers coming into school	54.6%	14.0%
Prestige	52.6%	14.8%
Friends	47.6%	16.3%
Celebrities	28.5%	27.4%

Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: 'How positively or negatively do the following influence your perceptions of engineering?' Percentages represent the proportions selecting a positive (left hand column) or negative (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 pressing need for the engineering community to combat negative perceptions of the profession. Encouragingly, much work is being done in this area. For example, campaigns such as 'This is Engineering' are seeking to overhaul the image of the profession, emphasising its key role in fields ranging from fashion and film to sport, music and technology.

However, young people need more than just the motivation to pursue engineering as a career – they must also possess the capability and be offered the opportunity to realise this aspiration.

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

There is a widespread belief that STEM is only for the brainy.[1.32] 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'.[1.33]

62.2% of young people aged 16 to 17 in England feel that 'subjects like science or maths are more difficult than others'.

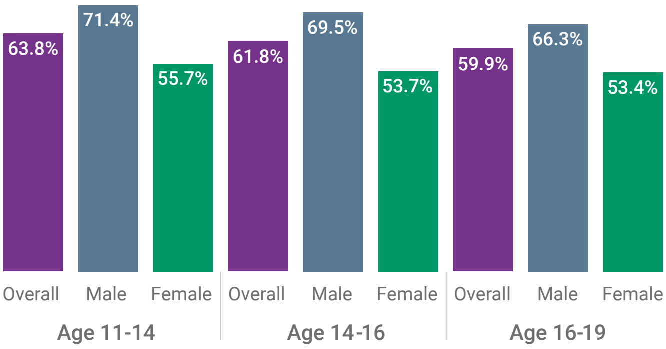
1.32 Archer, L. et al. 'Young people's science and career aspirations, age 10 – 14', King's Coll. London Dep. Educ. Prof. Stud., 2013.
1.33 CLS. 'Next Steps (LSYPE1), wave 3' data, 2006.

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 14 to 15 who agreed that they get good marks for their work, 53.0% 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.[1.34]

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.[1.35] 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 brainy 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 a low self-belief in their ability to do well in STEM.[1.36, 1.37] In the 2019 EBM, when asked whether they thought they could become an engineer if they wanted to, just 55.7% 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.

Figure 1.9 Engineering self-efficacy among 11 to 19 year olds by gender and age group (2019) – UK



Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: 'And if you wanted to, do you think you could become an engineer?' Proportions represent the percentages reporting '3 – yes, probably' or 4 – yes, definitely' on a 5-point scale with other values representing '1 – no, definitely not', '2 – no, probably not' and '5 – unsure'.
To view this chart by ethnicity, see **Figure 1.9a** in our Excel resource.

Lower self-belief in STEM abilities among girls is driven in part by a misalignment between their self-identities and what they perceive STEM identities to be.

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 or engineering 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,[1.38] as are some minority ethnic groups, including black students in particular.[1.39]

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

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!

1.34 DfE. 'Our Future (LSYPE2), wave 2' data, 2014.
1.35 EngineeringUK. 'Engineering Brand Monitor' data, 2019.
1.36 Lyons, T. 'Different countries, same science classes: Students' experiences of school science in their own words', Int. J. Sci. Educ., 2006.
1.37 Sjaastad, J. 'Sources of Inspiration: The role of significant persons in young people's choice of science in higher education', Int. J. Sci. Educ., 2012.
1.38 WISE. '"Not for people like me?" Under-represented groups in science, technology and engineering', 2014.
1.39 Archer, L. et al. 'Is science for us? Black students' and parents' views of science and science careers', Sci. Educ., 2015.

The trade-off between 'high-risk' and 'high-return' in STEM

STEM subjects are 'high return', with associated careers tending to offer higher salaries than other occupations. Young people seem to be aware of this. Among a nationally representative sample of young people in year 11 in England who were planning to go to university, 74.0% agreed or strongly agreed with the statement that 'people with science or maths degrees are in demand by employers' and 45.1% agreed or strongly agreed with the statement that 'people with science or maths degrees will usually get better paid jobs than students with other types of degree'.[1.40]

This could serve as a 'pull factor' – if young people expect to be highly remunerated in future, they may be encouraged to pursue STEM educational pathways. However, when young people consider all their options, it is likely they will also factor in their perceived chances of success in each one. The commonly held view that STEM subjects tend to be more difficult than others could then serve as an offsetting 'push factor'.

In the STEM context, these aspects may result in different socioeconomic and ethnic groups, and boys and girls, making different choices. Students from lower socioeconomic groups, for example, tend to achieve lower grades than their peers from higher socioeconomic backgrounds,[1.41] which could act as a deterrent for them.

A study looking into the intersectionalities in individuals' characteristics as a way of predicting STEM choices showed that young women from more advantaged backgrounds are more likely to choose STEM subjects. Meanwhile, their peers from more disadvantaged backgrounds are more likely to take social sciences, law and business, and administrative subjects – these are generally high return, but are not considered to be as difficult as STEM subjects.[1.42] This is consistent with the notion that individuals are inclined to be relatively risk averse. In other words, it may be that more advantaged female students are choosing 'riskier' options because they perceive the consequences of failure would not be so dire for them: should they fail, they have a safety net in the form of financial support from their family.[1.43]

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.

In relation to the gender gap, it may also be that girls' high performance in 'low risk', non-STEM subjects encourages them to pursue these instead of STEM. Girls outperform boys in verbal skills and tend to have comparative advantages in subjects such as English and languages. Even if they do well in STEM, leading them to perceive their chances of succeeding in other subjects as favourable as compared to STEM, even if they do well.[1.44]

Teacher expectations and assessments of ability in STEM

Continuing to higher level study in STEM is less attractive for young people who don't think they will achieve good grades in those subjects and may have limited opportunities to do so. In part, this is because young people usually need to demonstrate their competence in order to continue along any given educational pathway – university offers, for example, are often conditional on attainment in relevant subjects at A level.

Teachers' expectations 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 do in 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 can in turn affect their performance.[1.45]

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).[1.46] This tends to happen relatively early on in pupils' educational careers, resulting 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.[1.47]

Misallocation in setting and streaming practices is not uncommon.[1.48] This is of particular concern in STEM subjects, where ability grouping is most often used.[1.49, 1.50] OECD figures from 2013 suggested that 95% of students in England were taught in ability groups in maths.[1.51] What's more, studies have shown that misallocation can be a particular problem for those from lower socioeconomic backgrounds,[1.52] 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.[1.53]

1.40 CLS. 'Next Steps (LSYPE1), wave 4' data, 2007.
1.41 Joseph Rowntree Foundation. 'Poorer children's educational attainment: how important are attitudes and behaviour?', 2010.
1.42 Codiroli Mcmaster, N. 'Who studies STEM subjects at A level and degree in England? An investigation into the intersections between students' family background, gender and ethnicity in determining choice', Br. Educ. Res. J., 2017.
1.43 Ibid.
1.44 Raabe, I. J. et al. 'The Social Pipeline: How Friend Influence and Peer Exposure Widen the STEM Gender Gap', Sociol. Educ., 2019.
1.45 Jussim, L. et al. 'Teacher expectations and self-fulfilling prophecies', 2009.
1.46 'Setting' tends to involve grouping pupils by ability for particular classes, such as maths and English, whereas 'streaming' tends to involve grouping pupils by ability for all or most of their lessons, regardless of the subject.
1.47 EEF. 'Setting or streaming', 2015.
1.48 UCL, IOE. 'IOE research raises concerns about setting' [online], accessed 20/03/2020.
1.49 Codiroli Mcmaster, N. 'Who studies STEM subjects at A level and degree in England? An investigation into the intersections between students' family background, gender and ethnicity in determining choice', Br. Educ. Res. J., 2017.
1.50 Kutnick, P. et al. 'The Effects of Pupil Grouping: Literature Review (No. 688)', Dep. Educ. Ski., 2005.
1.51 Mazenod, A. et al. 'Nurturing learning or encouraging dependency? Teacher constructions of students in lower attainment groups in English secondary schools', Cambridge J. Educ., 2019.
1.52 EEF. 'Setting or streaming', 2015.
1.53 UCL, IOE. 'IOE research raises concerns about setting' [online], accessed 20/03/2020.

Only around 16% of predicted A level results are correct. Important life decisions, such as whether or not to apply to university, are therefore being made on the basis of inaccurate advice.

Similar concerns relate to the effects of the predicted grades system. Students often make decisions about what route to take after GCSEs and which, if any, universities to apply to after A levels, based on predicted grades assigned by their teachers. A study by the University and College Union (UCU) has suggested that these predictions are very often inaccurate, with only around 16% of predicted A level grades being correct. When this happens, it can be a massive problem for young people.[1.54]

Furthermore, there is a host of evidence to suggest that, similar to misallocations in ability grouping, the system of predicted grades is also often unfair. For example, high achieving young people from disadvantaged backgrounds have been found to receive under-predicted grades at A level more often than their more advantaged peers.[1.55]

The effect of this on pupils' confidence in their capabilities, as well as on the opportunities (or lack of) they are subsequently presented with, is worrying, particularly if these practices are perpetuating the underrepresentation of specific groups. Important life decisions, such as whether or not to apply to university, are being made on the basis of inaccurate advice. It is crucial that steps are taken to avoid unconscious teacher bias or institutional discrimination that may contribute to educational inequalities and the STEM skills shortage.

The accuracy of predicted grades can pose barriers for young people progressing in STEM, but this isn't a problem that only affects maths and science. A report by Cambridge Assessment showed that, of all OCR GCSE grades reported by teachers in 2014, 45% of science and maths and 42% of ICT/technology grades were accurately predicted, compared with 44% across all subjects. Similarly, 41% of maths and science and 45% of ICT/technology grades were optimistically predicted (compared with 42% across all subjects) and 13% of maths, science and ICT/technology grades were pessimistically predicted (compared with 14% across all subjects).[1.56]

Knowledge of relevant educational pathways

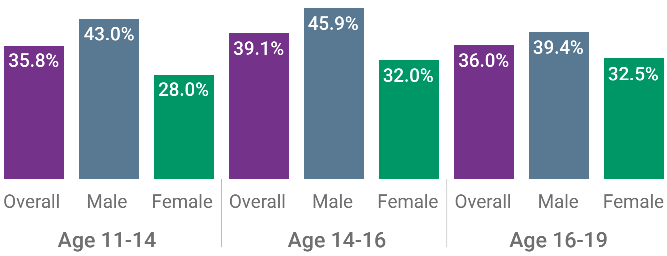
Another factor that can prevent young people pursuing engineering careers is a lack of knowledge about relevant STEM educational pathways.

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 19 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'.

Figure 1.10 Knowledge of engineering educational pathways among 11 to 19 year olds by age group and gender (2019) – UK



Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: 'How much do you agree or disagree with the following statement: I know what to do next in order to become an engineer.' Percentages represent the proportions reporting '4 – agree a little' or '5 – agree a lot' on a 5-point Likert scale with 1 representing 'disagree a lot' and 5 representing 'agree a lot'.
To view this chart by ethnicity, see **Figure 1.10a** in our Excel resource.

1.54 UCU. 'Predicted grades: accuracy and impact', 2016.
1.55 Ibid.
1.56 Cambridge Assessment. 'The accuracy of forecast grades for OCR GCSEs in June 2014', 2015.

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%.[1.57]

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 (60.6%), as shown in **Figure 1.11**.

Figure 1.11 Who 14 to 15 year olds spoke to about how GCSEs are related to A levels or university courses (2014) – England

Who young people spoke to	Percentage
Parents	78.4%
Teachers	60.6%
Friends	43.9%
Brothers or sisters	23.4%
The school careers advisor	14.9%
Careers advisor who came into the school	10.5%
Someone else at the school	9.9%
Somebody from a university	7.6%
I didn't discuss this with anyone	7.1%
Employers who came into the school	5.0%
Other	2.1%
An advisor from the National Careers Service	1.7%

Source: DfE. 'Our Future (LSYPE2), wave 2' data, 2014.

There has been little change in the levels of knowledge of educational pathways among young people over recent years,[1.58] which suggests that more needs to be done to increase awareness. Clearly conveying the importance of studying subjects such as maths and science to young people at key decision-making points is crucial for increasing opportunities to enter engineering educational pathways.

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 into 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 [1.59] 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**).

1.57 EngineeringUK. 'Engineering Brand Monitor', 2019.
1.58 Ibid.
1.59 DfE. 'Careers strategy: making the most of everyone's skills and talents', 2017.

Figure 1.12 The 8 'Gatsby benchmarks'

	The benchmarks	
1	**A stable careers programme**	Every school and college should have an embedded programme of careers education and guidance that is known and understood by students, parents, teachers, governors and employers.
2	**Learning from career and labour market information**	Every student, and their parents, should have access to good quality information about future study options and labour market opportunities. They will need the support of an informed adviser to make best use of available information.
3	**Addressing the needs of each student**	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.
4	**Linking curriculum learning to careers**	All teachers should link curriculum learning with careers. STEM subject teachers should highlight the relevance of STEM subjects for a wider range of future career paths.
5	**Encounters with employers and employees**	Every student should have multiple opportunities to learn from employers about work, employment and the skills that are valued in the workplace. This can be through a range of enrichment activities including visiting speakers, mentoring and enterprise schemes.
6	**Experiences of workplaces**	Every student should have first-hand experience of the workplace through work visits, work shadowing and/or work experience to help their exploration of career opportunities and expand their networks.
7	**Encounters with further and higher education**	All students should understand the full range of learning opportunities that are available to them. This includes both academic and vocational routes and learning in schools, colleges, universities and the workplace.
8	**Personal guidance**	Every student should have opportunities for guidance interviews with a careers adviser, who could be internal (a member of school staff) or external, provided they are trained to an appropriate level. These should be available whenever significant study or career choices are being made. They should be expected for all students but should be timed to meet their individual needs.

Source: Gatsby Charitable Trust. 'Good career guidance', 2014.

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.[1.60, 1.61]

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".[1.62] In 2018/19, only 38% of schools and colleges had achieved this indicator, with a further 58% partially achieving it.[1.63]

One issue for engineering is that young people consider teachers and parents as key providers of careers advice, but teachers 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 careers advisers for careers advice in 2019, but only 23.5% had so far heard about engineering careers from this source. Most young people who had heard about engineering careers from any source had heard about it from their teachers (31.5%) or online (30.0%), as **Figure 1.13** shows.

Figure 1.13 Main sources among 11 to 19 year olds who have heard about engineering careers (2019) – UK

Main sources	Percentage
Teachers	31.5%
Online	26.0%
Careers adviser	23.5%
Careers fairs	22.0%
Family	21.9%
Someone who works as an engineer	20.6%
Social media	17.8%
Friends	17.3%

Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: 'Have you heard about engineering careers from any of the following sources?'

1.60 CEC. 'State of the Nation 2019: Careers and enterprise provision in England's secondary schools and colleges', 2019.
1.61 The percentages do not total 100% because comparisons over time were drawn from only the sample of schools and colleges that provided 2 submissions (2017/18 and 2018/19) (N=2,880), while the most recent figures that relate only to 2018/19 are calculated from a sample of schools and colleges that provided the most recent submission (N=3,351).
1.62 Gatsby Charitable Trust. 'Good career guidance', 2014.
1.63 CEC. 'State of the Nation 2019: Careers and enterprise provision in England's secondary schools and colleges', 2019.

Following evidence that careers education provision has often been patchy and patterned in ways that are likely to exacerbate social inequalities,[1.64] 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.[1.65]

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 arriving with 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 county.

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 apprentices (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 UKs 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,[1.66] 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**).

Figure 1.14 Key influencers in the GCSE subject choices of 13 to 14 year olds (2004) – England

Key influencer	Percentage
Parents	59.9%
School	35.5%
Someone else	4.5%

Source: CLS. 'Next Steps (LSYPE1), wave 1' data, 2004.
Young people, who are reported to be the main decision makers, have been excluded from these calculations.

Figure 1.15 Key influencers in the decision of 16 to 17 year olds to stay on in full-time education after GCSE (2008) – England

Key influencer	Percentage
Parents	45.7%
Friends	17.6%
Older brother or sister	14.4%
Other family member	7.2%

Source: CLS. 'Next Steps (LSYPE1), wave 4' data, 2008.
Young people, who are reported to be the main decision makers, have been excluded from these calculations. The sample is restricted to those who stayed on in full-time education after GCSE.

The overwhelming influence of some parents in shaping career choices is shown by the tendency in some professions for children to follow the occupational footsteps of their parents: children of doctors are 24 times more likely than their peers to become doctors, for example.[1.67] Recent analysis of micro-class mobility by academics at the London School of Economics documents these trends for a number of 'elite' occupations[1.68], including engineering. The rates of consecutive generations of engineers in the UK are relatively high, being second only to medical practitioners: [1.69]

1.64 Moote, J. and Archer, L. 'Failing to deliver? Exploring the current status of career education provision in England', Res. Pap. Educ. 33, 2018.
1.65 CEC. 'State of the Nation 2019: Careers and enterprise provision in England's secondary schools and colleges', 2019.
1.66 CLS. 'Next Steps (LSYPE1), wave 1' data, 2004.
1.67 Friedman, S. and Laurison, D. 'The Class Ceiling: Why it Pays to be Privileged', Policy Press, 2019.
1.68 'Elite occupations' are defined as those that are among higher and lower managerial, administrative and professional occupations according to the National Statistics Socioeconomic Classification.
1.69 Laurison, D. and Friedman, S. 'The Class Pay Gap in Higher Professional and Managerial Occupations', Am. Sociol. Rev., 2016.

Figure 1.16 Consecutive generations within 'elite occupations' (2014) – UK

Occupation	Same occupation as main wage-earning parent (%)
Medical practitioners	17.2%
Engineers (such as civil engineers, mechanical engineers)	8.6%
Protective civil service (such as senior police officers, officers in armed forces)	8.2%
Law (such as barristers and judges, legal professionals)	8.1%
Managers and directors in business (such as advertising and PR directors, chief executives and senior officials)	7.3%
Other professionals (such as clergy, environment professionals)	6.2%
Finance (such as brokers, financial managers and directors)	4.6%
Accountants (such as taxation experts, actuaries, economists and statisticians)	4.6%
Higher education teaching professionals	3.9%
Other life science professionals (such as dental practitioners, veterinarians, pharmacists)	3.0%
Scientists (such as physical scientists, social and humanities scientists)	2.2%
Business professionals (such as business and related research professionals, management consultants and business analysts)	2.2%
Public sector managers and professionals (such as education advisers and school inspectors, social services managers and directors)	1.1%

Source: Data adapted from Laurison, D. and Friedman, S. 'The Class Pay Gap in Higher Professional and Managerial Occupations'. Am. Sociol. Rev., 2016.
The EngineeringUK footprint is not used here to define those in engineering occupations. Figures relate only to those in 'elite occupations' – considered as those in SOC major groups beginning 1 or 2. The data used for this study was from the 2014 Labour Force Survey.

These results reinforce literature that suggests familiarity with a given field or occupation can promote interest in it or raise aspirations to pursue it. Louise Archer's work on 'science capital' summarises this trend in the STEM context: science-related knowledge, attitudes, experiences and resources that young people are exposed to – most often through their parents and via the process of primary socialisation – can raise young people's science-related aspirations.[1.70] The more of these factors they are exposed to (in a positive sense), the higher their science capital. Parents who are themselves engaged in STEM make the choice of 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.[1.71]

Science capital

Science capital is a concept developed by the ASPIRES (now ASPIRES2) team, led by Professor Louise Archer, to explain why there are disparate rates of participation in post-16 science.[1.72] 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

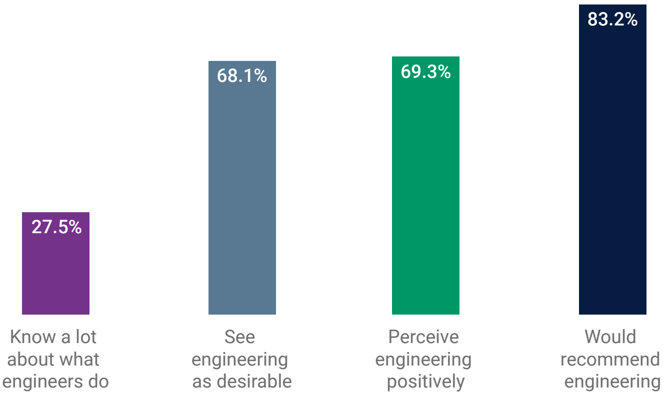
1.70 Archer, L. et al. 'Science Aspirations, Capital, and Family Habitus: How Families Shape Children's Engagement and Identification With Science', Am. Educ. Res. J., 2012.
1.71 Archer, L. et al. ''Science capital': A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts', J. Res. Sci. Teach., 2015.
1.72 Ibid.

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 83% 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.

Figure 1.17 Knowledge, perceptions and desirability of engineering careers among parents (2019) – UK



Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: 'How much do you know about what people working in engineering do?' Percentages represent the proportions 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 desirable do you believe a career in engineering to be for your children?' Percentages represent the proportions reporting '4 – quite desirable' or '5 – very desirable'.
Q: 'How positive or negative is your view of engineering?' Percentages represent the proportions reporting '4 – quite positive' or '5 – very positive'.
Q: 'Would you recommend that your children consider a career in engineering?' Percentages represent the proportions reporting '1 – yes'.

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.[1.73] 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.

Figure 1.18 Knowledge, perceptions and desirability of engineering careers, and confidence in giving engineering careers advice among parents by social grade (2019) – UK

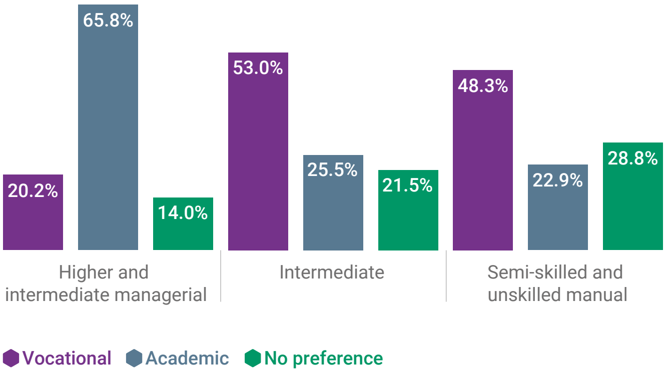
Social grade	Knowledge of engineering careers (%)	Positive perceptions of engineering (%)	Confidence in giving engineering careers advice (%)	Engineering will have a positive impact (%)	Would recommend engineering (%)
Higher and intermediate managerial	42.7%	79.5%	46.2%	93.3%	89.7%
Intermediate	23.0%	67.5%	27.7%	83.0%	83.0%
Semi-skilled and unskilled manual	23.0%	63.8%	26.7%	79.9%	77.7%
Overall	**27.5%**	**69.3%**	**31.7%**	**84.6%**	**83.2%**

Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: 'How much do you know about what people working in engineering do?' Percentages represent the proportions 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 positive or negative is your view of engineering?' Percentages represent the proportions reporting '4 – quite positive' or '5 – very positive';
Q: 'Would you recommend that your children consider a career in engineering?' Percentages represent the proportions reporting '1 – yes';
Q: 'How confident do you feel giving careers advice in the following areas?' Percentages represent the proportions reporting '4 - fairly confident' or '5 - very confident' on a 5-point Likert scale, with 1 representing 'not at all confident' and 5 representing 'very confident';
Q: 'How much do you agree or disagree that engineers will have a positive impact on our future?' Percentages represent proportions reporting '4 – agree a little' or '5 – agree a lot'.

1.73 In this instance, a 'higher social grade' refers to those in 'Higher and intermediate managerial, administrative and professional occupations' (social grades A and B), and 'lower social grade' refers to those in 'Semi-skilled and unskilled manual occupations, unemployed and lowest grade occupations' (social grades D and E).

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 (65.8% compared with 20.2% respectively).

Figure 1.19 Likelihood of recommending a vocational or academic path into engineering among parents by social grade (2019) – UK



Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: 'If your children were going to pursue a career in engineering, would you be most likely to recommend a vocational or academic route?'

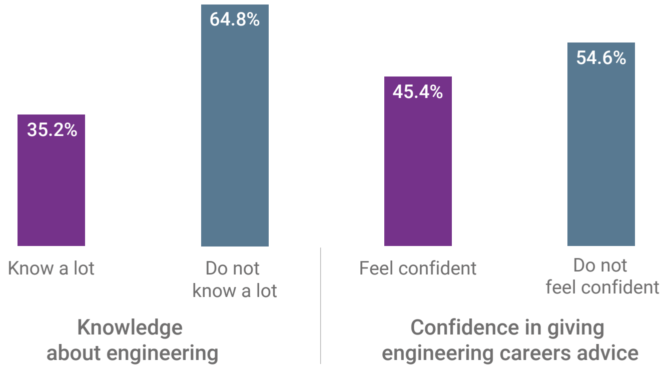
Parents also play an important role in preparing their children for the world of work through their social and professional networks. Work experience can provide influential workplace encounters for young people, and good quality placements can positively shape career choices. Since the removal of statutory 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.[1.74]

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**).

Figure 1.20 Knowledge of engineering careers and confidence in giving careers advice in engineering among teachers (2019) – UK



Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: 'How much do you know about what people working in engineering do?' Percentages represent the proportions 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 confident do you feel giving careers advice in the following areas?' Percentages represent the proportions reporting '4 - fairly confident' or '5 - very confident' on a 5-point Likert scale, with 1 representing 'not at all confident' and 5 representing 'very confident'.

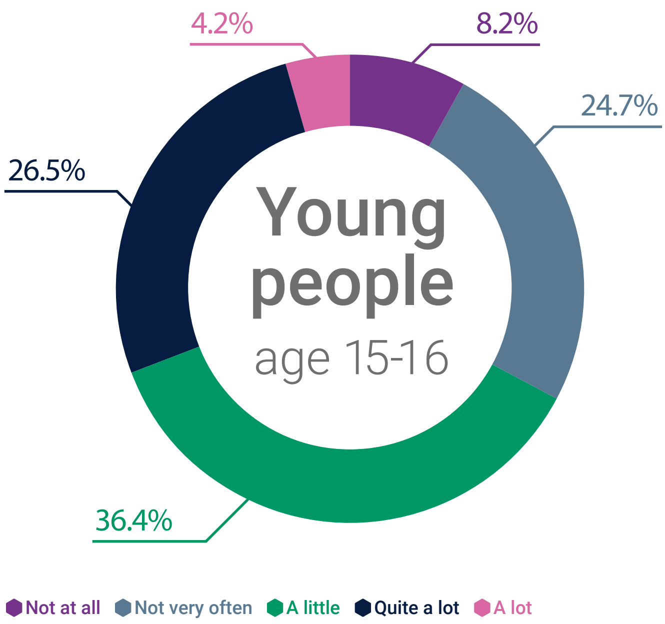
STEM teachers may have low levels of knowledge of engineering because many deliver lessons on subjects in which they are not a specialist.

1.74 EngineeringUK. 'Social mobility in engineering', 2018.

STEM teachers may have low levels of knowledge of engineering because many teachers 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.

Figure 1.21 How often 15 to 16 year olds talk to teachers about plans for future study (2015) – England



Source: DfE. 'Our Future (LSYPE2), wave 3' data, 2015.

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 20 ENTHUSE 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.

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 paths.[1.75] 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,[1.76] thus having obvious implications for the engineering talent pool.

1.75 Anders, J. et al. 'The role of schools in explaining individuals' subject choices at age 14', Oxford Rev. Educ., 2018.
1.76 EngineeringUK. 'Social mobility in engineering', 2018.

A recent study has shown that the school a young person attends can have a greater influence on ethnicity.[1.77] The socioeconomic composition 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 choices. 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.[1.78]

Peer effects

Sociological research suggests that people tend to form close ties with others who are – or who are perceived to be – socially 'similar' to themselves. One 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.[1.79]

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 environments with a large proportion of high-achieving peers and vice versa,[1.80] decisions relating to academic versus vocational pathways are influenced by the preferences of friends,[1.81] and decisions to continue in post-compulsory education are shaped in part by group behaviours.[1.82]

A recent study in Sweden looked at how peer effects can widen the gender gap in STEM. The study found that the role of peers in shaping young people's decisions is especially important during adolescent years. Peer socialisation can have long-lasting effects on attitudes, norms and values, and this can be influential when making career choices. They point out that since the majority of friendships are same sex (87% to 90%), young people are mostly influenced by their same-sex peers. Girls' interest in STEM is reinforced when other girls in their classroom also have an affinity for STEM. Conversely, this suggests that any pre-existing negative perceptions of STEM among girls can also amplify the gender gap.[1.83]

Interestingly, young people themselves don't tend to report their friends as being particularly influential in their decision-making processes, suggesting that this peer effect may be unconsciously felt. In a nationally representative survey of young people in year 9 in England, for example, they reported their friends as being low on a list of influencing factors for their year 10 subject choices:

Figure 1.22 Influences on the year 10 subject choices of 13 and 14 year olds (2004) – England

Influences	Young people agreeing or strongly agreeing with the statement (%)
I chose these subjects because I only wanted to do subjects I'm interested in	91.3%
I chose these subjects because I will need passes in them for the job/career I want after leaving school	85.0%
I chose these subjects because I will need passes in them for the courses I want to do after year 11	82.1%
I only want to do subjects that I know I will do well at in exams	80.0%
I chose these subjects because I like the teachers who teach these subjects in year 10	25.1%
I chose these subjects because I wanted to do the same subjects as my friends	10.9%

Source: CLS. 'Next Steps (LSYPE1), wave 1' data, 2004.

1.4 – Government strategies to plug the skills gap

It is widely recognised that more must be done to engage and inspire young people to pursue STEM education in order to address the continuing skills gap in engineering. Government, employers, the education sector and the wider engineering community have devoted significant efforts and resources to address the issue in recent years.[1.84]

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-skilled 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.[1.85]

A House of Commons report in 2018, 'Delivering STEM Skills for the Economy',[1.86] 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, 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

1.77 Anders, J. et al. 'The role of schools in explaining individuals' subject choices at age 14', Oxford Rev. Educ., 2018.
1.78 Ibid.
1.79 Raabe, I. J. et al. 'The Social Pipeline: How Friend Influence and Peer Exposure Widen the STEM Gender Gap', Sociol. Educ., 2019.
1.80 Anders, J. et al. 'The role of schools in explaining individuals' subject choices at age 14', Oxford Rev. Educ., 2018.
1.81 CVER. 'Peer Effects and Social Influence in Post-16 Educational Choice', 2017.
1.82 DfE. 'Subject and course choices at ages 14 and 16 amongst young people in England', 2011.
1.83 Raabe, I. J. et al. 'The Social Pipeline: How Friend Influence and Peer Exposure Widen the STEM Gender Gap', Sociol. Educ., 2019.
1.84 IET. 'Studying Stem: what are the barriers?', 2008.
1.85 BEIS. 'Industrial Strategy: building a Britain fit for the future', 2017.
1.86 House of Commons, Committee of Public Accounts. 'Delivering STEM skills for the economy Forty-Seventh Report of Session 2017-19 Report, together with formal minutes relating to the report', 2018.

expand STEM education. Separately, the Department for Business, Energy & Industrial Strategy (BEIS) is tasked with developing insights into business needs and encouraging 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 educational pathways.

Chapter 3 contains more information on the efforts that have been made by government to advance the aims of the industrial strategy since 2017, with a particular focus on increased funding and support for STEM pathways within the further education sector.

Careers strategy

The government's careers strategy[1.87] for England came into effect in 2017, in recognition of the long-standing issue of inadequate careers provision across the country, with a particular focus on increasing young people's engagement with STEM education. The aim is that the careers strategy should complement the UK's industrial strategy by promoting high-quality technical education and improving knowledge of where different qualifications can 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.

Under the careers strategy, the Careers & Enterprise Company (CEC) was given greater responsibility to provide additional support for schools and colleges in England to improve their careers provision, including assistance and guidance 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 2019 'State of the Nation' report[1.88] shows that careers 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 holding schools to account, 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.[1.89]

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 opportunity to study STEM in order to address the underrepresentation of particular groups.[1.90] 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',[1.91] Northern Ireland's STEM strategy published in 2011, sets out a vision of how to increase and enhance skills up to 2020. 'Further Education Means Success: The Northern Ireland Strategy for Further Education' was launched in 2016 to help implement Northern Ireland's STEM strategy and the innovation strategy.[1.92]

Wales' 'Skills implementation plan – Delivering the policy statement on skills'[1.93] aimed to boost competitiveness and help Wales move towards becoming a highly skilled society that can tackle poverty and be sustainable in the face of ever scarcer resources. Its delivery plan, 'Science, Technology, Engineering and Mathematics (STEM) in education and training', puts STEM at the heart of this ambition.[1.94]

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 developing explosive demonstrations to one-on-one mentoring and everything 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 Dalmarnock Primary in Glasgow, said that YSLP has 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 complete 4 digital badges – Discover, Create, Inspire and Lead – to gain their award. These are mapped to Curriculum for Excellence levels 2, 3 and 4. In the 'formal' version (YSL 4, 5 and 6), young people gain a formal Scottish Credit and Qualifications Framework (SCQF) level 4, 5 or 6 award, credit rated by the Scottish Qualifications Authority (SQA). Within their delivering centre, young people are supported and assessed by trained tutor assessors.

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 the programme progresses towards 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.

1.87 DfE. 'Careers strategy: making the most of everyone's skills and talents', 2017.
1.88 CEC. 'State of the Nation 2019: Careers and enterprise provision in England's secondary schools and colleges', 2019.
1.89 These figures pertain to schools and colleges that took part in CEC's Compass self-assessment tool on more than one occasion over the period in question – that is, those who can contribute to analyses of change over time (N=2,880).
1.90 Scottish Government. 'STEM Education and Training Strategy for Scotland - First Annual Report', 2019.
1.91 DEL and DfE. 'Success through STEM: STEM Strategy', 2011.
1.92 DELNI. 'Further Education Means Success: The Northern Ireland Strategy for Further Education', 2016.
1.93 Welsh Government. 'Skills implementation plan', 2014.
1.94 Welsh Government. 'Science, Technology, Engineering and Mathematics (STEM) in education and training', 2016.

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, Crossrail, Siemens were also involved.

The campaign is considered to have been a huge success, reaching over 1 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 36%.[1.95] Its legacy has continued with the 'Engineering: 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[1.96] – 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.

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

		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.
Age 7–11	Male	33.8%	18.5%	38.0%	30.4%	31.6%	17.2%	19.3%	310
	Female	37.1%	16.3%	35.0%	31.3%	26.8%	15.1%	24.6%	303
	Overall	35.4%	17.4%	36.5%	30.8%	29.2%	16.2%	21.9%	613
Age 11–14	Male	32.9%	20.7%	40.7%	32.8%	34.7%	17.3%	19.5%	353
	Female	30.9%	12.5%	30.2%	25.7%	28.8%	13.8%	29.8%	351
	Overall	31.9%	16.7%	35.7%	29.4%	31.9%	15.6%	24.5%	704

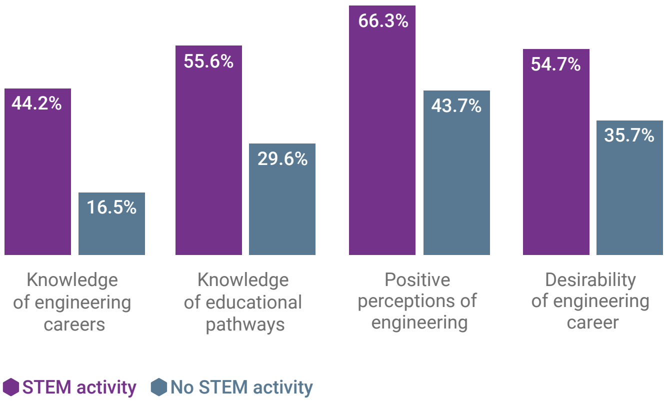
Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
Q: Do you do any of the following science related activities outside of school?

1.95 IMechE. 'Feature: Did the 2018 Year of Engineering Succeed?' [online], accessed 30/03/2020.
1.96 RaEng. 'The UK STEM Education Landscape', 2016.

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 enrichment experiences,[1.97] others have made the point that their influence will vary according to the characteristics of each activity.[1.98] 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.

Figure 1.24 Knowledge of engineering careers and educational pathways, perceptions of engineering and desirability of engineering as a career among young people by STEM engagement (2019) – UK



Source: EngineeringUK. 'Engineering Brand Monitor' data, 2019.
STEM activity includes young people who have attended a STEM engagement activity in the last 12 months.
Q: 'How much do you know about what people working in engineering do?' Percentages represent the proportions 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 with the following statement: I know what to do next in order to become an engineer.' Percentages represent the proportions reporting '4 – agree a little' or '5 – agree a lot' on a 5-point Likert scale with 1 representing 'disagree a lot' and 5 representing 'agree a lot'.
Q: 'How positive or negative is your view on engineering?' Percentages represent the proportions reporting '4 - quite positive' or '5 - very positive' on a 5-point Likert scale, with 1 representing 'very negative' and 5 representing 'very positive'.
Q: 'How desirable do you believe a career in engineering to be?' Percentages represent the proportions reporting '4 – quite desirable' or '5 – very desirable' on a 5-point Likert scale, with 1 representing 'not at all desirable' and 5 representing 'very desirable'.

This is Engineering is an initiative that showcases real-world case studies and experiences of engineering to young people.

Initiatives to promote greater coordination and impact

Increased opportunities for young people to experience STEM engagement actvities are promising, but this also brings about a need for greater coordination across the sector. Not only should activities be demonstrably impactful for participants, in particular if they come at a cost, but they should also be complementary such that they build upon each other. They should also be easily identifiable and accessible by teachers, parents and young people.

These needs have driven initiatives such as the Inspiring Engineers Code of Practice, led by the Department for Education in partnership with Shell, and Neon, a digital platform that allows teachers to easily access engineering experiences.

Neon is being developed by EngineeringUK and supported by the engineering community. Teachers using the platform will be required to sign up to 4 pledges:

- Ensure programmes contribute to a sustained and rich STEM journey for all young people.
- Ensure all young people have opportunities to engage in engineering-inspiration activities, so that nobody is left behind.
- Promote a positive, compelling and authentic view of engineering, which showcases the breadth of opportunities.
- Improve monitoring and evaluation to develop a shared understanding of what works.

Neon, being developed by EngineeringUK and supported by the engineering community, will support providers of engineering experiences in achieving their pledges by giving them the opportunity to feature their activities on a searchable platform for teachers. To feature on the platform, providers are required to meet a set of quality standards, which include a commitment to evaluation and learning to drive up quality, and alignment with at least 2 of the Gatsby benchmarks.

'This is Engineering', led by the Royal Academy of Engineering in collaboration with EngineeringUK, is an initiative that showcases real-world case studies and experiences of engineering to young people. It highlights the importance and breath of engineering careers and demonstrates that engineering has something to offer everyone. Founding principal partners include BAE Systems and National Grid, and major partners include Facebook.

1.97 Banerjee, P. A. 'Is informal education the answer to increasing and widening participation in STEM education?', Rev. Educ., 2017.
1.98 Vennix, J. et al. 'Do outreach activities in secondary STEM education motivate students and improve their attitudes towards STEM?', Int. J. Sci. Educ., 2018.

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.[1.99]

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.[1.100] 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.[1.101]

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 Exchange[1.102] exist to help connect teachers and young people with employers who are offering work experience opportunities. Others, such as Education and Employers,[1.103] 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.

1.99 Education and Employers. 'It's who you meet: Why employer contacts at school make a difference to the employment prospects of young adults', 2012.
1.100 EngineeringUK. 'Skills Partnership - EngineeringUK - Inspiring tomorrow's engineers' [online], accessed 20/03/2020.
1.101 CBI and CEC. 'How To Support Careers and Enterprise Activities in Schools: a Practical Guide for Employers', 2017.
1.102 The STEM Exchange. 'The STEM Exchange - Home' [online], accessed 20/03/2020.
1.103 Education and Employers. 'About – Education and Employers' [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.

We can't just tell young people engineering is for them, we need to show them

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.

This isn't the case across all STEM careers – many more girls wanted to become doctors or vets, for example. So, this isn't just a case of boys preferring science or maths. It's something about how young people view these careers themselves and what they imagine an 'engineer' or 'scientist' to look like.

Social inequalities as well as gender inequalities

It's not just gender stereotypes that influence career and study choices. How STEM is represented through education, media and everyday life influences young people's aspirations.

Young people's families and social connections, their perception of science and their socioeconomic backgrounds all have an impact. Research from the ASPIRES 2 programme shows that high-achieving, middle class pupils with high levels of 'family science capital' were much more likely to aspire to a career in science and to feel 'science-y'.

So, it's not enough to just make young people aware of the opportunities available to them in engineering. We need to show young people what a career in engineering looks like, show them that 'people like them' become engineers and inspire them to follow the path.

You can't be what you can't see

Careers education is important for all young people and all sectors. But because of these deep roots, it's particularly important when it comes to careers in STEM.

It's crucial for us to ensure that young people from all backgrounds are exposed to inspiring role models. They should be given the chance to directly interact with professionals from the sector. As the saying goes, you can't be what you can't see. For those young people who might not consider a career in engineering to be for 'people like them' – whether because of their gender, class or ethnicity – an experience with an inspiring role model from engineering could be a life changing moment.

Fortunately, 'employer engagement' is at the centre of the Government's careers strategy, which is now shaping how schools, colleges and employers prepare and inspire young people for the world of work.

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.

Careers education is no longer about box-ticking

Gone are the days when careers education was a box-ticking exercise – a one-off work experience placement and a solitary careers guidance interview before leaving school. Often these interventions took place too late – after stereotypes had been ingrained in young people's minds and they had made subject choices that would exclude them from a STEM career.

THE CAREERS & ENTERPRISE COMPANY

Aimee Higgins
Director of Employers and Partnerships,
The Careers & Enterprise Company

4x

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

Half a million more young people are meeting employers every year compared with 2 years ago.

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.

This provides a wealth of opportunities for employers and engineers to engage in a young person's journey – whether it's through providing careers talks, acting as a mentor, taking part in things like robot or computing clubs (Gatsby benchmark 5) and hosting young people at their workplace, with site tours and offer them the opportunity to ask questions (Gatsby benchmark 6).

Another key opportunity is to work with local teachers to help them co-deliver curriculum lessons (Gatsby benchmark 4). We're supporting schools to do that through a STEM toolkit for teachers, which links the science and maths curriculum to careers. Bringing curriculum content to life with workplace examples helps young people understand how their learning has real world application and helps inspire them to consider a career in engineering.

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 Careers & Enterprise Company's Enterprise Adviser Network was set up to bring together employers, schools and colleges across England and is ready to help connect employers with local schools and colleges.

The ambition in the careers strategy is to give every young person at least one employer engagement opportunity in every year of secondary school and college. That means we need 4 million encounters every year.

We've made huge progress recently – half a million more young people are meeting employers every year compared with 2 years ago. But there is still a long way to go to ensure that every young person has equal access to these opportunities.

A positive outlook

These changes can't happen overnight. And no one should underestimate the challenge of ensuring we produce enough highly skilled young people to meet the growing demands of our economy. But there are clearly reasons be positive.

A study last year from CBI showed that 51% of businesses are confident about the future availability of high-skilled workers. This was up from less than a third of businesses over the preceding 3 years. While challenges remain, we're confident that schools, colleges and employers are taking the right steps to help young people into careers like engineering.

The more interactions young people have with employers while they are at school, the better their employability and earning prospects.

2 - Secondary education

Design and technology GCSE entries decreased by 21.7% in 2018/19, continuing a trend of long-term decline.

Only 17.5% of engineering teachers and 36.0% of computer science teachers have a relevant post-A level qualification.

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 UK engineering sector depends on both high levels of participation and attainment in these qualifications.

At this stage of the educational pathway into engineering, however, the sector faces a number of challenges, including: a lack of presence of engineering on the curriculum; the underrepresentation of girls in key STEM subjects; a decline in exam entries for some subjects that facilitate engineering; and a critical shortage in STEM teachers.

Qualification reforms and performance measures

The government's GCSE and A level reform process reached its final stage 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 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.

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 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 4.8% respectively in 2019. At the same time, entries for engineering and design and technology (non-EBacc STEM subjects) fell by 31.1% and 21.7% respectively.

STEM subjects make up 4 of the top 10 most popular A level subjects. There were increases in entries of 8% to 9% for biology, chemistry and computing, with a more modest increase for physics (up 3.0%). The pass rate for A level maths has dropped by 5.2 percentage points, which may be due to the introduction of the new harder maths curriculum.

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 in 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 school 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 in 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 Highers qualifications. A to C pass rates in all STEM subjects at Higher level, except for administration 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 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 engineering 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 retention, recruitment 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 education 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 economic prosperity 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 on 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 total GCSE entries across all 3 nations.[2.1] 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: here, 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 young people aged 14 to 16 say that they "know what they need to do next in order to become an engineer".[2.2] Young people are opting out of STEM GCSEs and A levels unaware that they are closing doors to engineering higher education and training, and doing so long before they have a good understanding of the opportunities a career in engineering could 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 paradoxically, relatively few decide to study elective STEM subjects at GCSE (particularly engineering and computing).

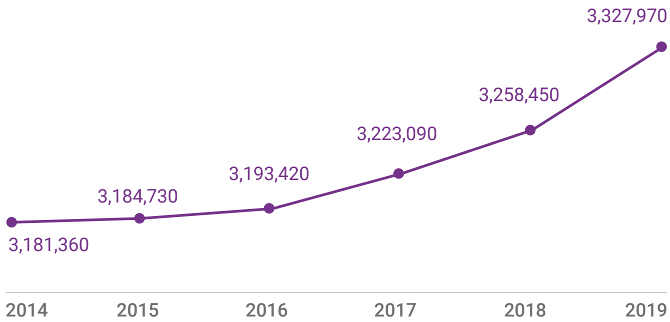
The gender gap widens still further at A level – which is surprising given girls' higher attainment in STEM GCSEs – with a particularly large drop off in the number of girls studying core STEM subjects.

It's crucial that the engineering sector works with government and the secondary education sector to advocate the importance of STEM education in secondary schools. Providing young people in the UK with a comprehensive and inspiring STEM secondary education that is accessible to all students, with high participation 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 shows 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]

Figure 2.1 State funded secondary school population over time (2014 to 2019) – England



Source: DfE. 'Schools, pupils and their characteristics: January 2019' data, 2019.

As a consequence of this population boom, the average state-funded secondary school now has 965 pupils on its roll, up from 948 in 2018.[2.4] 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.[2.5] There has also been a 258% rise in the number of secondary school pupils in 'supersized' classes of 36 or more, from 6,107 in 2010 to 21,843 in 2019.[2.6]

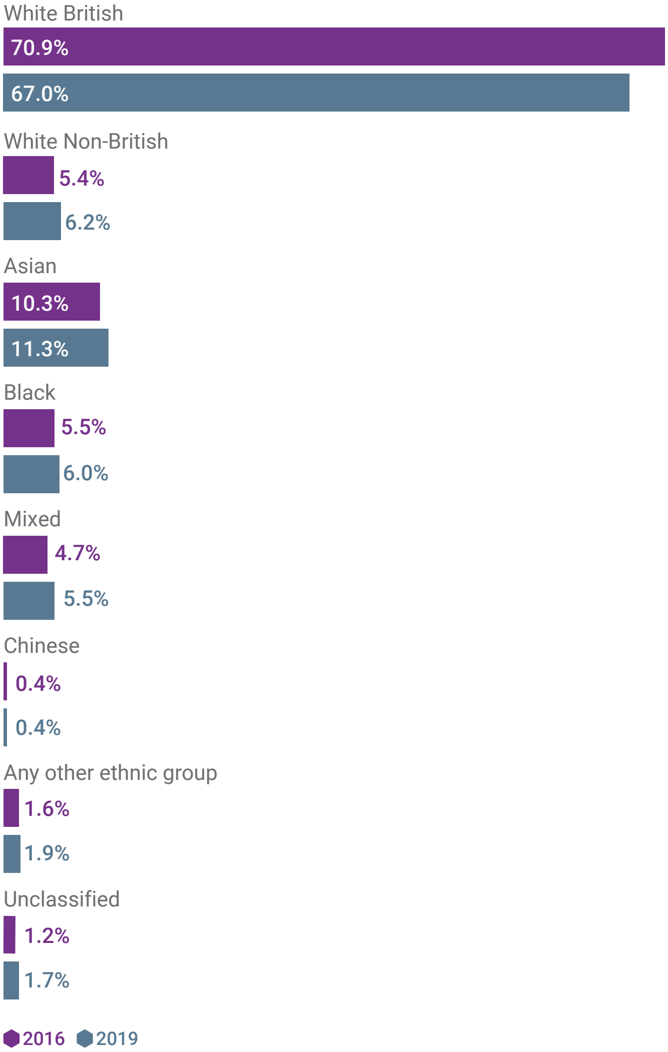
The increase in class sizes can be linked to severe funding pressures faced by the state education sector, which has meant that schools can afford to hire fewer staff.[2.7] The budgetary cuts disproportionately affect schools in the most disadvantaged areas, with real-term cuts being three times deeper for schools educating the poorest pupils compared with schools in the wealthiest areas.[2.8] The government has pledged an additional £7 billion to be spent on state and special schools between 2020 and 2023. However, for 1 in 3 schools this will mean only a 1.8% increase in funding, which still amounts to a real-world cut after inflation.[2.9] Many schools

2.1 JCQ. 'GCSE (Full Course) Results Summer 2019', 2019.
2.2 EngineeringUK. 'Engineering Brand Monitor 2019', 2020.
2.3 DfE. 'Schools, pupils and their characteristics: January 2019', 2019.
2.4 Ibid.
2.5 Ibid.
2.6 NEU. 'Class sizes' [online], accessed 24/03/20.
2.7 The Guardian. 'School funding crisis is blamed for surge in supersized classes - Education' [online], accessed 24/03/20.
2.8 The Guardian. 'Schools in deprived areas face further cuts next year, unions say - Education' [online], accessed 24/03/20.
2.9 Ibid.

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



Source: DfE. 'Schools, pupils and their characteristics' data, 2016 and 2019.

More pupils than ever are eligible for and claiming free school meals (FSM), reaching 14.1% in 2019.[2.10] 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 13.7% and 15.2% 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%.

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. 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 18/19 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.

Source: EngineeringUK. 'Engineering UK 2018: The State of Engineering', 2018.

2.2 – The secondary education landscape in England

The coalition government of 2010 to 2015 undertook the largest reform to secondary education qualifications in a generation. The central aims of the reforms were to raise educational standards through harder content and more rigorous assessment. Teaching of reformed subjects began in 2015, with the first cohort of students sitting the new exams in the academic years 2016 to 2017 and 2017 to 2018, and 2019 marking the final stages of the reform process. The majority of those pupils who took the first reformed GCSEs are now in higher education, training or employment.

2.10 DfE. 'Schools, pupils and their characteristics: January 2019', 2019.

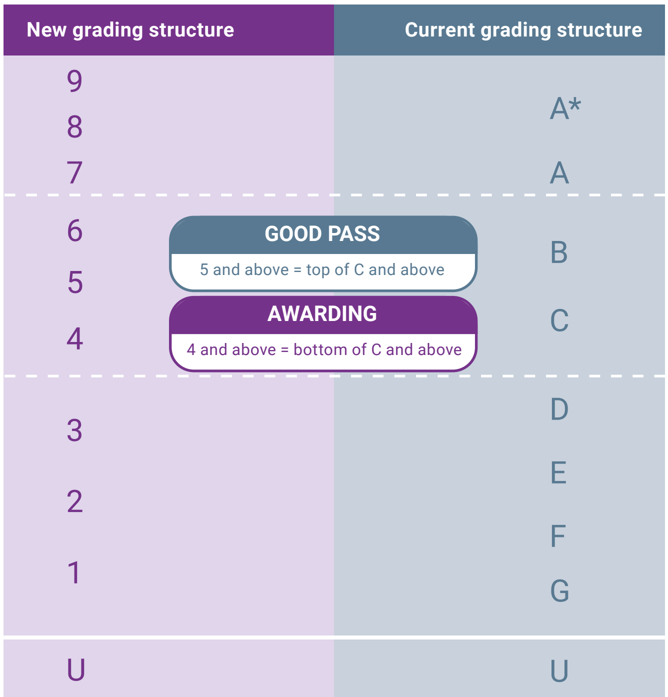
GCSE reforms

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 final 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, statistics, science and modern foreign languages (see STEM subject tiering on page **40**)

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



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

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 regulatory bodies, 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.

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 has 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

GSCE and A level courses are also structured differently. England has removed unitised qualifications and has moved to a linear structure with all assessments taken at the end of each course. In contrast, Wales and Northern Ireland have kept the unitised structure for some subjects, with assessments taken at the end of a unit rather than at the end of the course.

There are differences in the rules for resitting exams as well. In England, students are required to resit all exams for that subject when retaking the qualification, whereas in Wales and Northern Ireland there are options to retake individual units, depending on the subject.

The relationship between AS and A levels also differs. In England, AS levels are standalone qualifications and do not contribute to A level grades, so students don't have to take an AS qualification to enter for the corresponding A level. In Wales and Northern Ireland, students have to take both because an AS qualification contributes 40% of the marks for the full A level.[2.11]

It is important that colleges, universities and engineering employers are aware of the national differences in qualifications. The risk of misinterpreting exam results increases with the added complexity in qualifications, which could act as a barrier to talented young people entering engineering education, training and employment.

2.11 Ofqual. 'Statement from the qualification regulators on changes to GCSEs, AS and A levels', 2019.

Changes to GCSE science options

Prior to the GCSE reforms there were three main GCSE science routes that students could take:

- core science (one GCSE) which included one module in each of biology, chemistry and physics and aimed to provide students with a good basic knowledge across the sciences, suitable for students of all abilities
- double/combined science (2 GCSEs), the most common option which included 2 modules in each of biology, chemistry and physics to allow students to further their understanding of the living, material and physical worlds
- separate/triple science (3 GCSEs) with 3 modules in each of biology, chemistry and physics, which provided in-depth study and was intended for high ability students with a keen interest in science

Following GCSE reforms, the one GCSE core science option was phased out in most of the UK, with only Northern Irish pupils sitting core science exams in the 2018 to 2019 academic year.

There are now 2 main routes to science GCSEs,[2.12] which are:

- combined science (2 GCSEs) which requires students to sit 6 exams at the end of the course – 2 in each of biology, chemistry and physics – and results in students receiving 2 identical or adjacent grades based on overall performance across all papers
- separate sciences (one to 3 GCSEs) which requires students to sit 6 longer exams covering content from the combined science course plus additional content in each subject and results in students receiving a separate grade in each subject

Assessments in both routes have a mix of question types including multiple choice, short answer and extended answer questions. Throughout the course, students will take part in 8 practicals per science subject (or 16 in total for combined science) during lesson time, which cover the use of a range of apparatus and scientific techniques. Exam questions relating to these practicals account for 15% of overall final marks.

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 837 students who took 7 or more GCSEs achieved grade 9 in all of them, 66% of whom were girls.[2.13]

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.[2.14]

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, 8% of universities and 6% of head teachers incorrectly thought that 1 was the top GCSE grade.[2.15] 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.[2.16] 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.

2.12 Edexcel. 'GCSE (9-1) Sciences 2016 - Parent guide', 2016.
2.13 Ofqual. 'Guide to GCSE results for England', 2019.
2.14 FFT Education Datalab. 'The effect of GCSE reforms: Have they widened the disadvantage gap?', 2019.
2.15 YouGov. 'Perceptions of A levels, GCSEs and other qualifications in England – Wave 16', 2018.
2.16 The Sutton Trust. 'Making the Grade', 2019.

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% believe that student engagement in education has declined as a result of the reforms.[2.17] 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.[2.18]

The increase in the amount of content in the curriculum and level of difficulty has also 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.[2.19] There are also concerns that more content leads to rote learning and reduces scope for creativity and enjoyment of the subject.[2.20]

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.[2.22] In 2018 to 2019, more STEM subjects were added to the list of those already reformed, including design and technology, further maths, environmental science and electronics. The aim of the A level reforms was to reduce grade inflation and make the curriculum 'fit for purpose' in order to prepare students more adequately for degree level study and the world of work.

The reforms to AS and A levels mean that in England:

- assessments are now almost entirely exam based, with non-exam assessment types, such as coursework, only used when needed to test essential skills. In science A levels, students must pass a practical element, but the mark does not contribute to their final grade.
- previous modular courses have been 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 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 the same grade in one tier than 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 were awarded 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.[2.21] Schools with large numbers of exceptions made for higher tier grade 3s 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 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 more difficult during times of reform.[2.23]

2.17 NEU. 'Reformed GCSEs are damaging the mental health of young people, and failing to accurately reflect their abilities', 2019.
2.18 Schools Week. 'GCSE reforms led to more mock exams, report warns' [online], accessed 24/03/20.
2.19 NEU. 'Changes to GCSEs and A-levels are damaging students' mental health and increasing teachers' workload – NEU poll' [online], accessed 21/04/2020.
2.20 Ofqual. 'GCSE reform in schools: The impact of GCSE reforms on students' preparedness for A level maths and English literature GCSE reform in schools 2', 2019.
2.21 Ofqual. 'GCSE tiering decisions for summer 2019', 2019.
2.22 Ofqual. 'Get the facts: AS and A level reform', 2018.
2.23 JCQ. 'GCE 2019: Notes for users of the JCQ results tables', 2019.

Case study – Changes to A level maths

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

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.[2.24] 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 unitised, 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 unitised 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 science curriculum, with greater focus on programming, algorithms and problem solving. We welcome the inclusion of subject experts in the development of A level content and hope this will provide young people with relevant subject knowledge and skills that prepare them well for entering higher education and training.

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.[2.25] 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 A level is worth 48 points and A grade at AS level is worth 20.[2.26]

The decoupling and effective devaluing of AS levels 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.[2.27] Some universities are in favour of schools continuing to offer AS level qualifications, as they 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

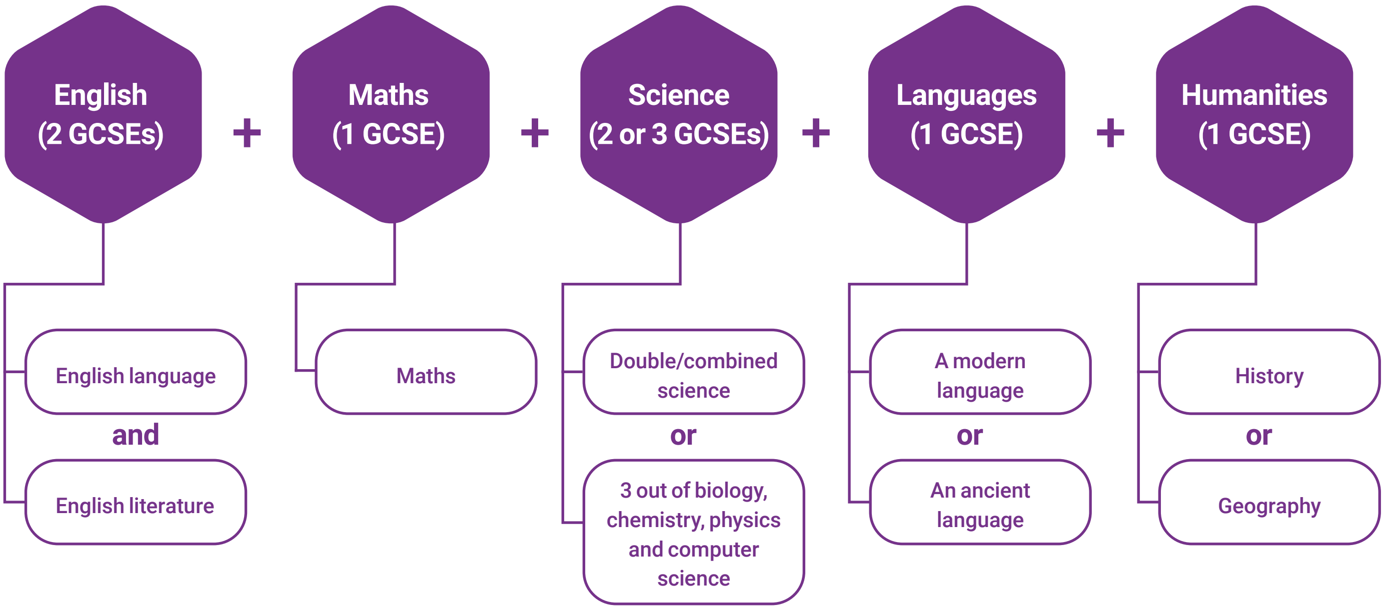
School quality in England is assessed based on a number of performance measures, published in secondary school performance tables.[2.28] The rationale of these performance measures, as provided in the DfE's statement of intent, is to improve educational standards and provide an accessible source of comparative information on pupil progress and attainment.[2.29]

The headline performance measures[2.30] 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

2.24 Ofqual. 'GCE subject-level conditions and requirements for mathematics', 2016.
2.25 The Conversation. 'Why reformed A levels are not preparing undergraduates for university study' [online], accessed 24/03/20.
2.26 Best Schools. 'The A Level Curriculum', 2019.
2.27 FFT Education Datalab. 'A-Level results 2019: The main trends in grades and entries', 2019.
2.28 DfE. 'School and college performance tables', 2019.
2.29 DfE. '2019 School and College Performance Tables: Statement of Intent', 2019.
2.30 DfE. 'Secondary accountability measures: Guide for maintained secondary schools, academies and free schools', 2019.

Figure 2.4 English Baccalaureate subjects



Source: Figure taken from DfE. 'Implementing the English Baccalaureate: Government consultation response', 2017.

Figure 2.5 Progress 8 measure

Source: Figure taken from Ofqual. 'Vocational qualifications, Progress 8 and 'gaming'', 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 of 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.[2.31]

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.[2.32, 2.33] Not only are these subjects being given less teaching time, but in addition subject specialist teachers are not being replaced and budgets are being cut.[2.34] 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 concerns 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.[2.35] 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.[2.36] 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.[2.37] 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.[2.38] It is claimed to be "the most evidence-based, research informed and tested framework in Ofsted's 26-year history".[2.39] The new inspection framework is intended to redirect 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-rolling 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.

2.31 NFER. 'Changing the subject? How EBacc is changing school timetables', 2017.
2.32 Schools Week. 'EBacc concerns: will the curriculum slim down?' [online], accessed 24/03/20.
2.33 Schools Week. 'Engineering and design technology GCSEs flop as EBacc soars' [online], accessed 24/03/20.
2.34 EDSK. 'A Step Baccwards: Analysing the impact of the 'English Baccalaureate' performance measure', 2019.
2.35 The Telegraph. 'Decline of 'Mickey Mouse' GCSEs revealed as entries for Media Studies and Home Economics plummet' [online], accessed 24/03/20.
2.36 DfE. 'Key stage 4 performance, 2019 (revised)', 2020.
2.37 The Education Policy Institute. 'Analysis: The introduction of Progress 8 ', 2017.
2.38 Ofsted. 'Education inspection framework', 2019.
2.39 Ofsted. 'Ofsted launches a consultation on proposals for changes to the education inspection framework', 2019.

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,[2.40] 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).[2.41] 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 applications 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).[2.42]

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%). There were 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.[2.43]

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 31.9% and design and technology by 53.3%. 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.[2.44] 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

Subject	Entries in 2018/19 (No.)	Change over 1 year (%)	Change over 5 years (%)
Biology	177,454	0.6% ▲	25.1% ▲
Chemistry	170,034	1.0% ▲	23.0% ▲
Computing	80,027	7.2% ▲	377.1% ▲
Design and technology	99,659	-21.7% ▼	-53.3% ▼
Engineering	3,424	-31.1% ▼	-31.9% ▼
ICT	9,515	-82.9% ▼	-90.2% ▼
Mathematics	778,858	4.2% ▲	5.8% ▲
Physics	168,330	1.1% ▲	22.7% ▲
Science: double award	839,258	4.8% ▲	–
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 is a new combined science double award GCSE. This replaces the single GCSE awards in science and additional science. The entries will be doubled to reflect the achievement of 2 grades in the subject.
'–' denotes no value available as subject was introduced after 2014 or has been discontinued.
To view this table with numbers from 2012/13 see **Figure 2.6** in our Excel resource.

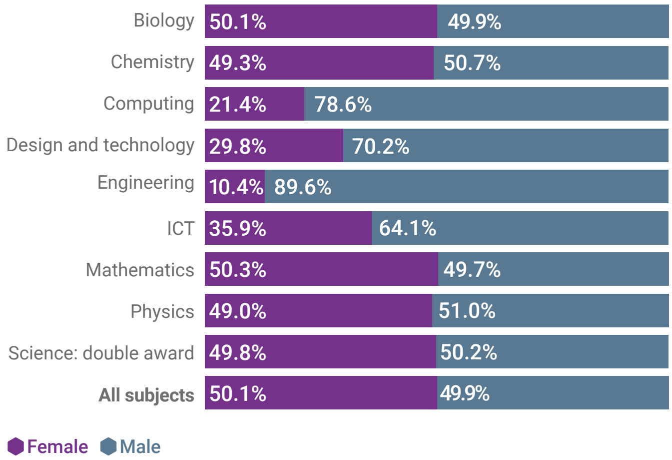
2.40 JCQ. 'GCSE (Full Course) Results, Summer 2019' data, 2019.
2.41 Not all schools offer their students the choice to study triple science. There is some evidence to suggest this differs by levels of social and economic deprivation. **See chapter 1** and EngineeringUK's 'Social mobility in engineering' briefing for further information.
2.42 JCQ. 'GCSE Press Notice UK Summer 2019', 2019.
2.43 FFT Education Datalab. 'GCSE results 2019: The main trends in grades and entries', 2019.
2.44 Schools Week. 'GCSE results: 'Bleak' and 'worrying' drop in non-EBacc subjects [online], accessed 24/03/20.

STEM GCSE entries by gender

There is a clear difference in the proportion of girls taking core and elective STEM subjects at GCSE (**Figure 2.7**). Girls and boys are equally likely to take maths, double science and individual science GCSEs, which is not surprising because all students must take these subjects. However, there is a notable dearth of girls choosing to take GCSEs in engineering, computing, ICT and design and technology.

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% female) and design and technology (29.8% female).

Figure 2.7 GCSE entries in selected STEM subjects by gender (2018/19) – England, Wales and Northern Ireland



Source: JCQ. 'GCSE (Full Course) Results, Summer 2019' data, 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.[2.45]

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".[2.46]

Understanding the reasons why D&T is in decline is necessary if we wish to reverse the trend. In a speech to the Innovate 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.[2.47] 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 equivalence in the league tables to GCSEs, which dramatically changed the subjects students were selecting at GCSE and A level, with D&T GCSE losing out in this realignment. In more recent years, D&T has not been given equal standing to other STEM subjects in performance measures - it is not included in the EBacc and only considered an optional subject in Progress 8. These policy changes put out a clear message that D&T is not as highly valued as other STEM subjects.

Shortage of qualified D&T teachers

A major barrier to high quality D&T education is lack of specialist teachers. In 2018 to 2019, D&T suffered the greatest shortfall in trainee teacher recruitment of all STEM subjects in England, with only 25.6% of the modest target of 1,167 trainee teachers being reached.[2.48] D&T also has a problem with keeping teachers up to date with subject knowledge and expertise. Technological innovation happens at great speed and teachers' knowledge often lags behind. Schools can find it difficult to send teachers on professional development courses to update their skills, especially in times of acute teacher shortages.

Budget pressures

D&T is a particularly expensive subject for schools to provide because of the space, increasingly specialised equipment and raw materials it requires. This means that in times of funding pressures, it is the first subject to have cuts. This may explain the squeezing out of D&T from the curriculum.

A report by the James Dyson Foundation on improving engineering education in schools[2.49] identified further problems facing D&T:

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 D&T

D&T has an image problem as there is lack of a clear understanding of what the subject involves. It isn't considered to be an academically rigorous subjects 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.

2.45 JCQ. 'GCSE (Full Course) Results Summer 2019', 2019.
2.46 The James Dyson Foundation. 'Addressing the skills shortage: A new approach to engineering education in schools', 2019.
2.47 FE News. 'Design and technology students in long-term decline: Where are the designers and innovators of the future going to come from?' [online], accessed 23/04/2020.
2.48 DfE. 'Initial Teacher Training (ITT) Census for the academic year 2018 to 2019, England', 2018.
2.49 The James Dyson Foundation. 'Addressing the skills shortage: A new approach to engineering education in schools', 2019.

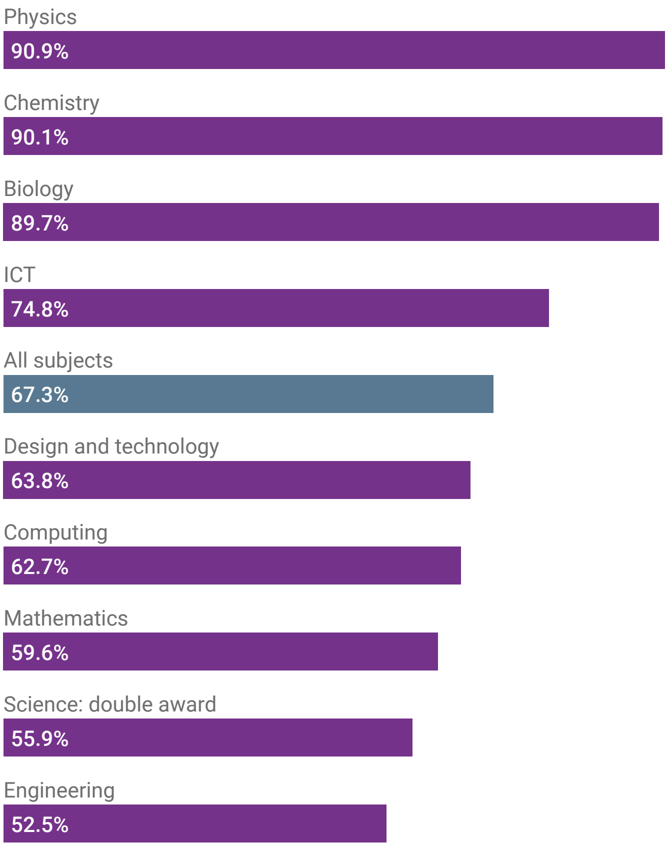
STEM GCSE attainment

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.[2.50] The pass rate across all GCSE subjects currently stands at 67.3% and this has remained stable for the past 5 years.

Physics, chemistry and biology continue to have very high pass rates, at around 90% for each subject (**Figure 2.8**). The pass rate for the combined double science award is much lower at 55.9%, which may be attributed to the practice of streaming by ability and possibly a lower level of interest in science among these pupils.

Most other STEM subjects have lower than average pass rates, at 59.6% for maths, 62.7% for computing, 52.5% for engineering and 63.8% for design and technology.

Figure 2.8 GCSE pass rates in selected STEM subjects (2018/19) – England, Wales and Northern Ireland



Source: JCQ. 'GCSE (Full Course) Results, Summer 2019' data, 2019.
A pass grade is considered as A* to C or 9 to 4.

Despite lower than average pass rates for some STEM subjects, **Figure 2.9** shows that pass rates for all of them increased in 2018 to 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 52.5% 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

Subject	Pass rates in 2018/19 (%)	Change over 1 year (%p)	Change over 5 years (%p)
Biology	89.7%	0.4%p ▲	-0.6%p ▼
Chemistry	90.1%	0.3%p ▲	-0.6%p ▼
Computing	62.7%	1.1%p ▲	-2.8%p ▼
Design and technology	63.8%	2.0%p ▲	2.8%p ▲
Engineering	52.5%	6.5%p ▲	10.9%p ▲
ICT	74.8%	7.7%p ▲	5.3%p ▲
Mathematics	59.6%	0.2%p ▲	-2.8%p ▼
Physics	90.9%	0.2%p ▲	-0.4%p ▼
Science: double award	55.9%	0.6%p ▲	–
All subjects	**67.3%**	**0.4%p ▲**	**-1.5%p ▼**

Source: JCQ. 'GCSE (Full Course) Results, Summer' data, 2014 to 2019.
Included in the academic year 2017 to 2018 is a new combined science double award GCSE. This replaces the single GCSE awards in science and additional science.
A pass grade is considered as A* to C or 9 to 4.
'–' denotes no value available as subject was introduced after 2014
To view this table with pass rates from 2012/13, see **Figure 2.9** in our Excel resource.

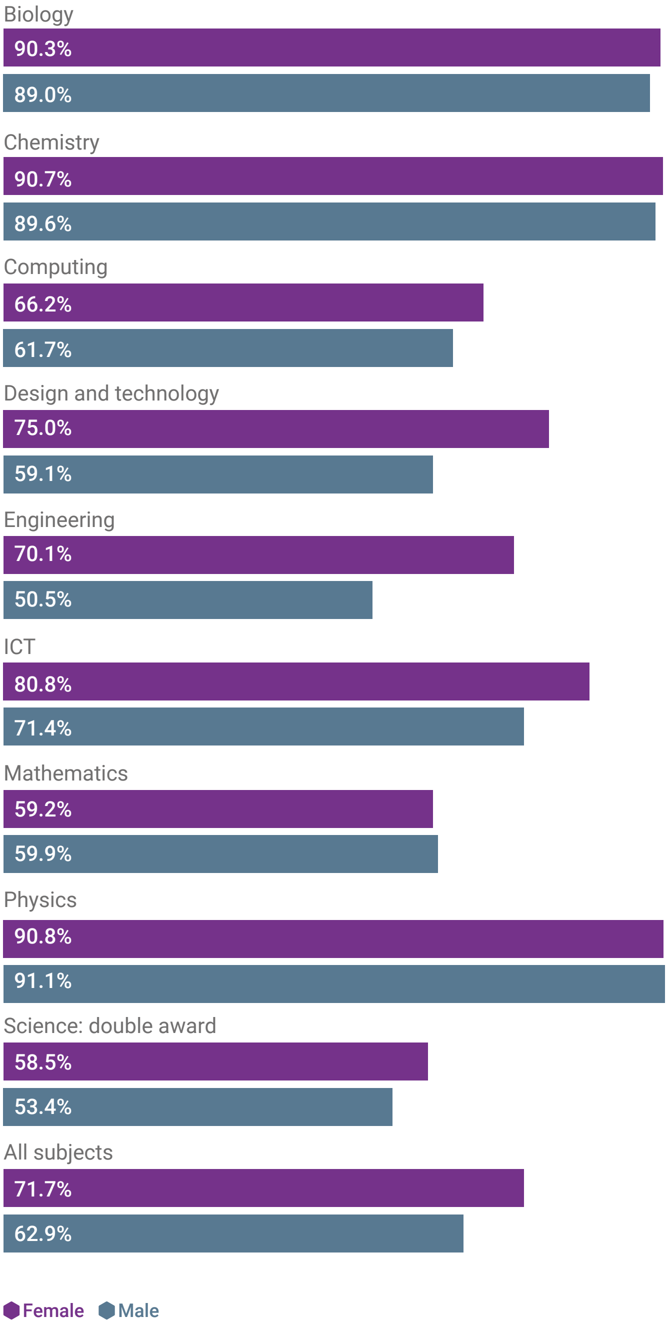
STEM GCSE attainment by gender

Girls outperform boys in almost all GCSE STEM subjects in terms of pass rates at A* to C or 9 to 4 (**Figure 2.10**). 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, in engineering the pass rate was 70.1% for girls compared with just 50.5% for boys, a difference of 19.6 percentage points. However, here we need to take account of the small sample sizes – only 355 (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.

2.50 JCQ. 'GCE A Level & GCE AS Level Results Summer 2019', 2019.

Figure 2.10 GCSE pass rates in selected STEM subjects by gender (2018/19) – England, Wales and Northern Ireland



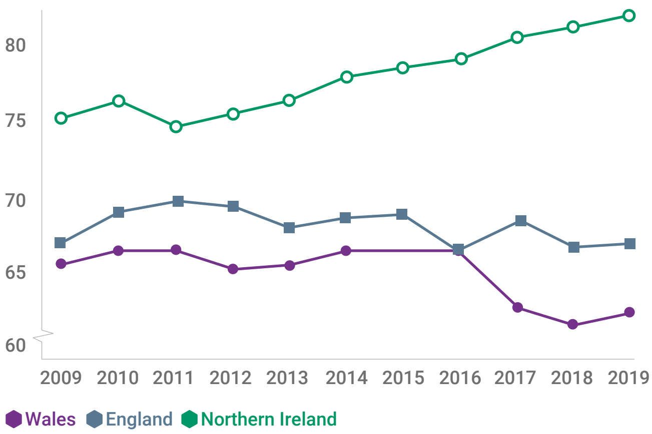
Source: JCQ. 'GCSE (Full Course) Results, Summer 2019' data, 2019.
A pass grade is considered as A* to C or 9 to 4.

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 (**Figure 2.11**). Of the three nations, Northern Ireland has by far the highest average pass rate at 82.2% compared with England (67.1%) and Wales (62.8%). However, GCSE attainment in these countries is no longer reliably comparable, due to the increased devolution of secondary education policy. Nevertheless, the apparent variation in attainment in England, Wales and Northern Ireland is worrying and has been linked to teacher training and education standards.[2.51]

Since 2015 to 2016, pass rates in Wales have seen a decline, although there was a slight increase of 1.2 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.

Figure 2.11 GCSE pass rates by nation over time (2008/09 to 2018/19) – England, Wales and Northern Ireland



Source: Figure taken from BBC News. 'GCSEs: A* to C pass rate increases after dip in 2018', 2019.
A pass grade is considered as A* to C or 9 to 4.

Within England, the difference between the regions with the highest and lowest pass rates is 6.8 percentage points.[2.52] 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 63.8% for both regions.

There is substantial regional variation in pass rates for GCSE STEM subjects.[2.53] For maths, the difference between the counties with the highest and lowest pass rates was 26.5 percentage points in 2018 to 2019. The counties with the highest pass rates were Rutland (80.3%), Dorset (70.1%) and Surrey (70.0%). The counties with the lowest pass rates were West Midlands (51.3%), West Yorkshire (52.5%) and Merseyside (53.8%).

In physics, there was a smaller gap between the counties with the highest and lowest pass rates, at 12.4 percentage points.[2.54] The top performing counties were Hampshire (94.9%), Bristol (94.7%) and Greater London (94.7%), while the bottom performing counties were Suffolk (82.5%), Staffordshire (83.2%) and Lincolnshire (84.7%).

2.51 BBC. 'Further drop in GCSE A* to C passes in Wales' [online], accessed 24/03/20.
2.52 JCQ. 'GCSE Additional Charts Summer 2019', 2019.
2.53 Ofqual. 'Map of GCSE (9 to 1) grade outcomes by county in England' [online], accessed 21/04/2020.
2.54 Ibid.

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.[2.55]

Figure 2.12 Changes in GCSE pass rates over time by nation and region (2013/14 to 2018/19) – England, Wales and Northern Ireland

Nation/region	Pass rates in 2018/19 (%)	Change over 1 year (%p)	Change over 5 years (%p)
England	67.1%	0.5%p ▲	-1.5%p ▼
North East	63.8%	-0.7%p ▼	-1.9%p ▼
North West	64.9%	0.3%p ▲	-3.4%p ▼
Yorkshire and the Humber	64.1%	0.6%p ▲	-0.8%p ▼
West Midlands	63.8%	0.7%p ▲	-2.9%p ▼
East Midlands	65.8%	0.7%p ▲	0.1%p ▲
Eastern	67.1%	-0.1%p ▼	-1.7%p ▼
South West	68.3%	0.5%p ▲	-0.7%p ▼
South East	70.2%	0.6%p ▲	-0.7%p ▼
London	70.6%	0.3%p ▲	-1.1%p ▼
Wales	62.8%	1.2%p ▲	-3.8%p ▼
Northern Ireland	82.2%	1.1%p ▲	4.2%p ▲
All nations	**67.3%**	**0.4%p ▲**	**-1.5%p ▼**

Source: JCQ. 'Entry trends, gender and regional charts GCSE' data, 2014 to 2019.
A pass grade is considered as A* to C or 9 to 4.
To view this table with pass rates from 2012/13, see Figure 2.12 in our Excel resource.

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 Figure 2.13, 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 entries for computing science (down 17.2%), administration and IT (down 13.1%) and design and manufacture (down 13.3%): 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%).

Figure 2.13 Changes in National 5 entries over time in selected STEM subjects (2014/15 to 2018/19) – Scotland

Subject	Entries in 2018/19 (No.)	Change over 1 year (%)	Change over 4 years (%)
Administration and IT	4,885	2.5% ▲	-13.1% ▼
Applications of mathematics	4,458	79.6% ▲	–
Biology	21,549	3.0% ▲	-0.4% ▼
Chemistry	16,035	0.7% ▲	-3.7% ▼
Computing science	6,344	-1.5% ▼	-17.2% ▼
Design and manufacture	4,481	-2.6% ▼	-13.3% ▼
Engineering science	1,646	-9.0% ▼	-9.0% ▼
Fashion and textile technology	382	-14.0% ▼	-19.6% ▼
Health and food technology	1,461	-0.9% ▼	-25.6% ▼
Mathematics	41,586	0.0%p ▬	14.0% ▲
Music technology	1,110	25.7% ▲	122.9% ▲
Physics	13,792	0.7% ▲	-7.7% ▼
Practical electronics	209	16.8% ▲	67.2% ▲
Practical metalworking	1,267	0.6% ▲	35.7% ▲
Practical woodworking	5,298	11.6% ▲	23.8% ▲
All subjects	**288,552**	**2.4% ▲**	**0.2% ▲**

Source: SQA. 'Attainment Statistics' data, 2015 to 2019.
'–' denotes no value available as subject was added in later years.
To view this table with entries from 2014/15, see Figure 2.13 in our Excel resource.

2.55 Institute for Public Policy Research. 'Northern schools putting education at the heart of the northern powerhouse', 2016.

STEM National 5 attainment

Figure 2.14 shows that the proportion of students achieving grades A to C in their National 5 qualifications in the 2018 to 2019 academic year was broadly stable, with a small increase of 0.7 percentage points from 77.4% in 2017 to 2018 to 78.2% in 2018 to 2019.

Of the core science subjects, chemistry has the highest pass rate at 76.9%, followed by physics at 74.6% and biology at 70.5%. Maths has a much lower pass rate at 65.5%. Pass rates in these subjects remained largely stable from the 2017 to 2018 academic year, with the exception of biology which saw a decrease of 2.4 percentage points.

Other STEM subjects saw large year-on-year increases in pass rates. For example, pass rates in practical electronics increased by 16.2 percentage points in the academic year 2018 to 2019 to reach 86.6%. Similarly, pass rates in design and manufacture increased by 13.8 percentage points to reach 70.4% and pass rates in engineering science rose by 6.0 percentage points to 83.8%.

Nevertheless, the general trend in pass rates in STEM subjects over the last 4 years is one of decline. For example, pass rates in computer science have dropped by 8.8 percentage points and music technology by 9.0 percentage points. There have been large decreases for fashion and textiles technology (down 39.4 percentage points), design and manufacture (down 15.2 percentage points) and practical metalworking (down 11.3 percentage points).

Figure 2.14 Changes in National 5 pass rates over time in selected STEM subjects (2014/15 to 2018/19) – Scotland

Subject	Pass rates in 2018/19 (%)	Change over 1 year (%p)	Change over 4 years (%p)
Administration and IT	78.7%	-1.3%p ▼	0.3%p ▲
Biology	70.5%	-2.4%p ▼	-0.2%p ▼
Chemistry	76.9%	-0.3%p ▼	4.4%p ▲
Computing science	74.7%	0.0%p ▬	-8.8%p ▼
Design and manufacture	70.4%	13.8%p ▲	-15.2%p ▼
Engineering science	83.8%	6.0%p ▲	-2.2%p ▼
Fashion and textile technology	58.9%	-5.3%p ▼	-39.4%p ▼
Health and food technology	74.3%	8.1%p ▲	-2.8%p ▼
Mathematics	65.5%	0.8%p ▲	3.7%p ▲
Music technology	85.0%	-0.2%p ▼	-9.0%p ▼
Physics	74.6%	-0.4%p ▼	-0.5%p ▼
Practical electronics	86.6%	16.2%p ▲	2.6%p ▲
Practical metalworking	82.6%	1.4%p ▲	-11.3%p ▼
Practical woodworking	86.0%	0.5%p ▲	-7.7%p ▼
All subjects	**78.2%**	**0.7%p ▲**	**-1.6%p ▼**

Source: SQA. 'Attainment Statistics' data, 2015 to 2019.
A pass grade is considered as A to C.
To view this table with pass rates from 2014/15, see Figure 2.14 in our Excel resource.

Inequalities in secondary STEM education in England

Ensuring equal opportunities for all young people to study STEM at secondary school is critical if we are to increase the number and diversity of young people in engineering educational pathways. However, there are clear disparities in participation and attainment in STEM education among underrepresented groups. Relative to their peers, young people from disadvantaged backgrounds are more likely to underperform in school and opt out of taking engineering facilitating subjects at GCSE and A level.

In the academic year 2016 to 2017, of those eligible for free school meals (FSM), 44% achieved an A* to C grade in GCSE maths compared with 71% of non-FSM students. The respective figures for physics are 8% and 23%.[2.56]

The attainment gap is still apparent at A level but is smaller, which may in part be due to low performing students deciding not to continue to study these subjects. Of those who sat an A level maths exam in 2017, 54% of those eligible for FSM achieved an A* to B grade, compared with 66% of those not eligible for FSM. The corresponding figures for physics are 39% and 52%.

The GCSE choices a young person makes will determine whether they can participate in engineering educational pathways: for example, young people who study triple science at GCSE are more likely to study physics A level. However, most young people are not given the choice of which GCSE science option to take and schools in disadvantaged areas are less likely to be able to afford to offer their pupils the choice of studying triple science at GCSE. Half of schools in North Lincolnshire, a highly deprived local authority, do not offer triple science, whereas all schools do in the highly affluent South East of England.[2.57]

Levels of choice of subjects at A level is also determined by socio-economic factors, with 16 out of 20 local authorities with the smallest range of subjects at A level located in the most deprived 30% of areas in England.[2.58] It's clear that inequalities are ubiquitous in STEM education and impact a young person's chance of progressing along engineering educational pathways. We welcome greater effort within the educational and engineering communities to address educational inequalities in future.

Excerpt from EngineeringUK's 'Social mobility in engineering' briefing

2.56 EngineeringUK. 'Social mobility in engineering', 2018.
2.57 OPSN. 'Lack of options: How a pupil's academic choices are affected by where they live', 2014.
2.58 Friedman, S. and Laurison, D. 'The class ceiling : why it pays to be privileged', Policy Press, 2019.

2.5 – STEM A levels in England, Wales and Northern Ireland

A levels are a key point in educational pathways into engineering careers as they are the main bridge between compulsory and tertiary education. Participation and attainment in STEM A levels enable young people to take higher education engineering degree courses – the most common academic route into engineering careers.

Good grades in A level STEM subjects are required for entry into most engineering related degree courses. The most popular engineering undergraduate courses require 3 A levels at A/B grades, one of which usually has to be maths. Many universities also ask for an A level in physics, although some may accept qualifications in other STEM subjects, including the other sciences, further maths, computer science or design and technology.[2.59]

Research suggests that STEM A levels are beneficial in widening job prospects and increasing earnings, even for those who don't continue on to higher education. A study by London Economics found that for all individuals with A levels, the earnings premium for 2 or more STEM A levels (out of a total of 3 or more A levels) is 13.1% relative to people whose highest qualifications are GCSEs or O levels. For one STEM A level it's 5.9% and for no STEM A levels it's 4.8%.[2.60]

STEM A level entries

STEM subjects comprised 4 of the top 10 most popular A levels in England, Wales and Northern Ireland in the academic year 2018 to 2019, based on number of entries (**Figure 2.15**). Maths tops the A level leader board with 11.5% of total A level entries, biology is in second position with 8.6% and chemistry remains in fourth place with 7.4%. Physics continues to be the least popular single science subject, ranking eighth of the 10 most popular A level subjects and comprising just 4.9% of total entries.

Other key engineering facilitating STEM subjects continue to be less popular choices at A level, including further maths (1.8% of entries), computing (1.4%) and design and technology (1.4%).

Figure 2.15 Top 10 STEM A level subjects ranked by number of entries (2018/19) – England, Wales and Northern Ireland

Ranking	Subject	Percentage of total	Number of entries
1	Mathematics	11.5%	91,895
2	Biology	8.6%	69,196
3	Psychology	8.1%	64,598
4	Chemistry	7.4%	59,090
5	History	6.4%	51,438
6	Art and design subjects	5.3%	42,307
7	English literature	5.1%	40,824
8	Physics	4.9%	38,958
9	Sociology	4.7%	38,015
10	Geography	4.4%	34,960

Source: JCQ. 'GCE A Level & GCE AS Level Results Summer' data, 2019.
To view this table with data from 2015/16, see **Figure 2.15** in our Excel resource.

Figure 2.16 shows that there were considerable increases in A level entries for some STEM subjects in the 2018 to 2019 academic year: for example chemistry entries increased by 9.2%, biology by 8.4% and physics by 3.0%. There was also a substantial increase in entries for computer science, at 8.1%.

Worryingly, there were significant decreases in entries for other STEM subjects in 2018 to 2019, including further maths (down 10.1%), maths (down 5.9%) and design and technology (down 5.0%). The take-up of maths subjects at A level may have decreased following the introduction of a harder and more content heavy GCSE syllabus.[2.61]

Over 5 years, computing entries increased by a striking 116.7%, whereas entries for ICT decreased by 83.4%. This can be explained by the introduction of the new computing A level in 2013 to 2014 and the phasing out of the ICT A level, which is no longer an option in the academic year 2019 to 2020.

Design and technology A level has seen a substantial decrease in entries of 20.6% over 5 years, continuing a long-term pattern of decline (see window box on page 45 for further discussion on this topic).

Figure 2.16 Changes in A level entries over time in selected STEM subjects (2013/14 to 2018/19) – England, Wales and Northern Ireland

Subject	Entries in 2018/19 (No.)	Change over 1 year (%)	Change over 5 years (%)
Biology	69,196	8.4% ▲	8.0% ▲
Chemistry	59,090	9.2% ▲	10.4% ▲
Computing	11,124	8.1% ▲	166.7% ▲
Design and technology	10,870	-5.0% ▼	-20.6% ▼
Further mathematics	14,527	-10.1% ▼	3.6% ▲
ICT	1,572	-72.1% ▼	-83.4% ▼
Mathematics	91,895	-5.9% ▼	3.5% ▲
Other sciences	2,527	-6.8% ▼	-27.5% ▼
Physics	38,958	3.0% ▲	6.1% ▲
All subjects	**801,002**	**-1.3% ▼**	**-3.9% ▼**

Source: JCQ. 'GCE A Level & GCE AS Level Results Summer' data, 2014 to 2019.
To view this table with entries from 2011/12 and the percentage of female entrants, see **Figure 2.16** 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 (61.3% boys) and further maths (71.5% boys).

In 2018/19, entries into computer science GCSE increased by 8.1%.

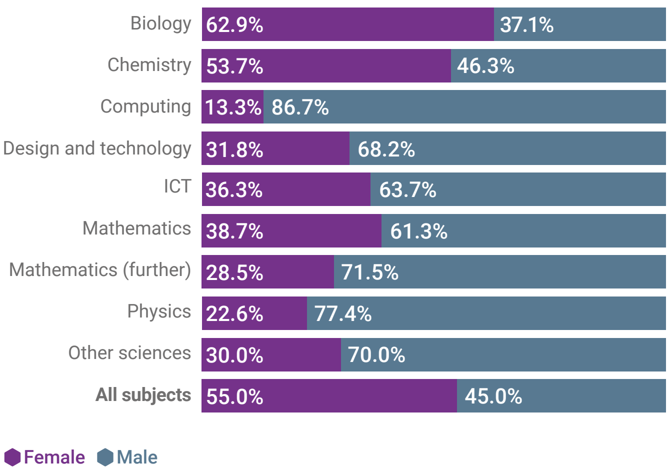
2.59 UCAS. 'Engineering and technology' [online], accessed 20/04/2020.
2.60 London Economics. 'The earnings and employment returns to A levels 2015.
2.61 FFT Education Datalab. 'A-Level results 2019: The main trends in grades and entries', 2019.

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 2 the proportion of entrants who are female has increased over the past 5 years, with notable increases in computing (up 5.7 percentage points) and chemistry (up 5.4 percentage points). However, there is a worrying drop in the proportion of girls taking design and technology, with a fall of 9.1 percentage points over the past 5 years.

Figure 2.17 A level entries in selected STEM subjects by gender (2018/19) – England, Wales and Northern Ireland



Source: JCQ. 'GCE A Level & GCE AS Level Results Summer' data, 2019.

STEM A level attainment

Across all A level subjects, the proportion of entries resulting in a pass grade (C or above) decreased from 77.0% in 2017 to 2018 to 75.8% in 2018 to 2019. This continues the slight downward trend in A level passes which has been happening since 2014 to 2015.

As can be seen in **Figure 2.18**, the A level STEM subjects with the highest pass rates in 2018 to 2019 were further maths (86.6%), maths (75.6%) and chemistry (72.2%). The STEM subjects with the lowest pass rates were computing (63.3%), ICT (66.7%) and biology (67.3%).

There was a large decrease in the pass rate for maths A level in 2018 to 2019, with a drop of 5.2 percentage points compared with 2017 to 2018. This may have been a result of the introduction of the new harder A level maths curriculum and the predicted 'sawtooth effect'.[2.62] Other STEM subjects that also saw slight year-on-year declines in pass rates include biology (down 2.5 percentage points), chemistry (down 2.1 percentage points) and further maths (down 1.4 percentage points).

Figure 2.18 Changes in A level pass rates over time in selected STEM subjects (2013/14 to 2018/19) – England, Wales and Northern Ireland

Subject	Pass rates in 2018/19	Change over 1 year (%p)	Change over 5 years (%p)
Biology	67.3%	-2.5%p ▼	-4.7%p ▼
Chemistry	72.2%	-2.1%p ▼	-5.8%p ▼
Computing	63.3%	0.8%p ▲	2.0%p ▲
Design and technology	68.2%	0.2%p ▲	-0.6%p ▼
Further mathematics	86.6%	-1.4%p ▼	-1.2%p ▼
ICT	66.7%	10.5%p ▲	6.1%p ▲
Mathematics	75.6%	-5.2%p ▼	-4.9%p ▼
Physics	70.5%	0.4%p ▲	-1.7%p ▼
All subjects	**75.8%**	**-1.2%p** ▼	**-0.9%p** ▼

Source: JCQ. 'GCE A Level & GCE AS Level Results Summer' data, 2014 to 2019.
A pass grade is considered as A* to C.
To view this table from 2012/13, see **Figure 2.18** in our Exel resource.

STEM A level attainment by gender

Across all subjects, girls and boys were equally likely to achieve A* and A grades at A level in 2018 to 2019 (25.5% and 25.4% respectively). The gender attainment gap appears when looking at A* to C pass rates, with girls outperforming boys – the pass rate is 77.6% for girls compared with 73.7% for boys (**Figure 2.19**).

Girls far outperform boys in design and technology at A level: 73.9% of girls and 65.6% 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.

Figure 2.19 A level pass rates in selected STEM subjects by gender (2017/18 to 2018/19) – England, Wales and Northern Ireland

Subject	Gender	Entries in 2018/19 (No.)	Percentage A* to C	Change over 1 year in numbers of students obtaining A* to C (%)
Biology	Overall	69,196	67.3%	4.5% ▲
	Male	25,641	65.5%	2.4% ▲
	Female	43,555	68.3%	5.7% ▲
Chemistry	Overall	59,090	72.2%	6.1% ▲
	Male	27,333	72.3%	2.9% ▲
	Female	31,757	72.1%	9.1% ▲
Computing	Overall	11,124	63.3%	9.5% ▲
	Male	9,649	63.4%	8.2% ▲
	Female	1,475	63.1%	19.0% ▲
Design and technology	Overall	10,870	68.2%	-4.8% ▼
	Male	7,415	65.6%	5.0% ▲
	Female	3,455	73.9%	-18.9% ▼
Further mathematics	Overall	14,527	86.6%	-11.5% ▼
	Male	10,380	86.6%	-11.7% ▼
	Female	4,147	86.6%	-11.2% ▼
ICT	Overall	1,572	66.7%	-66.9% ▼
	Male	1,001	62.9%	-69.1% ▼
	Female	571	73.4%	-63.0% ▼
Mathematics	Overall	91,895	75.6%	-11.9% ▼
	Male	56,290	75.5%	-10.7% ▼
	Female	35,605	75.7%	-13.7% ▼
Physics	Overall	38,958	70.5%	3.6% ▲
	Male	30,159	70.2%	3.4% ▲
	Female	8,799	71.4%	4.8% ▲
All subjects	**Overall**	**801,002**	**75.8%**	**-2.9%** ▼
	Male	**360,623**	**73.7%**	**-3.1%** ▼
	Female	**440,379**	**77.6%**	**-2.7%** ▼

Source: JCQ, 'GCE A level & AS level Results Summer' data, 2018 to 2019.
A pass grade is considered as A* to C.
To view this table with percentages for A* to A and from 2011/12, see **Figure 2.19** in our Excel resource.

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 70.0% in England.[2.63] 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 made 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 A level subjects by nation and English 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 Humber had the lowest A* to C pass grades at 72.8% and 74.7% respectively.

Figure 2.20 Changes in A level pass rates over time by nation and region (2014/15 to 2018/19) – England, Wales and Northern Ireland

Nation/region	Pass rates in 2018/19 (%)	Change over 1 year (%p)	Change over 4 years (%p)
England	75.5%	-1.3%p ▼	-1.0%p ▼
North East	76.3%	-0.5%p ▼	0.1%p ▲
North West	75.6%	-1.5%p ▼	-1.5%p ▼
Yorkshire and the Humber	74.7%	-0.7%p ▼	-0.2%p ▼
West Midlands	72.8%	-0.5%p ▼	-2.9%p ▼
East Midlands	73.0%	-1.7%p ▼	-1.0%p ▼
Eastern Region	75.7%	-1.5%p ▼	-2.4%p ▼
South West	76.0%	-1.6%p ▼	-2.7%p ▼
South East	78.0%	-0.7%p ▼	-1.2%p ▼
London	74.8%	-2.2%p ▼	-2.5%p ▼
Wales	76.3%	0.0%p	1.1%p ▲
Northern Ireland	84.8%	0.3%p ▲	1.1%p ▲
All nations	**75.8%**	**-1.2%p ▼**	**-0.9%p ▼**

Source: JCQ. 'GCE Entry, gender and regional charts Summer 2019' data, 2015 and 2019.
A pass grade is considered as A* to C.
To view A level pass rates by nation and gender from 2014/15, see **Figure 2.20a** in our Excel resource.

For STEM A levels, there are notable differences in pass rates at county level in England with, for example, a 20 percentage point difference in A level maths pass rates between the highest and lowest performing counties in 2018 to 2019.[2.64] Surrey had the highest pass rate for maths (83.9%), closely followed by East Sussex (83.5%) and Cornwall (81.6%). The county with lowest pass rate for maths was Staffordshire (63.9%), followed by Cumbria (65.0%) and Bedfordshire (65.5%).

For physics, the difference in pass rates between the highest and lowest performing counties was larger, at 23.6 percentage points.[2.65] Again, Surrey had the highest pass rate (80.1%), followed by Cornwall (77.5%) and Herefordshire (76.7%). Staffordshire also had the lowest pass rate for physics (56.5%), followed by Isle of Wight (57.9%) and Northamptonshire (58.5%).

When it comes to the top grades at A level, a student's chances of attaining an A or A* grade are typically higher the further south they live. In London and the South East, 30% of pupils attained an A grade in at least one A level compared with 20% in the North East. Although there is no conclusive explanation for this regional difference in exam performance, one possible reason is there are a higher number of selective and independent schools in the south of England.[2.66] However, some northern regions are seeing large annual improvements in A level results. In 2018 to 2019, the North East recorded the highest improvement in A grades out of all English regions, with an increase of 1.4%.

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 require Scottish 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 baccalaureates, each of which involves studying a group of coherent subjects. The science baccalaureate is a 2-year course that comprises a mandatory component in maths (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 (18,626), followed by chemistry (10,047) and physics (8,325) (**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 41.9%, computing science by 21.2% and design and manufacture by 20.3%. Promisingly, engineering science saw a 9.5% increase in entries compared with 2017 to 2018, up from 1,014 to 1,110.[2.67, 2.68]

2.63 JCQ. 'GCE A Level & GCE AS Level Results Summer 2019', 2019.
2.64 Ofqual. 'Map of A level grade outcomes by county in England' [online], accessed 21/04/2020.
2.65 Ibid.
2.66 Gill, T. and Bell, J. F. 'What Factors Determine the Uptake of A-level Physics?', Int. J. Sci. Educ., 2013.
2.67 SQA. 'Attainment Statistics (August) 2019', 2019.
2.68 SQA. 'Attainment Statistics (August) 2018', 2018.

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 (74.9%). 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, went down 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).

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 (3,706), chemistry (2,452) and biology (2,314), with physics in fourth place (1,646).

The STEM subjects with the highest A to C pass rates were engineering science (83.3%) followed by chemistry (82.2%) and physics (78.6%). The STEM subjects with 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.

Figure 2.21 Higher qualification attainment by selected STEM subjects (2018/19) – Scotland

Subject	Entries in 2018/19 (No.)	Percentage A to C grade	Number A to C grade	Percentage A grade	Number A grade
Administration and IT	3,770	78.4%	2,955	28.7%	1,081
Biology	7,685	72.7%	5,588	27.6%	2,124
Chemistry	10,047	75.5%	7,590	29.7%	2,985
Computing science	3,228	63.9%	2,064	23.2%	748
Design and manufacture	2,248	54.2%	1,219	11.8%	265
Engineering science	1,110	65.3%	725	26.7%	296
Fashion and textile technology	215	74.4%	160	8.8%	19
Mathematics	18,626	72.4%	13,481	32.9%	6,127
Physics	8,325	74.9%	6,239	28.7%	2,390
All selected STEM subjects	**55,254**	**72.4%**	**40,021**	**29.0%**	**16,035**
All subjects	**185,914**	**74.8%**	**138,972**	**28.3%**	**52,564**

Source: SQA, 'Attainment Statistics' data, 2019.
A pass grade is considered as A to C.
To view this table with attainment from 2014/15, see **Figure 2.21a** in our Excel resource.

Figure 2.22 Advanced Higher qualification attainment in selected STEM subjects (2018/19) – Scotland

Subject	Entries in 2018/19 (No.)	Percentage A to C grade	Number A to C grade	Percentage A grade	Number A grade
Biology	2,314	74.1%	1,715	24.6%	569
Chemistry	2,452	82.2%	2,016	33.8%	828
Computing science	614	65.5%	402	24.1%	148
Design and manufacture	79	64.6%	51	7.6%	6
Engineering science	36	83.3%	30	25.0%	9
Health and food technology	22	77.3%	17	4.5%	1
Mathematics	3,706	75.4%	2,795	37.2%	1,379
Mathematics of mechanics	294	76.9%	226	40.8%	120
Physics	1,646	78.6%	1,293	31.5%	518
All selected STEM subjects	**11,163**	**76.5%**	**8,545**	**32.1%**	**3,578**
All subjects	**23,460**	**79.4%**	**18,627**	**31.8%**	**7,458**

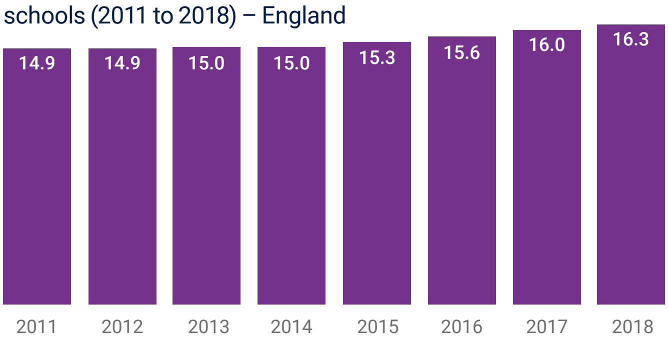
Source: SQA. 'Attainment Statistics' data, 2019.
A pass grade is considered as A to C.
To view this table with attainment from 2015/16, see **Figure 2.22a** in our Excel resource.

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 2012, whereas pupil numbers have been growing.[2.69] 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,[2.70] whereas Northern Ireland has a lower PTR at 15.7[2.71] and Scotland has the lowest PTR at 12.4.[2.72]

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



Source: DfE. 'School Workforce Census' data, 2011 to 2018.
The pupil-teacher ratio is calculated by dividing the total full time equivalent (FTE) number of pupils on roll in schools by the total FTE number of qualified and unqualified teachers regularly employed in schools.
To view the number of secondary school STEM teachers for England, Scotland and Wales, see **Figure 2.23a-c** in our Excel resource. Subject level data is not available for Northern Ireland.

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.[2.73] 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 teacher retention 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.[2.74] 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

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

Source: DfE, 'School workforce census' data, 2013 to 2018.
Teachers in post include full-time qualified regular teachers in (or on secondment from) state funded secondary schools. Figures on vacancies in computing were available for the first time in 2017. Prior to this, vacancies in computing were included under ICT. Figures for ICT are therefore not comparable with earlier years. 'All sciences' includes physics, chemistry and biology, plus other and general science. '-' denotes no value available.
To view this table with number of vacancies and data from 2010, see **Figure 2.24** in our Excel resource.

2.69 DfE. 'School Workforce in England: November 2018', 2019.
2.70 Statistics for Wales. 'Schools' Census Results: as at January 2019', 2019.
2.71 Education NI. 'Teacher workforce statistics 2018/19', 2019.
2.72 Scottish Government. 'Summary statistics for schools in Scotland', 2019.
2.73 Education Policy Institute. 'Teacher shortages in England: analysis and pay options', 2020.
2.74 DfE. 'School Workforce in England: November 2018', 2019.

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.[2.75] 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.[2.76]

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.[2.77] Analysis conducted by the DfE found a positive association between specialist teaching in maths and student attainment in the subject at the end of key stage 4 in England.[2.78]

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 17.5% 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.[2.79]

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.[2.80] 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.

Figure 2.25 Teacher Supply Model targets for state funded secondary schools by selected STEM subjects (2018/19 and 2019/20) – England

	2018/19 (revised)			2019/20 (provisional)		
Subject	**Target**	**Recruited**	**Contribution to target (%)**	**Target**	**Recruited**	**Contribution to target (%)**
Computing	723	540	74.7%	631	498	78.9%
Design and technology	1,167	299	25.6%	1,022	418	40.9%
Mathematics	3,116	2,174	69.8%	3,343	2,145	64.2%
Total science, of which:	3,460	3,236	93.5%	3,609	3,324	92.1%
Biology	1,188	1,819	153.1%	1,192	1,973	165.5%
Chemistry	1,053	838	79.6%	1,152	804	69.8%
Physics	1,219	579	47.5%	1,265	547	43.2%
Total secondary	**19,674**	**16,327**	**83.0%**	**20,087**	**17,098**	**85.1%**

Source: DfE. 'Initial teacher training: trainee number census 2019 to 2020' data, 2019.

2.75 DfE. 'Initial Teacher Training (ITT) Census for the academic year 2018 to 2019, England', 2018.
2.76 DFE. 'Main tables: initial teacher training trainee number census 2019 to 2020', 2019.
2.77 Education Policy Institute. 'The teacher labour market in England: shortages, subject expertise and incentives', 2018.
2.78 DfE. 'Specialist and non-specialist' teaching in England: Extent and impact on pupil outcomes', 2016.
2.79 CBI and Pearson. 'Educating for the modern world CBI/Pearson education and skills annual report', 2019.
2.80 Education Policy Institute. 'The teacher labour market in England: shortages, subject expertise and incentives', 2018.

Figure 2.26 State funded secondary school teachers with no relevant post-A level qualifications by selected STEM subjects (2018) – England

Subject	No relevant post-A level qualification (%)
Engineering	82.5%
Computing	64.0%
ICT	47.8%
Physics	37.3%
Design and technology – electronics/systems and control	31.5%
Design and technology – food technology	30.8%
Chemistry	27.7%
Design and technology – textiles	22.7%
Design and technology – graphics	22.4%
All design and technology	21.8%
Mathematics	21.7%
Design and technology – resistant materials	17.9%
Other/combined technology	16.8%
Combined/general science	10.5%
Biology	10.4%
English Baccalaureate	21.3%

Source: DfE. 'School workforce census' data, 2019.
To view this table by level of qualification, see **Figure 2.26** in our Excel resource.

Factors influencing STEM teacher shortages

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.

Figure 2.27 Comparison of teacher and non-teacher median salaries by degree subject (2016) – England

Outside pay ratio	Degree subject	Median salary of teachers	Median salary of non-teachers	Difference (for teachers)
> 1	Physics	£31,600	£38,000	-£6,400
	Maths	£35,500	£40,000	-£4,500
	All science	£32,000	£35,000	-£3,000
	Biology	£31,000	£32,600	-£1,600
< 1	English	£28,000	£25,300	£2,700
	Modern languages	£31,200	£27,700	£3,500
	History	£34,100	£29,400	£4,700
	PE	£33,100	£25,000	£8,100

Source: Figure taken from Education Datalab. 'Improving Science Teacher Retention: do National STEM Learning Network professional development courses keep science teachers in the classroom?', 2017.
Outside pay ratio: If this is greater than one, graduates earn more outside teaching than inside. If it is less than one, they earn more inside teaching than outside.
This table shows only selected subjects. Chemistry not shown due to small sample size.

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 15%, which was more than other public sector professions, including nursing and policing.[2.81] The National Union of Teachers (NUT) pay loss calculator found that teachers were more than £5,000 a year worse off on average in real terms compared with 2010 due to the pay freeze.[2.82]

In July 2019, the government announced a 2.75% uplift to teachers' pay ranges for the 2019 to 2020 academic year.[2.83] Although this 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 against earnings in the wider economy.[2.84] The government has also announced that it is committed to increasing minimum teacher starting salaries to £30,000 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 teacher 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.[2.85]

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.[2.86]

2.81 NFER. 'Research Update 4: How Do Teachers Compare To Nurses And Police Officers', 2018.
2.82 NEU. 'Pay loss calculator' [online], accessed 24/03/20.
2.83 DfE. 'School teachers' pay to rise by 2.75% - GOV.UK' [online], accessed 24/03/20.
2.84 NEU. 'Pay advice' [online], accessed 24/03/20.
2.85 FFT Education Datalab. 'Improving Science Teacher Retention: do National STEM Learning Network professional development courses keep science teachers in the classroom?', 2017.
2.86 Ibid.

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.[2.87] The problem is compounded by the fact that there is 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:[2.88]

- to improve work life balance (75%)
- workload (71%)
- target driven culture (57%)
- teaching making me ill (51%)
- government initiatives (43%)
- lack of support from management (38%)

Science teachers often have higher workloads than other subject teachers as they are more likely to teach more than one subject: for example they may be required to teach biology, physics and chemistry. This means that they are also more likely to be teaching subjects outside the comfort zone of their specialist subject, adding to work stress. Research has found that teachers who teach multiple subjects are more likely to leave their school.[2.89]

Government initiatives to address the STEM teacher shortage

In 2019, the DfE announced a new strategy for recruiting and retaining teachers in state-funded schools. The aim of the strategy is to make teaching an attractive, rewarding and sustainable career option.[2.90]

The strategy focuses on 4 key areas:

- establishing more supportive school cultures and reducing teacher 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 proposed initiatives to meet these challenges include:

- simplifying the accountability system to reduce unnecessary workload
- transforming support for early years teachers via the Early Careers Framework
- encouraging flexible working and job share options
- introducing specialist qualifications for teachers who do not want to go down a leadership route
- introducing a one-stop application process for initial teacher training

Postgraduate trainees looking to teach physics, maths, chemistry and computing in 2020 to 2021 are eligible for a scholarship of £28,000 or a bursary of £26,000.

The government's teacher recruitment and retention strategy[2.91] 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-fee bursaries and 330 tax-free scholarships were awarded to trainee teachers at a total cost of £191 million.[2.92] **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.[2.93]

Figure 2.28 Scholarships and bursaries available to trainee teachers by subject taught (2020/21) – England

Subject taught	Scholarship	Bursary (Trainee with 1st, 2:1, 2:2, PhD or Master's)
Chemistry, computing, languages, mathematics and physics	£28,000	£26,000
Biology and classics	–	£26,000
Geography	£17,000	£15,000
Design and technology, engineering	–	£15,000
English	–	£12,000
Art and design, business studies, history, music and religious education	–	£9,000

Source: DfE. 'Initial teacher training bursary funding manual: 2020 to 2021 academic year', 2019.
'–' denotes no scholarship available.

2.87 Ibid.
2.88 Perryman, J. and Calvert, G. 'What motivates people to teach, and why do they leave? Accountability, performativity and teacher retention', Br. J. Educ. Stud., 2019.
2.89 Donaldson, M. L. and Johnson, S. M. 'The Price of Misassignment: The Role of Teaching Assignments in Teach For America Teachers' Exit From Low-Income Schools and the Teaching Profession', Educ. Eval. Policy Analysis, 2010.
2.90 DfE. 'Teacher recruitment and retention strategy', 2019.
2.91 House of Commons. 'Teacher recruitment and retention in England', 2019.
2.92 DfE. 'Funding: initial teacher training (ITT), academic year 2020 to 2021', 2019.
2.93 Ibid.

Early career payments

In addition to bursaries and scholarships, trainee maths, physics and chemistry teachers going into state schools may be eligible to receive early careers payments of up to £6,000 after tax, or £9,000 if they are teaching in listed local authorities. Payments are made in instalments during the first 5 years of their teaching career.[2.94]

Maths and physics teacher supply package

There is a targeted intervention to increase the supply of maths and physics teachers and upskill current teachers.[2.95] The support package targets different entry points into the teaching pipeline including:

- paid internships for maths and physics undergraduates in their final year of university to get experience of teaching
- Maths and Physics Chairs programme for PhD researchers, which recruits, trains and places candidates as teachers in state schools, allows them to combine research and teaching on an uplifted salary
- Return to Teaching programme, which supports teachers not currently active in the state school sector to return to teaching
- teacher subject specialism training targeted at non-specialist maths and physics teachers and returning teachers

STEM International teacher recruitment programme

The government aims to recruit maths and physics teachers from Australia, New Zealand, Canada and the USA into state funded schools and academies.[2.96] The DfE will fund recruitment costs, acclimatisation packages and continuing professional development (CPD) programmes during the first year.

STEM teacher retention and recruitment initiatives

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 £84 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 more challenges ahead, there is a lot to be hopeful about in the near future!

2.94 Ibid.
2.95 DfE. 'Maths and physics teacher supply package: report', 2017.
2.96 DfE. 'Recruit a qualified maths or physics teacher from abroad', 2019.

Case study – Training a new generation of teachers

Richard Warenisca, 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. From the 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 – Pathways into teaching

Clare Geldard, Executive Director, Now Teach

Now Teach is an innovative education charity offering experienced professionals from industry and business a structured pathway into teaching and bespoke support to help them thrive in the classroom for the long term. Set up in 2016 by Financial Times journalist Lucy Kellaway, Now Teach has recruited more than 200 experienced 'career changers' into teaching, including CEOs, lawyers, hostage negotiators and NASA scientists.

With this approach, Now Teach is not only addressing the decline in numbers of teachers qualifying, but also giving something new and valuable to schools. Even without a crisis in teacher recruitment, we should be doing all we can to bring people into the classroom who understand the world outside education.

Among qualified teachers starting in schools this September through Now Teach:

- 41% hold a Master's degree and 13% hold a PhD
- 64% are teaching STEM subjects
- In total they have over 1,800 years of combined career experience in more than 25 industries

Our aim is to become a national movement and prove that bringing different generations together for mutual benefit helps eradicate inequality in education.

John Richardson, who began his career as a Civil Engineer specialising in the design and construction of large-scale foundations, is now retraining as a maths teacher. "I first seriously considered teaching as a career at the age of 50 after completing 20 years with my employer. I wanted a change, have always loved mathematics and wanted to give something back. My advice to anyone thinking about this is don't be afraid of change or the challenge. Everyone I have met is supportive and wants you to succeed, and every trainee has applicable skills."

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. Participants also benefit from one day a week off timetable to focus on these additional activities, as well as honorary academic status from a partner university and generous funding options for 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 pupils met our targeting criteria, meaning they came from backgrounds underrepresented at highly selective universities, helping to create not just a larger pipeline of future mathematicians and physicists, but a fairer, more diverse one too.

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 exploring 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. CBI/Pearson's Educating the Modern World shows that over half of employers (60%) 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.

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, XP School 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, teamworking 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 every 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 Edge Foundation

Olly Newton
Executive Director,
The Edge Foundation

3 - Further education and apprenticeships

74%

of further education college principals said engineering and manufacturing was the most difficult subject to recruit teachers for.

Engineering-related apprenticeships made up 26% of all apprenticeship starts in 2018 to 2019.

Key points

The UK's further education (FE) sector is rapidly changing, with a funding boost for 'high value' courses, the shift to apprenticeship standards and new qualifications and institutes of technology. In such a changing landscape, it is critical for the engineering sector not to lose its focus on addressing long-standing issues of STEM teacher shortages and the lack of diversity among apprentices.

T levels

In September 2020, students will be able to enrol on the first T level qualifications in construction, digital, and education routes, which will include an extended industry placement with relevant employers. The engineering and manufacturing T level will be available to students as of September 2022.

Overall, both T level providers and employers are supportive of and welcome the new T level qualifications. They particularly appreciate the emphasis placed on attaining broad industry knowledge, which engineering employers believe will provide an alternative to the 'deep, specialist' knowledge that an apprenticeship offers. There are, however, some concerns. Both providers and employers suggest that there may be sector-specific barriers to young people completing an industry placement in the engineering and manufacturing, and construction routes.

Teaching in the FE sector

FE colleges have reported they struggle to attract sufficiently qualified engineering teachers, with 74% of college principals ranking it as the subject most difficult to recruit for. With the introduction of T levels, there will be significant additional demand placed on FE teachers. This problem is particularly acute in the engineering sector, where the need to have industry experience means that providers are competing directly with engineering employers, which offer potentially higher salaries. In order to address FE teaching shortages, there are a range of initiatives, including £26,000 training bursaries for prospective engineering and manufacturing teachers.

Apprenticeship reforms

The apprenticeship levy came into full effect in April 2017. As of 2019, there were 227 apprenticeship standards approved for delivery in engineering-related areas, and by August 2020, all new apprenticeship starts must be on apprenticeship standards.

Employers in the engineering sector have made several criticisms of the levy. The main concerns relate to the rigidity of the funds and there have been broad calls by industry to adapt the levy into a wider 'training levy'. Despite the necessity of, and benefits associated with off-the-job training, some businesses are confused about exactly what it entails and whether it is appropriate for their apprentices.

Apprenticeship trends in England

In England, apprenticeship starts in the academic year 2018 to 2019 have increased by 4.7% compared with the year before. However, they have decreased by 21.3% since 2014 to 2015, with the largest drop observed immediately after the introduction of the levy.

Engineering-related apprenticeships have followed a similar pattern, with a small year-on-year increase (3.6%) in the academic year 2018 to 2019, but an overall decrease of 4.1% since 2014 to 2015. The smaller drop for engineering-related areas means that their share of apprenticeship starts has risen to 26.3% from 21.5% in 2014 to 2015.

The post-levy decrease varied by engineering-related subject and level. Intermediate level apprenticeship starts fell across all areas between the academic years 2014 to 2015 and 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.

Diversity among engineering-related apprentices 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 (6.4%), engineering and manufacturing (7.9%) and ICT (19.8%) in England. Those from minority ethnic backgrounds made up 5.4% of starts in construction and 7.9% in engineering and manufacturing. In ICT, on the other hand, they were overrepresented, with 19.1% of starts.

In Scotland and Wales, engineering-related apprenticeships represented 34.3% and 19.9% of all starts in 2018 to 2019, respectively. Women comprised just 3.8% of those on engineering-related apprenticeships in Scotland, a figure that has not changed significantly in 5 years. By contrast, in Wales, the proportion of women on engineering related apprenticeships has increased each year since 2014 to 2015 and is now 7.5%. In Northern Ireland, engineering related apprenticeships were more popular, making up 61.4% of the total participants. However, women were similarly underrepresented, making up just 6.8% of all engineering-related participants.

3.1 – Context

Technical education, such as apprenticeships and training, is a key route for many people to develop the skills necessary to enter or progress in the engineering workforce.

Following the 2016 Sainsbury Review and subsequent Post-16 Skills Plan, a host of reforms have been introduced with the aim of streamlining the number of qualifications on offer and improving their quality. Ultimately, the goal is to create a technical education system that is responsive to the changing skills needs of the economy. These changes include the introduction of: the apprenticeships levy and standards; the Institute for Apprenticeships and Technical Education (IfATE); Institutes of Technology; and the forthcoming T levels. Given that the reforms to further education have - for the most part - taken place in England, with the Department for Education covering only English education, this chapter will primarily cover the FE sector in England. Section 3.8 contains context and analysis on apprenticeships in Scotland, Wales and Northern Ireland.

With employers being asked to assist in the development and delivery of these changes, such reforms offer a key opportunity for engineering 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 (for example the higher costs associated with training) as well as how to resolve wider issues such as the lack of diversity within apprentices.

Currently, technical education is split into two main streams – apprenticeships 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).[3.2]
- **Vocational qualifications:** Other vocational qualifications are delivered primarily 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.[3.3] The picture is similar for broader further education and skills,[3.4] with 60.6% aged 19 and over.[3.5] However, as the focus of this report is the participation of young people in pathways into 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 and make them 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 wide-ranging reforms including the introduction of the apprenticeship levy, with the goal of achieving 3 million apprenticeship starts 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 'strengthening technical education', 'increasing opportunities for everyone', 'reforming and refunding the FE college network' and 'improving the apprenticeship offer'.

Terminology

Terms such as 'further education', 'technical education' and 'vocational education' are often used interchangeably, which can cause confusion. In this report, we define these as:

Further education (FE): Any study after secondary education that is not part of higher education (that is, not taken as part of an undergraduate or graduate degree) and is not delivered in schools. This could include academic qualifications taken outside a school setting.

The FE sector: Institutions and organisations that deliver any kind of further education. This includes general FE colleges, independent training providers, local authority providers, employer providers and third sector providers.

Technical education: Any training, such as qualifications and apprenticeships, that focuses on progression into skilled employment and requires the acquisition of both a substantial body of technical knowledge and a set of practical skills valued by industry.[3.1] This replaces what was previously referred to as 'vocational education' – increasingly, the UK government and others in the sector prefer the term 'technical' over 'vocational'.

Technical education can be thought of as a sub-set of FE, as the latter encompasses both technical courses, such as diplomas in engineering, and non-technical courses, such as English for speakers of other languages (ESOL), beginner computer courses and cooking courses.

Vocational qualification: In this chapter, a vocational qualification refers to a broad range of non-academic qualifications, such as a diploma.

Technical qualifications is a term we use for a subset of vocational qualifications in the context of a specific new qualification, such as the T level or the higher technical qualification.

3.1 DfE. 'Review of post-16 qualifications at level 3 and below in England: glossary of terms. Accompanying document for the government consultation on the review of qualifications at level 3 and below in England', 2019.
3.2 DfE. 'Apprenticeships: Off the job training' [online], accessed 15/04/2020.
3.3 DfE. 'Further Education and skills January 2020' data, 2020.
3.4 In this context, further education and skills is defined as non-apprenticeship learning taking part in non-school settings.
3.5 DfE. 'FE and skills learner participation by provider, local authority, funding stream, learner and learning characteristics: 2018 to 2019' data, 2020.

- **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:[3.6]

- 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 £64 million investment for digital and construction training

An additional £400 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.[3.7]

Within these changes, the government has made clear its intention to encourage more young people to undertake STEM subjects – the majority of subjects eligible for the HVCP fall into this category. Likewise, in recognition that they cost more to deliver, 5 of the 6 subject areas that will receive an uplift in their 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[3.8, 3.9] and has seen a funding decline since 2011 to 2012 compared with other phases of education, especially higher education.[3.10] Only 8% of 14 to 18/19-year olds in the UK[3.11] 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 EU23 average of 33% for the proportion of young people on vocational courses doing these subjects, it also means the UK ranks last.[3.12, 3.13, 3.14]

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 on apprenticeships and those studying other vocational qualifications – data is recorded in the Individualised 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 apprenticeship 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 – 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.

3.6 HM Government. 'Industrial Strategy: building a Britain fit for the future', 2017.
3.7 UK Government. '16 to 19 funding: programme cost weighting changes' [online], accessed 15/04/2020.
3.8 OECD. 'Education at a glance 2019 - OECD indicators', 2019.
3.9 The United Kingdom ranks 22nd out of the 29 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.
3.10 IFS. 'Annual Report on Education Spending in England', 2019.
3.11 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, not 16 to 18/19 year olds as in the UK.
3.12 OECD. 'Education at a glance 2019 - OECD indicators', 2019.
3.13 The OECD's ranking of countries for the proportion of upper secondary graduates from vocational programmes who have completed an engineering, manufacturing and construction qualification is based on available national data.
3.14 EU23 refers to the 23 EU member states that are in the OECD.

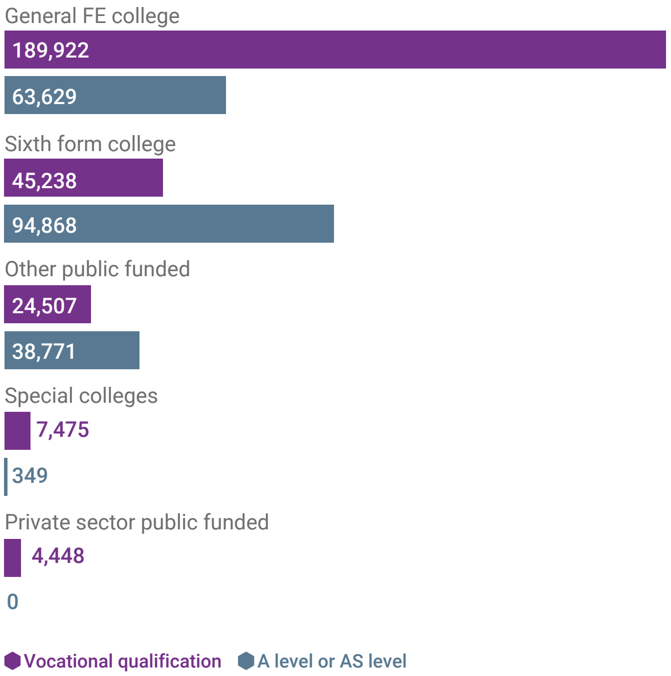
Figure 3.1 Learners in the FE sector by provider type and funding stream (2018/19) – England

	Apprentices (all ages)		16-18 Education and skills		19+ Education and skills	
Provider type	**No.**	**%**	**No.**	**%**	**No.**	**%**
General FE college	206,820	27.9%	470,830	66.7%	712,560	65.8%
Private sector public funded	441,210	59.4%	50,690	7.2%	198,460	18.3%
Other public funded	86,170	11.6%	46,700	6.6%	128,980	11.9%
Sixth form college	2,290	0.3%	118,260	16.8%	10,000	0.9%
Special colleges	6,130	0.8%	19,030	2.7%	33,420	3.1%
All provider types	**742,620**	**100.0%**	**705,510**	**100.0%**	**1,083,420**	**100.0%**

Source: DfE, 'FE and skills learner participation by provider, local authority, funding stream, 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 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 Specialist designated college.

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 qualifications[3.15] – 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 (2018/19) – England



Source: DfE, 'National achievement rate tables 2018/19' data, 2020.
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 specialist designated college.

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

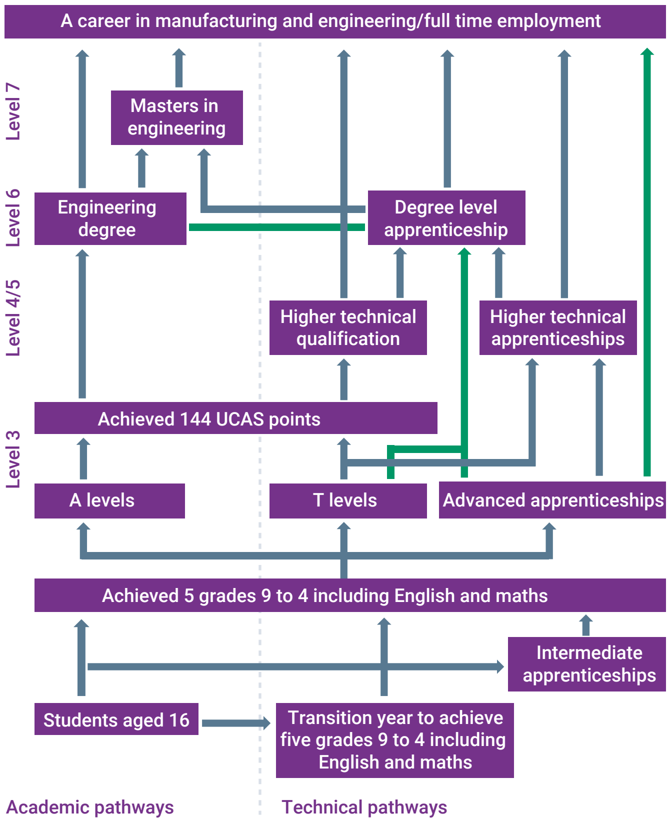
Changes to the further education landscape

Over recent years, this wide-ranging sector has experienced significant policy changes, including dramatic changes to apprenticeships, and an evolving relationship with government. In one example, FE colleges were reclassified twice in 3 years, changing from private to public sector organisations and then being moved back to the private sector. These changes had implications for FE colleges being able to borrow money, as this was dependent on their status, and on public sector debt. The reclassification also changed how much control government had over individual FE colleges.[3.16]

Further changes are on the way with the imminent introduction of T levels, a new qualification that will follow on from GCSEs and be equivalent to 3 A levels. It is intended to create a simplified and fit-for-purpose technical pathway that meets the needs of industry and prepares students for work. Once implemented, it is hoped there will be clear vocational pathways into engineering, although some degree of flexibility will remain, with learners able to transfer directly from one stage to another without necessarily completing each intermediary step (depicted in **Figure 3.3** by the green arrows between options).

3.15 Applied general qualifications are level 3 qualifications for post-16 students who want to continue their education through applied learning. These are normally BTEC or diploma qualifications and allow students to apply their learning to a general job area such as law, or business.
3.16 ONS. 'Reclassification of further education corporations and sixth form colleges in England', 2012.

Figure 3.3 Qualification pathways into engineering



Source: Figure adapted from RaEng. 'Engineering skills for the future: The 2013 Perkins review revisited', 2019.
This diagram represents typical pathways and qualification names in England. Scotland has a different qualification level hierarchy (see **Figure 1.2** in **Chapter 1**), and Wales and Northern Ireland have different naming conventions.
This figure does not show every possible pathway into the engineering sector, as it is possible to transition between academic and technical pathways. This is intended to give typical examples of the steps that students can take.

The different levels of qualification (on the left of **Figure 3.3**) represent separate entry points into the engineering sector. Those completing higher levels of qualifications can start at more senior levels and in different types of roles to those who only complete the lower levels.

People with level 3 qualifications tend to follow the 'technician' route in engineering, whereas those with degree (or higher) qualifications are eligible to become incorporated or chartered engineers, as outlined in the Engineering Council's information on professional registration.[3.17] Level 4 and 5 qualifications are also known as Higher National Certificates (HNCs) and Higher National Diplomas (HNDs) respectively: these allow some degree of flexibility when choosing career options. For more information about qualification levels please see **Figure 1.2** in **Chapter 1**.

There is more detail on the different options later in this chapter, but **Figure 3.3** is a useful way to understand the options facing future vocational engineering students. Learners are expected to be able to move from T levels to apprenticeships and, in some cases, on to academic pathways, if they want to do so. Those students who have completed either a higher technical qualification or higher level apprenticeship will often be able to complete a degree level qualification in a reduced time frame, which is one of the benefits of these lesser-known qualifications.

In the context of the so-called 'policy churn' within the FE sector,[3.18] there are understandable concerns about what may happen should T levels not be implemented properly. The Association of Colleges (AoC), for example, has discussed the risk to the UK's long-term economic prosperity,[3.19] while the Policy Exchange has cited the importance of success given the failure of previous vocational qualifications such as GNVQs and diplomas.[3.20]

The provider landscape is also experiencing significant changes, with FE colleges being encouraged to merge in order to meet government objectives around financial stability and institutional deficits.[3.21] These changes have caused concern, with a DfE review into the effect of college mergers highlighting stakeholder perception of there being "too much focus placed on financial efficiency at the cost of other key sector issues such as leadership, governance and learning provision",[3.22] into the effect of college mergers highlighting stakeholder perception of there being "too much focus placed on financial efficiency at the cost of other key sector issues such as leadership, governance and learning provision" and FE Week reporting the restructuring process to be "complex, costly" and "shrouded in secrecy".[3.23] Given that this restructuring has coincided with key reforms to qualifications and delivery, the FE sector is clearly at a crossroads.

Vocational engineering qualifications and learners

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 provision is no exception. In August 2019, 2,390 engineering-related vocational qualifications[3.24] for 16 to 18 year olds had been approved for funding (**Figure 3.4**).[3.25]

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 "qualifications with little currency in the labour market" and "large numbers of young people enrolling on courses, which do not help them succeed in the world of work".[3.26]

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. One awarding organisation will be granted exclusive delivery rights for each available qualification.[3.27]

As **Figure 3.5** 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.

3.17 Engineering Council. 'Professional registration' [online], accessed 15/04/2020.
3.18 Institute for Government. 'All change: Why Britain is so prone to policy reinvention and what can be done about it', 2017.
3.19 AoC. 'T levels won't succeed unless they are implemented correctly' [online], accessed 26/02/2020.
3.20 Policy exchange. 'A qualified success: an investigation into T-levels and the wider vocational system', 2019.
3.21 AoC. 'College Mergers' [online], accessed 09/04/2020.
3.22 DfE. 'Further education sector reform case studies', 2019.
3.23 FE week. 'College restructuring is complex, secretive and costly' [online], accessed 09/04/2020.
3.24 In this report, vocational qualifications are counted as any qualification type that is not one of the following: GCSE, AS, A level, advanced extension award, project or principal learning. This is in line with the methodology in Ofqual's 'Vocational qualification and other qualifications quarterly'.
3.25 ESFA. 'List of qualifications approved for funding 14-19' data, 2019.
3.26 DfE. 'Assessing the vocational qualifications market in England', 2017.
3.27 DfE. 'Implementation of T level programmes government consultation response', 2018.

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

Sector subject area	Entry levels	Level 1	Level 1/2	Level 2	Level 3	Levels 4+	Total
Construction, planning and the built environment	34	134	8	379	242	8	805
Engineering and manufacturing technologies	28	122	18	528	470	27	1,193
Information and communication technology	41	76	11	104	122	38	392
All engineering-related sector subject areas	**103**	**332**	**37**	**1,011**	**834**	**73**	**2,390**
All sector subject areas	**1,552**	**1,944**	**162**	**3,849**	**3,170**	**310**	**10,677**

Source: ESFA. 'List of qualifications approved for funding 14 to 19' data, 2019.
Vocational qualifications are counted as any qualification type that is not one of the following: GCSE, AS, A level, advanced extension award, project or principal learning.

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

		Qualification level			
Sector subject area	**Provider type**	**Level 1**	**Level 2**	**Level 3**	**Total by sector subject area**
Construction, planning and the built environment	General FE college	21,389	11,865	4,194	37,448
	Private sector public funded	1,130	48	–	1,178
	Other public funded	52	29	–	81
	Sixth form college	66	–	–	66
	Specialist college	424	93	–	517
	All provider types	23,061	12,035	4,194	39,290
Engineering and manufacturing technologies	General FE college	10,804	14,608	12,391	37,803
	Private sector public funded	635	256	–	891
	Other public funded	83	38	270	391
	Sixth form college	32	152	625	809
	Specialist college	149	207	65	421
	All provider types	11,703	15,261	13,351	40,315
Information and communication technology	General FE college	5,386	5,259	13,513	24,158
	Private sector public funded	115	123	–	238
	Other public funded	127	210	1,755	2,092
	Sixth form college	–	753	3,967	4,720
	Specialist college	–	–	–	–
	All provider types	5,628	6,345	19,235	31,208
All engineering-related sector subject areas	**General FE college**	**37,579**	**31,732**	**30,098**	**99,409**
	Private sector public funded	**1,880**	**427**	**–**	**2,307**
	Other public funded	**262**	**277**	**2,025**	**2,564**
	Sixth form college	**98**	**905**	**4,592**	**5,595**
	Specialist college	**573**	**300**	**65**	**938**
	All provider types	**40,392**	**33,641**	**36,780**	**110,813**
All sector subject areas	**General FE college**	**148,283**	**124,707**	**189,922**	**462,912**
	Private sector public funded	**29,703**	**11,624**	**4,448**	**45,775**
	Other public funded	**3,128**	**3,391**	**24,507**	**31,026**
	Sixth form college	**4,049**	**15,756**	**45,238**	**65,043**
	Specialist college	**3,737**	**8,278**	**7,475**	**19,490**
	All provider types	**188,900**	**163,756**	**271,590**	**624,246**

Source: DfE. 'Education and training overall qualification level achievement rates tables 2018/19' data, 2020.
For 16 to 18 year olds students in engineering-related sector subject areas, there were no higher level vocational achievements in 2018 to 2019. Across all sector subject areas, 641 16 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 specialist designated college. '-' denotes there were no achievements.
To view engineering-related vocational achievements for all ages, see **Figure 3.5a** in our Excel resource.

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 2 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.[3.28] 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',[3.29] 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',[3.30] 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.[3.31] 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.[3.32] 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".[3.33]

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 of 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.[3.34]

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).[3.35] 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
- English, maths and digital skills
- Industry placements
- Occupational-specific requirements
- Employment, enrichment and pastoral care

Students will receive a separate grade from A* to E for the core component plus a grade for 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 university (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.

3.28 DfE. 'T level transition programme', 2019.
3.29 DfE. 'Review of post-16 qualifications at level 3 and below in England', 2019.
3.30 Sainsbury, D. et al. 'Report of the independent panel on technical education', 2016.
3.31 Ofqual. 'Vocational qualifications dataset' data, 2020.
3.32 BIS and DfE. 'Post-16 skills plan', 2016.
3.33 UK Government. 'T levels' [online], accessed 09/04/2020.
3.34 DfE. 'Introduction of T levels' [online], accessed 09/04/2020.
3.35 City and Guilds. 'T level extended work placement research', 2018.

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.[3.36]

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.

T levels have been developed in collaboration with employers and businesses, reflecting the strong emphasis on meeting the needs of industry and preparing students for work. For each industry, T level panels, consisting of employers, professional bodies and providers, define the skills and requirements for relevant T levels and develop the outline content for the qualification itself, based on the same standards as apprenticeships. These panels are also responsible for promoting T levels as part of wider government communications and engagement strategies.[3.37]

Figure 3.6 T level routes, pathways and start dates

Route	Pathway	Start date
Agriculture, environmental and animal care	Animal care and management	Sep 2023
	Agriculture, land management and production	Sep 2023
Business and administration	Management and administration	Sep 2022
	Human resources	Sep 2022
Care services	Care services	Apprenticeship only
Catering and hospitality	Hospitality	Apprenticeship only
	Catering	Sep 2023
Construction	Design, surveying and planning	Sep 2020
	Onsite construction	Sep 2021
	Building services engineering	Sep 2021
Creative and design	Craft and design	Sep 2023
	Cultural heritage and visitor attractions	Sep 2023
	Media, broadcast and production	Sep 2023
Digital	Digital support and services	Sep 2021
	Digital production, design and development	Sep 2020
	Digital business services	Sep 2021
Education and childcare	Education	Sep 2020
Engineering and manufacturing	Engineering, design and development	Sep 2022
	Engineering, manufacturing, process and control	Sep 2022
	Maintenance, installation and repair	Sep 2022
Hair and beauty	Hair, beauty and aesthetics	Sep 2023
Health and science	Health and science	Sep 2021
	Healthcare science	Sep 2021
	Science	Sep 2021
	Community exercise, physical activity, sport and health	Apprenticeship only
Legal, finance and accounting	Legal	Sep 2022
	Financial	Sep 2022
	Accountancy	Sep 2022
Protective services	Protective services	Apprenticeship only
Sales, marketing and procurement	Customer service	Apprenticeship only
	Marketing	Apprenticeship only
	Procurement	Apprenticeship only
	Retail	Apprenticeship only
Transport and logistics	Transport	Apprenticeship only
	Logistics	Apprenticeship only

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

3.36 TES. 'Russell group universities still undecided on T levels' [online], accessed 09/04/2020.
3.37 DfE. 'T level action plan', 2019.

Engineering-related T levels

After completing a T level, students will have several options. These include skilled employment, an apprenticeship or higher education.[3.38]

The Institute for Apprenticeships and Technical Education (IfATE) has published occupational maps for each route,[3.39] 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,[3.40] 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**), with the full route on offer by September 2021, albeit by a limited number of providers.

Naturally, there is a high degree of engineering content within this route, with many of the occupations within the associated occupational map related to engineering. The design, surveying and planning pathway, for example, covers a broad range of engineering skills as well as a deep understanding of core industry knowledge in the construction sector. This core knowledge will be required in each of the construction pathways available (with the second and third starting in 2021), thereby ensuring that learners will be comfortable in a broad range of roles within the construction industry, regardless of where they choose to hone their skills further along in their careers.

Notably, there is an occupational specialism within the pathway that focuses on civil engineering, meaning that this first pathway will be particularly relevant for students wishing to join the engineering talent pipeline. This specialism contains specific performance outcomes developed by experts in the field, including a member of the Institute of Civil Engineers and a chief engineering surveyor for Skanska UK Plc.[3.41] The involvement of these experts was intended to give both students and employers confidence that upon completion of the T level, students will be equipped with the relevant knowledge, skills and behaviours to perform their chosen occupation.

In addition to civil engineering, the occupational map of the design, surveying and planning cluster includes digital engineering and railway engineering design technicians.

Case study – Preparing for the new T level qualification

Rosalind Tsang, Programme Leader, Professional Construction, Blackpool and The Fylde College

The government has selected Blackpool and The Fylde College to be one of the first colleges offering the design, surveying and planning T Level in September 2020. This new course will provide the framework for our students to gain quality work experience and the technical skills and knowledge to progress to a Higher Level Technical qualification or gain a career in industry. Our target is to enrol 16 students for the new term and we have 18 students already interested in applying.

In preparation for delivering T levels, we have invested over £500,000 in upgrading our Construction Skills Centre. This will enable students and tutors to have flexible, robust workspaces to deliver the new curriculum. We are committed to remaining at the forefront of technology and therefore digital development, construction, design, surveying and business information management apps have been purchased for our new iPad Pros. Tutors have also been networking with local employers for future placement opportunities.

In September 2019, level 3 construction and the built environment students piloted the 315-hour industry placements. These included surveying, design, planning and site management roles provided by a variety of local and national construction companies, such as McLaughlin and Harvey, Evolution Ltd and Fylde Borough Council.

The initiative was extremely successful as students were able to gain practical experience and learn more about the variety of jobs in construction. Of 11 students, 9 secured part time paid work that is industry relevant. The pilot was useful in building relationships with employers interested in offering placements for T levels. For example, McLaughlin and Harvey is currently building a conference and exhibition centre, and has supported students with site visits and future placements as the project progresses. Based on what we have learnt from the pilot, we are working on designing new resources and planning for September.

3.38 DfE. 'Introduction of T levels', 2020.
3.39 IfATE. 'Occupational maps' [online], accessed 09/04/2020.
3.40 IfATE. 'Occupational map: Engineering and manufacturing' [online], accessed 09/04/2020.
3.41 DfE. 'Membership of T level panels for 2020 and 2021 delivery', 2018.

T level routes in engineering and manufacturing

Schools, colleges and other providers will start offering the engineering and manufacturing T level in the academic year 2022 to 2023. The core content for this T level was finalised in March 2020 by IfATE and is summarised in brief in Figure 3.7.

It is expected that students will develop their technical and practical skills from the beginning of this programme, and at the same time grow confident in the workplace practices that underpin safe and effective engineering and manufacturing activities.

Figure 3.7 Core knowledge and understanding required within the engineering and manufacturing T level route

Core knowledge and understanding
Working within the engineering and manufacturing sectors
Engineering and manufacturing past, present and future
Engineering representations
Essential mathematics for engineering and manufacturing
Essential science for engineering and manufacturing
Materials and their properties
Mechanical principles
Electrical and electronic principles
Mechatronics
Engineering and manufacturing control systems
Recognised standards in engineering and manufacturing
Standard Operating Procedures (SOPs)
Health and safety principles and coverage
Business, commercial and financial awareness
Professional responsibilities, attitudes and behaviours
Stock and asset management
Quality assurance, control and improvement
Continuous improvement
Project and programme management

Source: IfATE. 'Engineering and Manufacturing: Design and Development T Level outline content: final version for ITT', 2020.

Each of the engineering T level pathways will have its own occupational specialisms, which have now been published (Figure 3.8). While the core knowledge element will be required across the entire engineering and manufacturing route, the specialisms will allow students to choose a narrower skill set once they have grasped the basics of working in the engineering sector.

Figure 3.8 Occupational specialisms in engineering and manufacturing T level pathways

Pathway	Occupational specialism
Design and development	Mechanical engineering
	Electrical and electronic engineering
	Control and instrumentation engineering
	Structural engineering
Maintenance, installation and repair	Maintenance engineering technologies: mechanical
	Maintenance engineering technologies: mechatronic
	Maintenance engineering technologies: electrical and electronic
	Maintenance engineering technologies: control and instrumentation
	Maintenance, installation and repair: vehicles
	Maintenance, installation and repair: energy and utilities
Manufacturing, processing and control	Production technologies
	Manufacturing technologies
	Processing technologies
	Materials technologies

Source: IfATE. 'T levels final outline content', 2020.

As stated above, engineering and manufacturing has the most occupational specialisms attributed to it in its occupational map. The range of occupations that these T level students could move into is vast, with 10 distinct job clusters in the engineering and manufacturing route alone.[3.42] It is hoped that the strong association with specific occupations and specialisms will be a key draw for both prospective students and employers, with clear expectations of the skills and possible employment each qualification may lead to.

Providers' and employers' views of T levels

In general, providers and employers appear to be broadly supportive of new T level qualifications. In a Chartered Institute of Personnel and Development (CIPD) report, for instance, 44% of employers surveyed indicated that a T level would make a positive difference to a young person's employability overall.[3.43] The same report found that hiring someone with a T level would be employers' second most popular way to fill an entry level vacancy (17% of respondents), behind taking on a graduate (28%). This suggests employers have some faith in the upcoming qualifications, even though they have not yet been implemented.

43% of manufacturing employers would prefer T level students to have a breadth of engineering and manufacturing knowledge, rather than a deep, specialist knowledge.

3.42 IfATE. 'Occupational map: Engineering and manufacturing' [online], accessed 09/04/2020.
3.43 CIPD. 'Reforming Technical Education', 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 CIPD report,[3.44] 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 MakeUK, the manufacturers' organisation, 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.[3.45]

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".[3.46] 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 forefront of technical education and the importance of close collaboration between industry and providers for delivery.

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 research and consultation with 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 level placements – of which engineering, manufacturing 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".[3.47]

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 supervision in certain environments due to the age of most T level students. Some engineering and manufacturing employers also pointed out that certain types of work – often related to safety requirements – 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.[3.48]

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

Similar sector-specific concerns have been voiced via other channels. In a survey of employers and training providers conducted by City and Guilds, for example, those working within construction and engineering and manufacturing were most likely to report barriers to work placements for young people.[3.49] 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.[3.50] Chief among their concerns was the need to juggle work placement delivery with business needs (55% 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.[3.51]

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 work placement 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 CIPD 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%).[3.52]

Even as recently as October 2019, after a £250,000 branding campaign by government, NFER reported that delegates from a roundtable discussion with provider and sector representatives said there remained "significant work to do to raise the awareness and understanding of T levels among young people, parents/carers and employers".[3.53]

A lack of awareness of T level placements also appears to be an issue among engineering employers. A 2019 survey 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 said they have capacity to offer placements (59%) and under half (43%) said they intend to offer industrial placements.[3.54]

3.44 Ibid.
3.45 MakeUK. 'T levels: make or break for manufacturers?', 2019.
3.46 NFER. 'T levels research: how are providers preparing for delivery?', 2019.
3.47 DfE. 'Employer engagement and capacity to support T level industry placements', 2018.
3.48 Engineering council. 'European directive: recognition of professional qualifications' [online], accessed 15/04/2020.
3.49 AELP and City and Guilds. 'T level work placements research', 2018.
3.50 MakeUK. 'T levels: make or break for manufacturers', 2019.
3.51 Ibid.
3.52 CIPD. 'Reforming Technical Education', 2018.
3.53 NFER. 'T levels research: how are providers preparing for delivery? Follow up report', 2019.
3.54 IET. 'IET skills and demand in industry', 2019.

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) – level 4 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 far 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.[3.55]

However, CBI has predicted that in 5 years' time, almost half of all employment will be in management, professional and technical roles, suggesting level 4 or 5 qualifications will be in high demand.[3.56] 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 only a level 3 qualification.[3.57]

In response to the clear demand for these levels of skills within the STEM sector,[3.58] 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 to help close skills gaps in key STEM areas.[3.59]

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 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 regulation 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".[3.60] 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.[3.61] 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 to succeed.

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.[3.62] There is no formal requirement to hold a teaching 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.

Results from the DfE's 2018 College Staff Survey into the experience, qualifications and expectations of teachers and leaders in general and specialist FE colleges suggest that there are recruitment and retention challenges. Asked what related challenges they face, the most common responses among the principals surveyed were competition from higher salaries in industry (22%) and schools (17%) and a lack of qualified staff (18%). Existing teachers surveyed also noted retention challenges, with 14% reporting that they were very likely to leave FE and 2% saying they were leaving for a role outside FE.[3.63]

74% of college principals said engineering and manufacturing was the most difficult subject to recruit teachers for.

3.55 DfE. 'Higher technical education: the current system and the case for change', 2019.
3.56 CBI. 'Education and learning for the modern world', 2019.
3.57 DfE. 'Research reveals lesser known qualifications could help boost skills and jobs' [online], accessed 09/04/2020.
3.58 UKCES. 'Reviewing the requirement for high level STEM skills', 2015.
3.59 DfE. 'The first twelve institutes of technology' [online], accessed 09/04/2020.
3.60 DfE. 'DfE strategy 2015-2020', 2016.
3.61 FE Week. 'Where will all the T -level teachers come from?' [online], accessed 15/04/2020.
3.62 College jobs. 'Teacher training on the job: Working as an unqualified teacher in FE' [online], accessed 09/04/2020.
3.63 DfE. 'College staff survey 2018', 2018.

Figure 3.9 Institutes of technology open from September 2019 – England

Lead institution	Providers	Employers	Subject specialisms
Barking and Dagenham College	Barking and Dagenham College	Huawei, Saint Gobain, Transport for London	Construction and infrastructure, advanced engineering and robotics, creative and digital
Dudley College of Technology	Dudley College of Technology, In-Comm Training & Business Services Ltd	Thomas Dudley Ltd, Fulcro COINS, The Dudley Group NHS Foundation Trust, Marches Centre for Manufacturing	Manufacturing, construction, medical technology
New College Durham	New College Durham, NA College Trust, Middlesbrough College, Sunderland College, Tyne Coast College, East Durham College, Newcastle University	Nissan Motor Company Ltd, ESH Group Ltd	Digital advanced manufacturing, construction and the built environment
University of Exeter	Bridgwater and Taunton College, City College Plymouth, Exeter College, Petroc, Truro and Penwith College, University of Exeter, University of Plymouth	Babcock, Met Office, Oxygen House, TDK Lambda	Digital, engineering, manufacturing
Harrow College and Uxbridge College (HCUC)	HCUC, Brunel University London	Heathrow, Fujitsu, West London Business	Engineering technologies (digital, cyber security, ICT). Related: construction, professional and business services, creative industries
University of Lincoln	Grimsby Institute of Further and Higher Education, DN Colleges Group (North Lindsey College), Lincoln College, Boston tCollege, Grantham College, Bishop Burton (Riseholme College), Lincoln UTC, University of Lincoln	Siemens, Bakkavor Ltd, Olympus Automation Limited	Agri-tech, food manufacturing, energy, digital, engineering
Queen Mary University of London	Newham College, Queen Mary University of London	Siemens, Port of London Authority, London and Regional Properties	Transport, engineering, infrastructure, energy, digital
Milton Keynes College	Milton Keynes College, Activate Learning Cranfield University	Microsoft Ltd, KPMG, Evidence Talks, McAfee, (Volkswagen Financial Services (VWFS)	Cyber security, digital sector, fintech, ICT
Solihull College and University Centre	Solihull College and University Centre, South and City College Birmingham, Birmingham Metropolitan College (BMet), Aston University, Birmingham City University, University of Birmingham, University College Birmingham	Bosch Thermotechnology Ltd, Salts Healthcare	Manufacturing, engineering
Swindon College	Swindon College, New College Swindon, University of Gloucester	Nationwide, Catalent Pharma Solutions, Excalibur Communications Ltd, BMW Group, Appsbroker Consulting Ltd, Hartham Park, Recycling Technologies, Render, Create Studios	Advanced engineering and high value manufacturing, digital and information and communications technology, creative industries, health and life sciences
Weston College of Further and Higher Education	Weston College of Further and Higher Education, Bath College, Gloucester College, Yeovil College, University of the West of England (UWE Bristol)	Airbus, GE Aviation, GKN Aerospace, JISC, National Composites Centre, North Somerset Council, Mayden Academy, Renishaw, St Monica Trust, Tech Op Solutions Ltd, Weston Area Health NHS Trust	Health and life sciences, engineering and advanced manufacturing, creative, digital and hi-tech
York College	York College, Grimsby Institute of Further and Higher Education (Scarborough TEC), Askham Bryan College, Bishop Burton College, Craven College, East Riding College, Selby College, University of Hull, University of York St John	ENGIE Fabricom, Skipton Building Society, GB Recruitment	Agri-tech, engineering, manufacturing, digital

Source: Figure taken from DfE. 'Institutes of technology: details of providers, employers and specialisms', 2020.

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 and manufacturing rank second and third respectively in terms of number of staff teaching in colleges.

Figure 3.10 Teaching staff numbers in FE colleges by vocational subject taught (2018) – England

Vocational subject taught	Total number of teachers	Proportion of vocational teaching population (%)
Creative and design	5,700	14.4%
Construction	4,980	12.6%
Engineering and manufacturing	4,580	11.6%
Agriculture, environmental and animal care	4,030	10.2%
Health and science	3,700	9.3%
Business and admin	2,980	7.5%
Hair and beauty	2,900	7.3%
Childcare and education	2,420	6.1%
Catering and hospitality	1,650	4.2%
Digital/IT	1,980	5.0%
Social care	1,970	5.0%
Protective services	800	2.0%
Legal, finance and accounting	830	2.1%
Sales, marketing and procurement	720	1.8%
Transport and logistics	390	1.0%

Source: Figure adapted from DfE. ‘College staff survey 2018’, 2018.
The total number of teachers are based on population estimates and are rounded to the nearest 10.

It’s also evident that those with the requisite skills to teach at certain levels are in short supply. Although 88% of engineering and manufacturing teachers said they felt qualified to teach level 3 or higher qualifications – a positive finding given the imminent introduction of the new level 3 T level qualifications – just 48% said the same of level 4 or higher. In other words, just under half of the vocational engineering teaching workforce feel qualified to teach higher technical qualifications. Yet with the increased emphasis on level 4 and 5 qualifications, it is likely that additional teachers will be needed in the FE sector who are able to teach at these levels.

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’s industrial strategy as key to the UK’s growth prospects, specifically construction, planning and the built environment, engineering and manufacturing technologies and ICT”.[3.64] This is borne out in salary data, where the median average salary for an engineering professional in 2019 is £41,912,[3.65] which is around £10,000 more than that of an engineering teacher in FE.[3.66]

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.[3.67] 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.

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 following political and strategic initiatives – you must be prepared to engage with that side of things if you want to succeed.

3.64 DfE. ‘Identifying further education teacher comparators’, 2018.
3.65 ONS. ‘Earnings and hours worked, occupation by four digit SOC: ASHE table 14’ data, 2019.
3.66 ETF. ‘Further Education workforce data for England’, 2019.
3.67 DfE. ‘College staff survey 2018’, 2018.

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:

- **Taking Teaching Further**, a national initiative to attract experienced industry professionals with expert technical knowledge and skills to work in FE, which is being managed by ETF and aims to recruit 150 new teachers across 2 rounds of funding.[3.68] 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.[3.69]
- **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".[3.70] While this offer is focused on those teachers delivering the new T level qualifications, it applies to any provider offering any of the new T levels, so it is 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".[3.71]
- **The introduction of 'knowledge hubs'**, which include the industry insight aspect of the TLPD offer.[3.72] 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.[3.73] In an engineering 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 profession.
- **Initial Teacher Education (ITE) bursaries**, which are financial incentives to attract high-quality individuals into the teaching profession in the FE sector.[3.74] 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.

Given the shortage of engineers in the UK economy already, the role of engineering teachers will be of paramount importance in training a skilled workforce. However, the difficulty lies in attracting those with sufficient industry experience to teach engineering in a practical setting. The government has made a good start with the programmes mentioned above, but the engineering community must strengthen the relationship between industry and the teaching profession by working closely with local employers and colleges, encouraging collaboration between them.

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 apprenticeship standards (England only) in October 2013 to replace the old style of apprenticeships called frameworks. These have since been phased in gradually.

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.

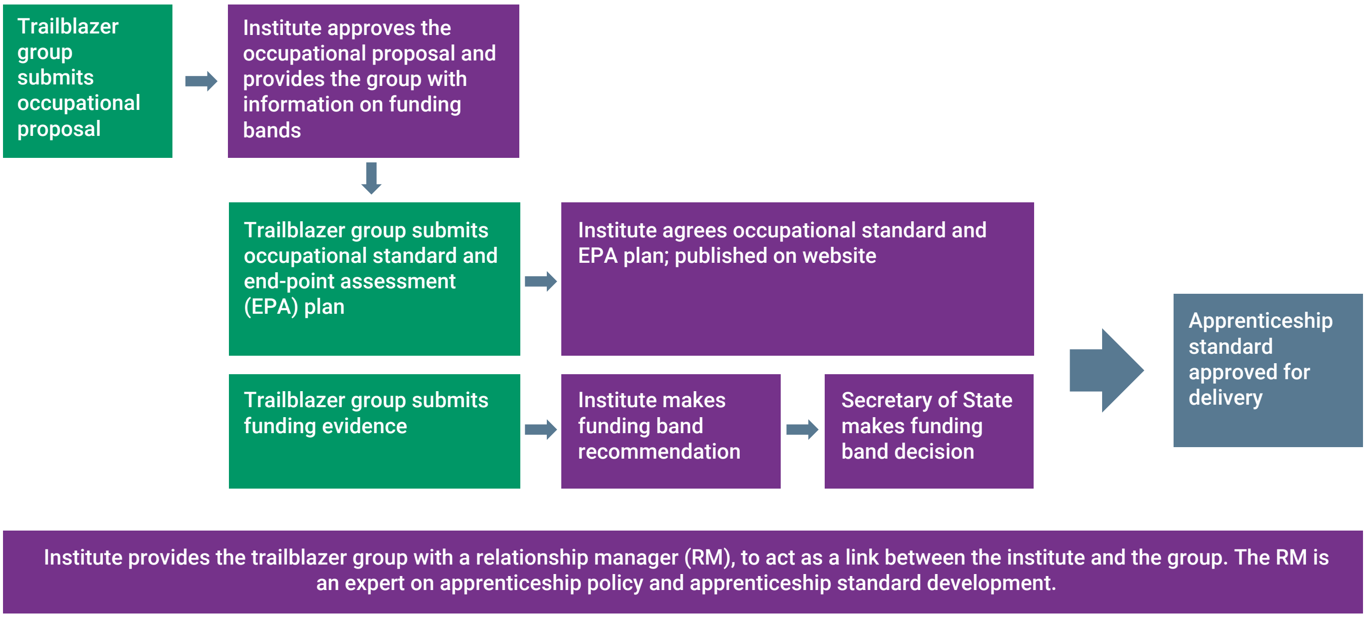
Standard: A standard is an occupational profile, which includes a list of duties and the skills, knowledge and behaviour that an apprentice needs to have learned by the end of their apprenticeship. Learning happens throughout the entire apprenticeship, with an end-point assessment to determine whether the student can carry out the job. Apprentices are required to spend 20% of the time completing off-the-job learning, normally at an FE college or training provider.

Apprenticeship standards are developed by groups of employers called trailblazers, with the intention that these industry experts will be well placed to determine the skills needs within their sector.

There are currently 227 standards approved for delivery in the engineering and manufacturing, construction and digital routes, with an additional 41 in development and 17 with a proposal in development.[3.75, 3.76] Many of these are brand new, so did not have any learners in the academic year 2018 to 2019. By comparison, there were 31 engineering-related frameworks with apprenticeship starts and 156 standards. Despite these figures being heavily skewed towards standards, the number of starts on each type of apprenticeship was more balanced, with around 91,000 starts on frameworks and 86,000 starts on standards.[3.77]

3.68 ETF. 'Taking teaching further' [online], accessed 09/04/2020.
3.69 Specifically, the programme aims to "increase the overall number of skilled FE teachers in the technical routes that will be taught first (childcare and education, digital, construction, engineering and manufacturing and other STEM technical routes)."
3.70 AoC. 'T level regional knowledge hubs' [online], accessed 15/04/2020.
3.71 ETF. 'T level professional development' [online], accessed 09/04/2020.
3.72 Ibid.
3.73 ETF. 'T level knowledge hubs, teacher regional improvement projects and industry insight activity set to launch' [online], accessed 15/04/2020.
3.74 DfE. 'Further Education (FE) initial teacher education (ITE) bursaries funding manual', 2020.
3.75 IfATE, 'Apprenticeship standards' data, 2020.
3.76 Correct as at 27/02/2020.
3.77 DfE. 'Apprenticeships and traineeships 2018/19' data, 2019.

Figure 3.11 Apprenticeship standard development process – England



Source: Figure adapted from: Institute for Apprenticeships and Technical Education. 'Developing new apprenticeship standards', 2019.

This represents an increase from 2017 to 2018. In 2018 to 2019, standards accounted for 40% of apprenticeship 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 apprenticeship 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".[3.78] 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.[3.79, 3.80] 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 Osbourne 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.[3.81] 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.[3.82]

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 a reduction in the rate that smaller employers had to pay for their apprentices.[3.83] 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.[3.84] 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.

3.78 HMRC. 'Policy paper: Apprenticeship levy' [online], accessed 15/04/2020.
3.79 Ibid.
3.80 DfE. 'Key facts you should know about the apprenticeship levy' [online], accessed 14/04/2020.
3.81 HM Treasury. 'Chancellor George Osborne's summer budget 2015 speech' [online], accessed 14/04/2020.
3.82 FE week. 'Government says they will fail conservative manifesto commitment to 3 million apprenticeship starts' [online], accessed 09/04/2020.
3.83 FE News. 'Extra £90M in funding and 25% of apprenticeship levy able to be transferred to supply chain' [online], accessed 27/02/2020.
3.84 NAO. 'The apprenticeships programme', 2019.

However, recent evidence suggests that there is now a possibility of overspend of the apprenticeship levy in future. This is due to the transition to apprenticeship standards – which are around double the cost they were expected to be[3.85] – and the increased numbers of higher level apprenticeship starts (see **Figure 3.16** in section 3.6 below for more detail), which cost more than lower levels. A 2019 report by the Learning and Work Institute suggested there could be a £1 billion overspend in coming years,[3.86] but analysis by Richard Marsh for FE News suggests this may be an exaggeration.[3.87]

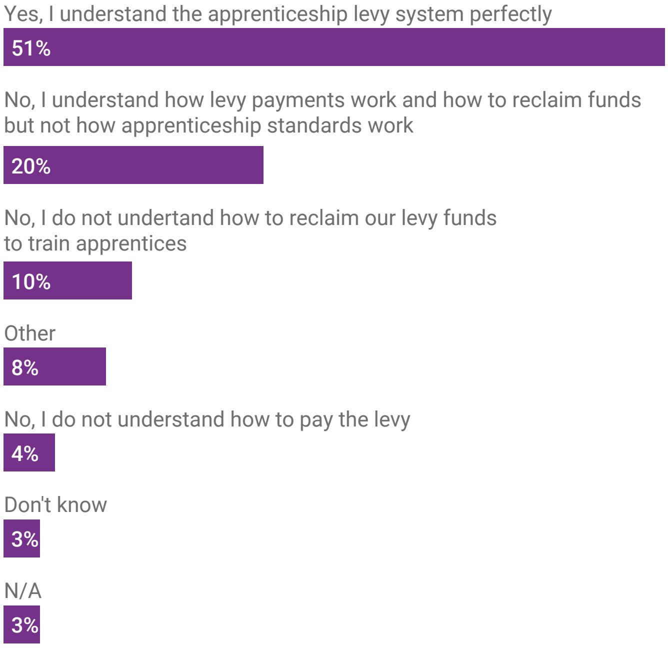
While it is impossible to predict exactly how much levy funding will be spent by employers, it is clear that engineering and technology apprenticeships tend to be more expensive than those in other sectors and a large proportion of engineering-related apprenticeship standards sit within higher funding bands. Indeed, 23% of engineering and manufacturing technologies apprenticeship standards were placed in the maximum possible funding band of £27,000.[3.88] This means that engineering firms in particular should take full advantage of the levy funds available to them to train new and existing staff.

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.[3.89] One issue, however, seemed to be the time constraints that accessing funding requires, with 30% of employers saying it took longer than expected and 18% agreeing that the administration required was a drain on management time.[3.90]

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 'administrative burden' or 'time constraints' as the reason for not doing so. This was in the context of 51% of levy-paying employers saying they 'understood the levy system perfectly' and a further 20% indicating that they understood the levy system, but not how apprenticeship standards work (**Figure 3.12**).[3.91]

Figure 3.12 Understanding of the apprenticeship levy system among levy-paying employers (2018) – England



Source: Figure adapted from Institute of Directors. 'Business leaders finally getting to grips with apprenticeship levy' [online], accessed 06/04/2020.
Q: Do you feel you understand sufficiently how the government's apprenticeship levy system works?
Data presented in this figure is based on 215 respondents from businesses that pay the levy.

Use of levy funding initially appeared low among engineering and manufacturing employers. Research by MakeUK found that manufacturers surveyed were as unlikely as businesses across industry to have used levy funding, with just 19% having spent levy money in 2018.[3.92] Furthermore, those who were using their funds were spending on average just 26% to 50% of the levy. The largest barriers to recruiting apprentices reported by manufacturers – both levy paying and non-levy paying – were time and staff constraints, as significant resources were needed to mentor and train the apprentices during their on-the-job training.

However, a more recent (2019) skills survey of engineering employers by the IET offered more encouraging findings, with 71% of companies liable to pay the levy indicating they use it to some degree, and almost one in four (23%) noting they had increased the number of engineering or technical apprenticeships offered.[3.93] The survey results furthermore suggest that 47% of engineering firms find it "extremely easy" or "somewhat easy" to use the apprenticeship levy, and that "having the capacity within the firm to take on an apprentice" is thought to be the best way to encourage establishments to create an engineering or technical apprenticeship.[3.94]

These findings suggest that over and above accessing and using levy funding, it is practical capacity and resource constraints that pose the most significant challenges for engineering companies to employ apprentices.

3.85 Ibid.
3.86 Learning and work institute. 'Bridging the gap: next steps for the apprenticeship levy', 2019.
3.87 FE news. '£2bn Levy underspend: Has the demise of the levy been much exaggerated?' [online], accessed 14/04/2020.
3.88 IfATE. 'Apprenticeship standards' data, 2020.
3.89 The Open University. 'The apprenticeship levy: one year on', 2018.
3.90 Ibid.
3.91 Institute of Directors. 'Business leaders finally getting to grips with apprenticeship levy' [online], accessed 02/04/2020.
3.92 MakeUK. 'An unlevy playing field for manufacturers', 2019.
3.93 IET. 'Skills and demand in industry 2019 survey', 2019.
3.94 Ibid.

Employers in the engineering sector agree with those in wider industry, and would like to see the apprenticeship levy changed to a skills levy.

Calls for flexibility in the apprenticeship levy

Many employers have expressed concerns about the restrictive nature of the funding and have called for more flexibility. Among firms taking part in a survey by the Confederation of British Industry (CBI) in 2018, 59% indicated "the main change that would boost business confidence in the apprenticeship levy is allowing use of levy funds to cover a wider range of costs for training".[3.95]

Similarly, a 2019 CIPD report found that 53% of employers who currently pay the levy would prefer a training levy, compared with just 17% supporting an apprenticeship levy.[3.96] A 2018 survey of apprenticeship decision makers commissioned by City and Guilds found that "92% of those we polled called for greater flexibility in how the levy is spent, with more emphasis placed on spend that more broadly supports apprenticeship delivery and other vital workplace training".[3.97]

This viewpoint has also been found among engineering employers, with the MakeUK research suggesting that 42% of manufacturing employers want "greater flexibility when spending money on training apprentices" and that 95% want to see the levy changed, with many wanting it to be moved to a skills levy.[3.98] In its 2019 skills survey, The IET recommended greater flexibility on levy spending for wider skills development.[3.99]

Highlighting a broad agreement within the engineering sector, the 2019 report 'Engineering skills for the future: The 2013 Perkins review revisited' recommended that "government should give employers greater control and flexibility in how they spend the apprenticeship levy, including to support other high quality training provision in the workplace, such as improving the digital skills of the workforce".[3.100] This crucial recommendation has since been endorsed by the National Engineering Policy Centre.[3.101]

Given the widespread consensus – between both engineering employers and those across industry more generally – on the need for change in the apprenticeship levy, a review by the government may be appropriate. This could seek to address concerns around both the flexibility and the appropriateness of the tax in its current form.

At the time of writing no such review has been announced, but employers within the engineering sector should continue to engage with apprenticeship decision-makers in government to ensure the sector has a key role to play in any future development of the apprenticeship programme.

Off-the-job training

A key element of the English apprenticeship system, introduced into legislation in 2017, is the requirement that apprentices spend a certain amount of their time completing 'off-the-job training'. This is defined as "training which is not on-the-job training and is received by the apprentice, during the apprentice's normal working hours, for the purpose of achieving the knowledge, skills and behaviours of the approved apprenticeship referenced in the apprenticeship agreement."[3.102]

Off-the-job training is not a new requirement for apprenticeships. However, the requirement that apprentices spend at least 20% of their 'normal hours' in off-the-job training was only made mandatory for government funded apprenticeships by the Education and Skills Funding Agency (ESFA) in the 2017 to 2018 academic year.[3.103]

Case study – New approaches to apprenticeships in light of government reforms

Chris Shirley, Apprentice Services Manager, Network Rail

At Network Rail, we have had a long-standing rail engineering apprenticeship programme. The introduction of the apprenticeship levy and the move to standards has led to a new approach to how we use apprenticeships to meet our skills gaps.

Along with the rest of the rail industry, we have developed rail engineering career pathways from entry level to senior management (this year we saw progression from level 3 to 4, and level 4 to 6 apprenticeships), covering all aspects of railway engineering and offering different step on and off points, reflecting varied career development.

We have also recognised the value of apprenticeships in developing career pathways for railway operators – particularly in signalling, train driving and railway operations – where we have recently launched a new level 5 apprenticeship programme. We have doubled our apprenticeship recruitment rates and are also seeing a strong internal demand to upskill existing employees who have historically not wanted to follow an academic development pathway.

The future looks promising, with the introduction of higher level apprenticeships across a wide range of engineering and professional disciplines, which will allow us to increase the capability of our organisation across different career pathways. The apprenticeship levy has encouraged a different approach to skills development, because historically at the higher levels it has been more academically led, whereas the levy has encouraged the pursuit of development pathways that include skills and behaviours in addition to the more traditional academic focus.

Looking forwards, the momentum that has been gained over the past 3 years needs to be maintained, as apprenticeships play a vital role in increasing organisational capability, improving diversity within the workforce and encouraging social mobility. Flexibility in how apprenticeships can be delivered and tailored to individual needs is key to getting the best out of our people.

3.95 CBI and Pearson. 'Educating for the modern world', 2018.
3.96 CIPD. 'Addressing employer underinvestment in training', 2019.
3.97 City and guilds. 'Flex for success? Employers' perspectives on the apprenticeship levy', 2018.
3.98 MakeUK. 'An unlevy playing field for manufacturers', 2019.
3.99 IET. 'Skills and demand in industry 2019 survey', 2019.
3.100 RAEng. 'Engineering skills for the future: the 2013 Perkins review revisited', 2019.
3.101 NEPC. 'Engineering priorities for our future economy and society', 2019.
3.102 The Apprenticeships (Miscellaneous Provisions) Regulations 2017 (SI 2017/1310). [online], accessed 20/02/2020.
3.103 ESFA. 'Apprenticeship funding: rules and guidance for employers May 2017 to July 2018', 2018.

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, ensuring that someone else other than their employer is inputting to the transferability."[3.104]

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.

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

Apprenticeships in other countries also tend to include of 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 at a time.[3.105]
- Typically, apprentices in Germany spend at least one day per week (20% of their time) completing off-the-job training.[3.106]
- In the Netherlands, apprentices spend one day per week (20%) at 'school' and 4 days in the company.[3.107]
- 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.[3.108]
- 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. [3.109, 3.110]

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.[3.111] 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".[3.112]
- 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.[3.113]

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.[3.114]

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 retrain 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 a 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".[3.115]

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.

3.104 Richard, D. 'The Richard review of apprenticeships', 2012.
3.105 German Federal Ministry of Education and Research (BMBF). 'The German vocational training system' [online], accessed 20/02/2020.
3.106 Gatsby Charitable Trust. 'Taking training seriously: lessons from an international comparison of off-the-job training for apprenticeships in England', 2018.
3.107 European Centre for the Development of Vocational Training (Cedefop). 'Apprenticeship schemes in European countries: a cross-nation overview', 2018.
3.108 Ibid.
3.109 Ibid.
3.110 The Swedish apprenticeship differs in that it is based within the school system, unlike in the majority of programmes where students complete apprenticeships after their school education.
3.111 European Centre for the Development of Vocational Training (Cedefop). 'Apprenticeship schemes in European countries: a cross-nation overview', 2018.
3.112 CBI. 'Learning on the job: improving the apprenticeship levy', 2019.
3.113 ISE. 'Stability, transparency, flexibility and employer ownership. Employer recommendations for improving the apprenticeship system', 2019.
3.114 NAO. 'The apprenticeships programme', 2019.
3.115 National Apprenticeship Service. 'Off-the-job training: myth vs fact' [online], accessed 20/02/2020.

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 apprenticeship starts 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 (see **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 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

Apprenticeship 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 analyse the success of the apprenticeship programme.

Apprenticeship achievements – 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.

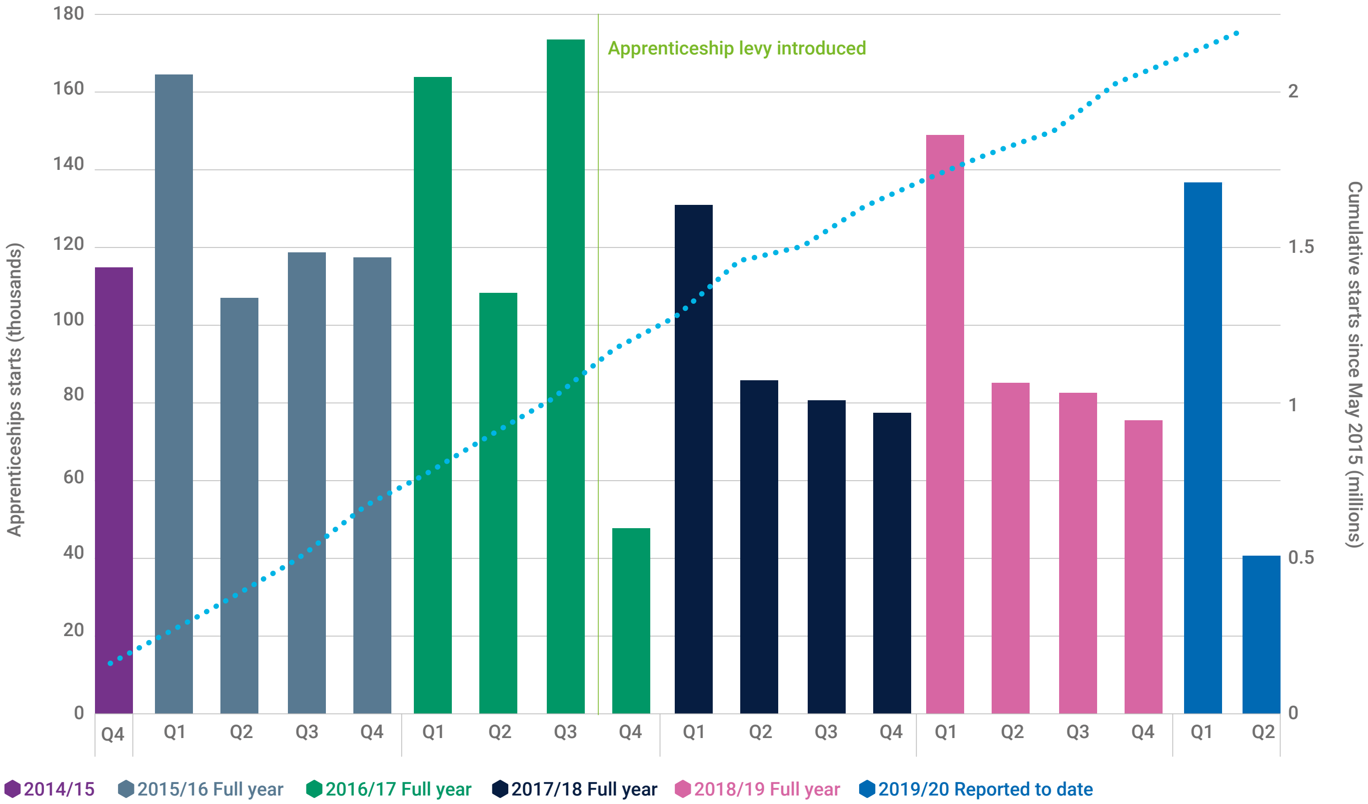
The two indicators measure different aspects of apprenticeships. In this section we will primarily provide analysis on apprenticeship starts. This is because starts provide the most up to date information on the make-up of apprentices and how the picture is changing in the rapidly-developing FE landscape. 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.

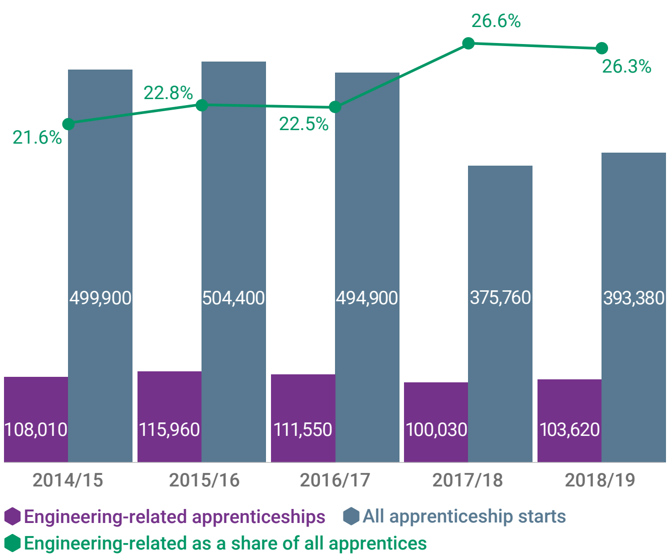
Published DfE data does not allow analysis of apprenticeship achievement rates by both sector subject area and personal characteristics such as gender and ethnicity, so it is not possible to present engineering-related achievement rates by those characteristics.

Figure 3.13 Quarterly apprenticeship starts over time (2014/15 to 2019/20) – England



Source: DfE. 'Apprenticeships and traineeships data 2014/15 to Q2 2019/20'data, 2020.
To view this figure with numbers, see **Figure 3.13** in our Excel resource

Figure 3.14 Engineering-related apprenticeships as a share of all apprenticeship starts over time (2014/15 to 2018/19) – England



Source: DfE, 'Apprenticeship demographic and sector subject area: starts and achievements 2014/15 to 2018/19' data, 2019.
All engineering-related sector subject areas includes: construction, planning and the built environment; engineering and manufacturing technologies; and information and communication technology.
To view apprenticeship starts by sector subject area, and the same table for achievements, see **Figure 3.14-3.14a** in our Excel resource.

Over the 5 year period up to the academic year 2018 to 2019, the number of engineering-related apprenticeship starts decreased by 4.1%. 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 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**).

Figure 3.15 Changes in engineering-related apprenticeship starts and achievements over time by level (2014/15 and 2018/19) – England

		Starts			Achievements		
Sector subject area	**Level**	**Starts in 2018/19 (No.)**	**Change over 1 year (%)**	**Change over 5 years (%)**	**Achievements in 2018/19 (No.)**	**Change over 1 year (%)**	**Change over 5 years (%)**
Construction, planning and the built environment	Intermediate	12,960	-12.3% ▼	-9.9% ▼	7,580	-15.3% ▼	18.8% ▲
	Advanced	6,270	9.2% ▲	65.0% ▲	3,210	-5.0% ▼	55.1% ▲
	Higher	3,310	54.0% ▲	3,210.0% ▲	240	166.7% ▲	1,100.0% ▲
	All levels	22,530	-0.6% ▼	23.2% ▲	11,030	-11.2% ▼	30.2% ▲
Engineering and manufacturing technologies	Intermediate	23,550	-13.7% ▼	-46.9% ▼	17,940	-31.3% ▼	-28.0% ▼
	Advanced	33,170	12.3% ▲	13.2% ▲	17,530	-7.0% ▼	9.4% ▲
	Higher	3,250	57.0% ▲	673.8% ▲	340	47.8% ▲	277.8% ▲
	All levels	59,970	1.8% ▲	-19.0% ▼	35,810	-20.7% ▼	-12.7% ▼
Information and communication technology	Intermediate	3,980	6.1% ▲	-11.8% ▼	2,710	25.5% ▲	-1.1% ▼
	Advanced	10,910	3.3% ▲	10.2% ▲	4,570	-13.6% ▼	-19.7% ▼
	Higher	6,220	49.2% ▲	3,97.6% ▲	970	-7.6% ▼	148.7% ▲
	All levels	21,110	14.2% ▲	34.8% ▲	8,240	-3.1% ▼	-6.6% ▼
All engineering-related apprenticeships	**Intermediate**	**40,490**	**-11.6% ▼**	**-36.0% ▼**	**28,230**	**-24.2% ▼**	**-17.1% ▼**
	Advanced	**50,350**	**9.8% ▲**	**17.1% ▲**	**25,310**	**-8.0% ▼**	**6.4% ▲**
	Higher	**12,780**	**52.3% ▲**	**622.0% ▲**	**5,150**	**275.9% ▲**	**930.0% ▲**
	All levels	**103,610**	**3.6% ▲**	**-4.1% ▼**	**55,080**	**-16.7% ▼**	**-5.6% ▼**
All sector subject areas	**Intermediate**	**143,590**	**-11.0% ▼**	**-51.9% ▼**	**86,150**	**-42.2% ▼**	**-46.3% ▼**
	Advanced	**174,730**	**5.1% ▲**	**-3.9% ▼**	**85,100**	**-23.6% ▼**	**-11.6% ▼**
	Higher	**75,060**	**55.9% ▲**	**279.7% ▲**	**13,900**	**-11.9% ▼**	**220.3% ▲**
	All levels	**393,380**	**4.7% ▲**	**-21.3% ▼**	**185,150**	**-33.0% ▼**	**-29.0% ▼**

Source: DfE, 'Apprenticeship demographic and sector subject area: starts and achievements 2014/15 to 2018/19' data, 2020.
To view engineering-related apprenticeship starts and achievements from 2014/15, see **Figure 3.15-3.15a** in our Excel resource.

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 622% 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 number 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.[3.116, 3.117] 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.[3.118] 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.[3.119] 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**).

3.116 IfATE. 'Apprenticeship standards' data, 2020.
3.117 Correct as of 27/02/2020.
3.118 DfE. 'Apprenticeships and traineeships 2018/19' data, 2019.
3.119 DfE. 'Employer Skills Survey 2017', 2018.

Figure 3.16 Changes in engineering-related higher apprenticeship starts by level (2014/15 to 2018/19) – England

Sector subject area	Level	Starts in 2018/19 (No.)	2018/19 share of higher apprenticeships (%)	Change over 1 year (%)	Change over 5 years (%)
Construction, planning and the built environment	Level 4 and 5	1,257	38.0%	15.3% ▲	1,169.7% ▲
	Level 6 + (degree apprenticeship)	2,053	62.0%	94.4% ▲	–
Engineering and manufacturing technologies	Level 4 and 5	1,902	58.5%	41.3% ▲	451.3% ▲
	Level 6 + (degree apprenticeship)	1,350	41.5%	87.8% ▲	1,828.6% ▲
Information and communication technology	Level 4 and 5	4,507	72.4%	57.9% ▲	261.1% ▲
	Level 6 + (degree apprenticeship)	1,715	27.6%	30.7% ▲	–
All engineering-related sector subject areas	**Level 4 and 5**	**7,666**	**60.0%**	**44.9%** ▲	**353.1%** ▲
	Level 6 + (degree apprenticeship)	**5,118**	**40.0%**	**65.8%** ▲	**7,211.4%** ▲
All sector subject areas	**Level 4 and 5**	**52,579**	**70.1%**	**41.0%** ▲	**167.2%** ▲
	Level 6 + (degree apprenticeship)	**22,479**	**29.9%**	**106.7%** ▲	**23,562.1%** ▲

Source: DfE. 'Monthly apprenticeship starts by sector subject area, characteristics and degree apprenticeship 2014/15 to 2018/19' data, 2019.
'-' denotes that a 5-year comparison is unavailable.
To view engineering-related higher apprenticeship starts from 2014/15, see **Figure 3.16** in our Excel resource

In the construction, planning and the built environment subject area, 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 106.7% for all areas) and over a 5 year period. However, degree apprenticeship starts comprised a larger proportion (40.0%) of all higher level starts in engineering-related areas in 2018 to 2019 than they did for all sector subject areas (29.9%).

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.[3.120] Analysis of DfE data shows that in 2018 to 2019, 5 of the 10 degree apprenticeships with the highest numbers of starts were in engineering-related areas (**Figure 3.17**).

With established employers such as Rolls-Royce[3.121] and the RAF[3.122] 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.[3.123]

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.[3.124] 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".[3.125]

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.

3.120 Universities UK. 'The future of degree apprenticeships', 2019.
3.121 Rolls-Royce. 'Engineering degree apprenticeship' [online], accessed 08/04/2020.
3.122 RAF. 'Apprentices in the RAF' [online], accessed 08/04/2020.
3.123 DfE. 'Apprenticeships and traineeships Q2 2019/20' data, 2020.
3.124 Ofsted. 'Ofsted 2017/18 annual report', 2018.
3.125 FE Week. 'Ofsted annual report warns apprenticeship levy being spent on graduate scheme rebadging' [online], accessed 14/04/2020.

Figure 3.17 Top 10 degree apprenticeships ranked by number of starts (2018/19) – England

Ranking	Sector subject area	Framework/standard name	Level	Starts in 2018/19
1	Business, administration and law	Senior leader (degree)	7	3,410
2	Business, administration and law	Chartered manager (degree)	6	2,850
3	Information and communication technology	Digital and technology solutions professional (integrated degree)	6	1,508
4	Construction, planning and the built environment	Chartered surveyor (degree)	6	1,192
5	Health, public services and care	Registered nurse - degree (NMC 2010)	6	1,034
6	Construction, planning and the built environment	Civil engineer (degree)	6	623
7	Engineering and manufacturing technologies	Manufacturing engineer (degree)	6	280
8	Engineering and manufacturing technologies	Product design and development engineer (degree)	6	249
9	Health, public services and care	Healthcare science practitioner (degree)	6	248
10	Health, public services and care	Advanced clinical practitioner (degree)	7	247

Source: DfE. 'Monthly apprenticeship starts by sector subject area, characteristcs and degree apprenticeship 2014/15 to 2018/19' data, 2019.
To view the full list of degree apprenticeship starts from 2014/15, see '**Figure 3.17-3.17a** in our Excel resource.

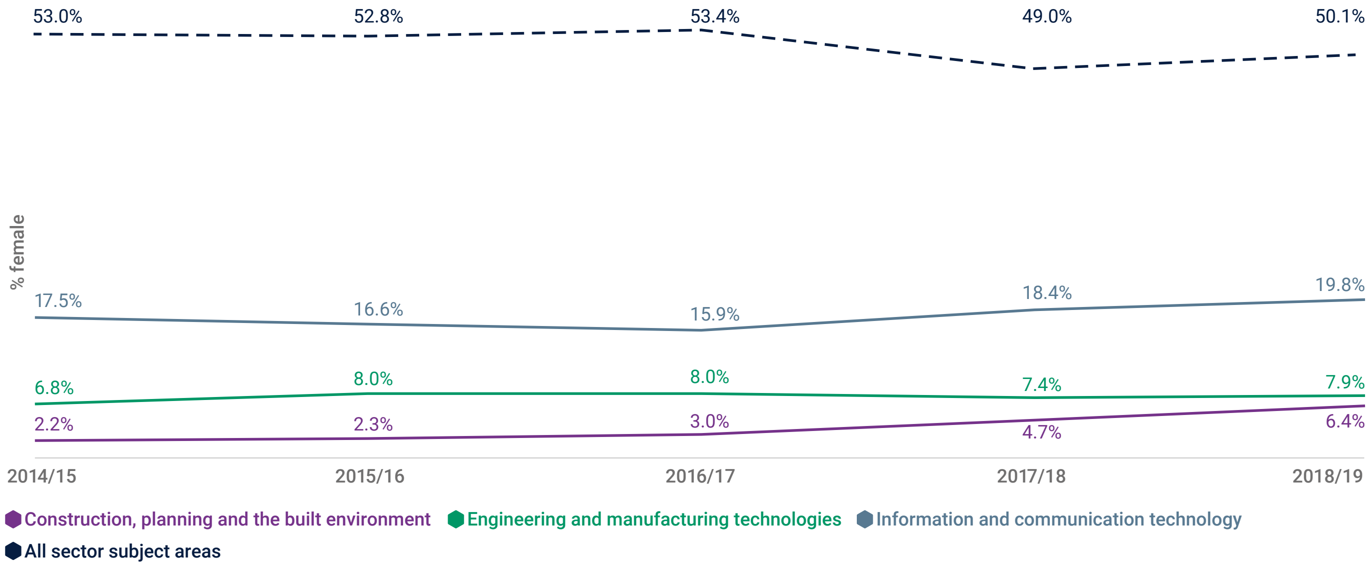
Gender

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.[3.126] The engineering sector in particular suffers from a lack of diversity, with women making up just 12% of the current engineering workforce.[3.127] Those from minority ethnic backgrounds also comprise 9% of the workforce.[3.128]

Chapter 2 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 apprenticeship starts 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 3.9 percentage points since 2016 to 2017, but women still made up less than 20% of ICT apprenticeship starts in 2018 to 2019 (**Figure 3.18**).

Figure 3.18 Female apprentices as a share of engineering-related sector subject area starts and all starts over time (2014/15 to 2018/19) – England



Source: DfE. 'Apprenticeship demographic and sector subject area: starts and achievements 2014/15 to 2018/19' data, 2019.
To view this chart with numbers and the same time series for achievements see **Figure 3.18 - 3.18a** in our Excel resource.

3.126 In 'English Apprenticeships: Our 2020 Vision', the government committed to a 20% increase in the proportion of apprentices from black and minority ethnic (BAME) backgrounds.
3.127 EngineeringUK. 'Gender disparity in engineering', 2018.
3.128 EngineeringUK. 'Social mobility in engineering', 2018.

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.[3.129] 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 apprenticeship starts by women in engineering-related areas in 2018 to 2019 shows that concerted efforts to increase the number of women taking up engineering[3.130] 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-related apprenticeships. 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 (IMechE) 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.[3.131] 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 orientated 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.

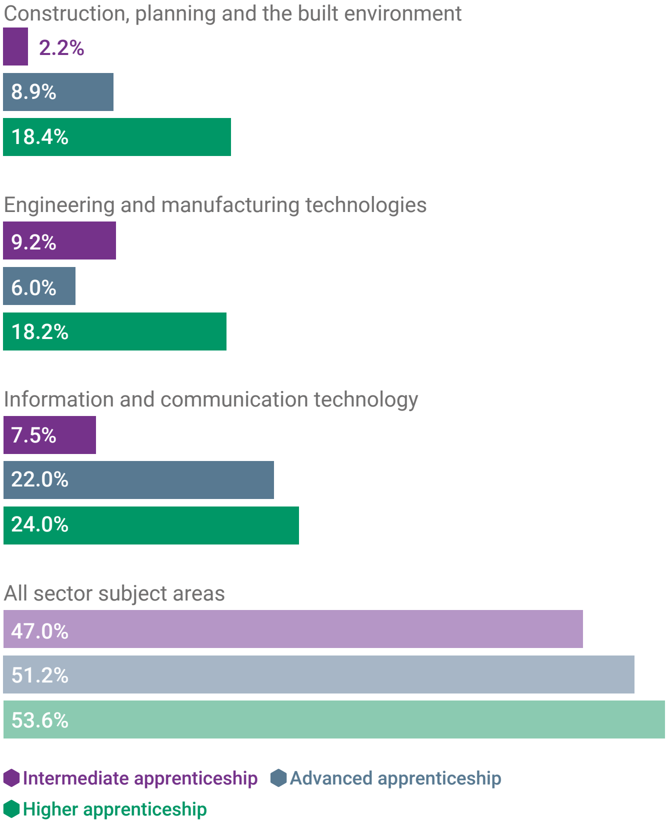
Becoming an engineer allows you to make a difference and contribute towards future innovations. The satisfaction of turning a piece of material into an item with a purpose or being able to fix something previously broken and to see it working again, either on your own or as part of a team, is priceless.

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.

3.129 House of Commons. 'Women and the economy', 2020.
3.130 Such as, for example, the Women in Science and Engineering (WISE campaign).
3.131 IMechE. 'Never too late: profiling female engineering apprentices', 2018.

Figure 3.19 Female apprentices as a share of engineering-related sector subject area starts by level (2018/19) – England



Source: DfE. 'Apprenticeship demographic and sector subject area: starts and achievements 2014/15 to 2018/19' data, 2019.
To view this figure with numbers and the same breakdown for achievements, see **Figure 3.19 -3.19a** in our Excel resource.

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 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.

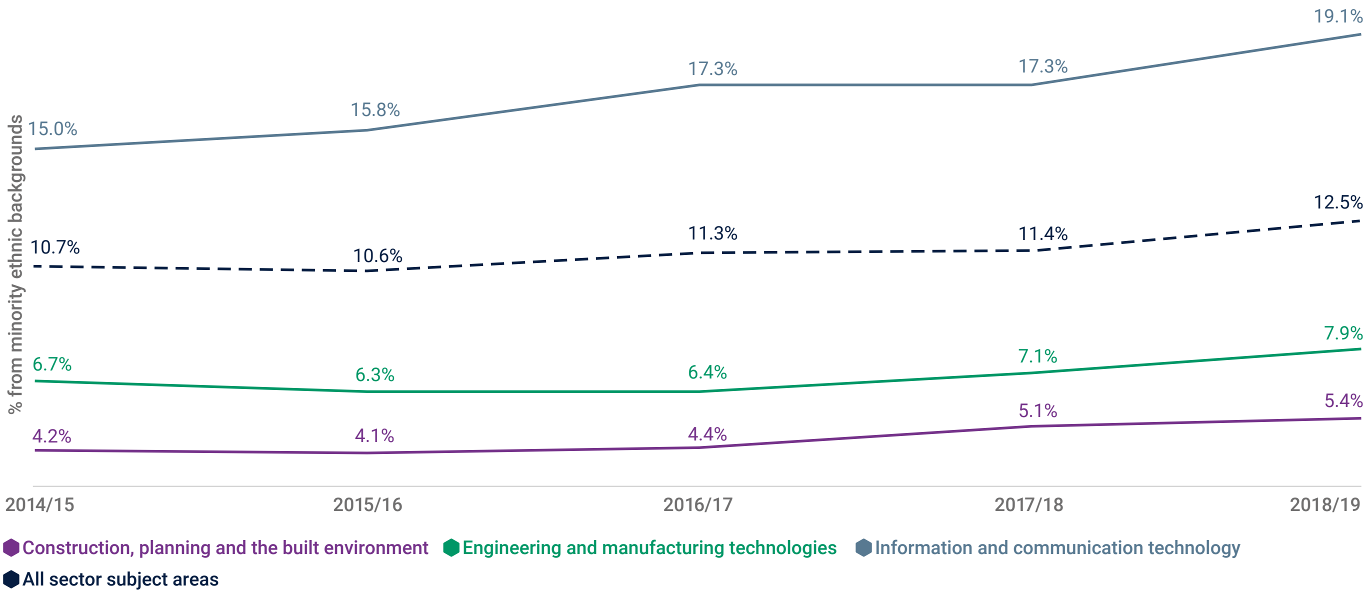
This varied by sector subject area, with just 3.1% of construction, planning and the built environment achievements by women, 6.2% of engineering and manufacturing achievements, and 14.3% of ICT achievements.

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 apprenticeship 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.

Figure 3.20 Minority ethnic apprentices as a share of engineering-related sector subject area starts and all starts over time (2014/15 to 2018/19) – England



Source: DfE. 'Apprenticeship demographic and sector subject area: starts and achievements 2014/15 to 2018/19' data, 2019.
To view engineering-related starts and achievements by ethnicity since 2014/15, see **Figure 3.20-3.20a** in our Excel resource.

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.

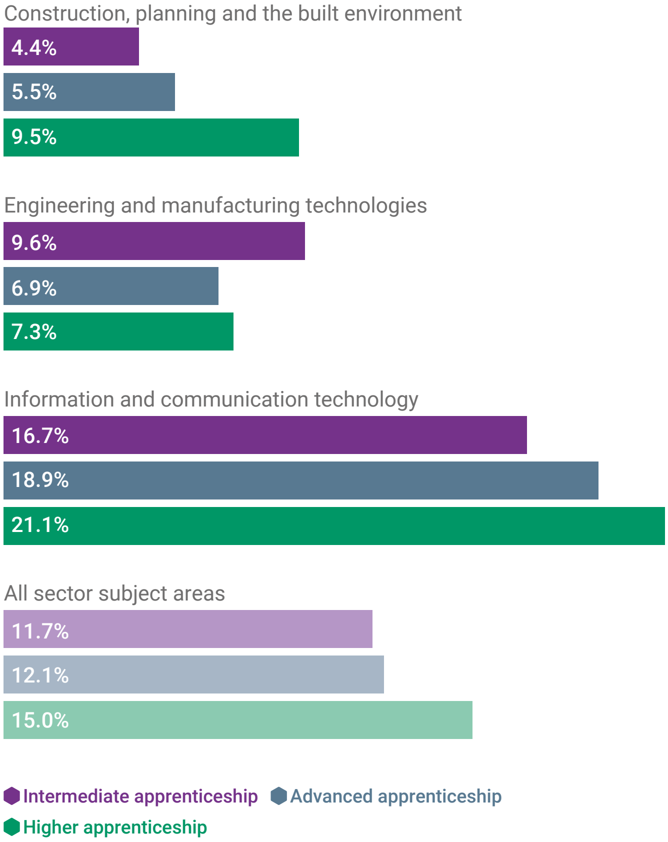
This is in stark contrast to the high proportion of engineering and technology students in higher education (HE) from minority ethnic backgrounds, which is explored in more detail in **Chapter 4**. Apprentices and higher education students are different, but those responsible for technical education 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 apprenticeship 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.[3.132] 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 be 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.

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



Source: DfE. 'Apprenticeship demographic and sector subject area: starts and achievements 2014/15 to 2018/19' data, 2019.
To view this figure with numbers, a full ethnicity breakdown and the same breakdown for apprenticeship achievements, see **Figure 3.21-3.21a** in our Excel resource.

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 declines 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.

3.132 EngineeringUK. '2019 Excel resource' data, 2019.

Engineering-related apprenticeship achievements by those from minority ethnic backgrounds

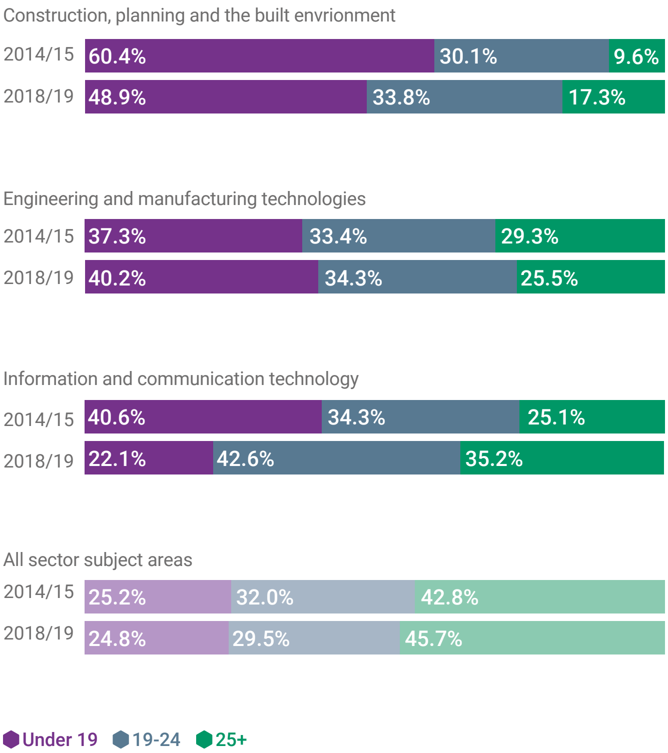
In 2018 to 2019, there were 7,550 engineering-related apprenticeship achievements by those from minority ethnic backgrounds, making up 6.9% of all achievements.

There was a large variation in achievements by sector subject area, 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.

Age

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



Source: DfE. 'Apprenticeship demographic and sector subject area: starts and achievements 2014/15 to 2018/19' data, 2019.
To view this chart with numbers, levels and historical data for both starts and achievements, see **Figure 3.22-3.22a** in our Excel resource.

Apprentices in engineering-related areas were younger than the wider apprenticeship cohort, but there has been a shift towards older apprentices in construction, planning and the built environment, and ICT since the introduction of the levy.

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 and 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.[3.133]

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.

3.133 CIPD, 'Addressing employer underinvestment in training', 2019.

Area

Figure 3.23 Engineering-related apprenticeship starts by sector subject area and region (2018/19) – England

Sector subject areas	North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East of England	London	South East	South West	England total
Construction, planning and the built environment	8.6%	16.2%	13.7%	9.6%	8.9%	9.1%	7.0%	13.3%	13.4%	22,330
Engineering and manufacturing technologies	6.0%	14.5%	12.3%	9.5%	13.9%	8.7%	6.2%	15.1%	13.7%	59,320
Information and communication technology	4.7%	11.5%	8.7%	7.1%	10.1%	9.4%	17.6%	16.2%	14.7%	20,980
All engineering-related starts	**6,470**	**14,660**	**12,190**	**9,300**	**12,350**	**9,180**	**8,960**	**15,300**	**14,220**	**103,610**
2018/19 share of engineering-related starts	**6.2%**	**14.1%**	**11.8%**	**9.0%**	**11.9%**	**8.9%**	**8.6%**	**14.8%**	**13.7%**	

Source: DfE. 'Apprenticeships geography and sector subject area: starts and achievements 2018 to 2019' data, 2019.
To view this table with numbers and data from 2014/2015, see **Figure 3.23** in our Excel resource.

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 apprenticeship 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 (15.1%), 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[3.134] shows that the highest number of engineering employees – according to the Engineering Footprint explained in the 2018 EngineeringUK report[3.135] – 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 apprenticeship 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.[3.136] 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 apprenticeship opportunities around the country".

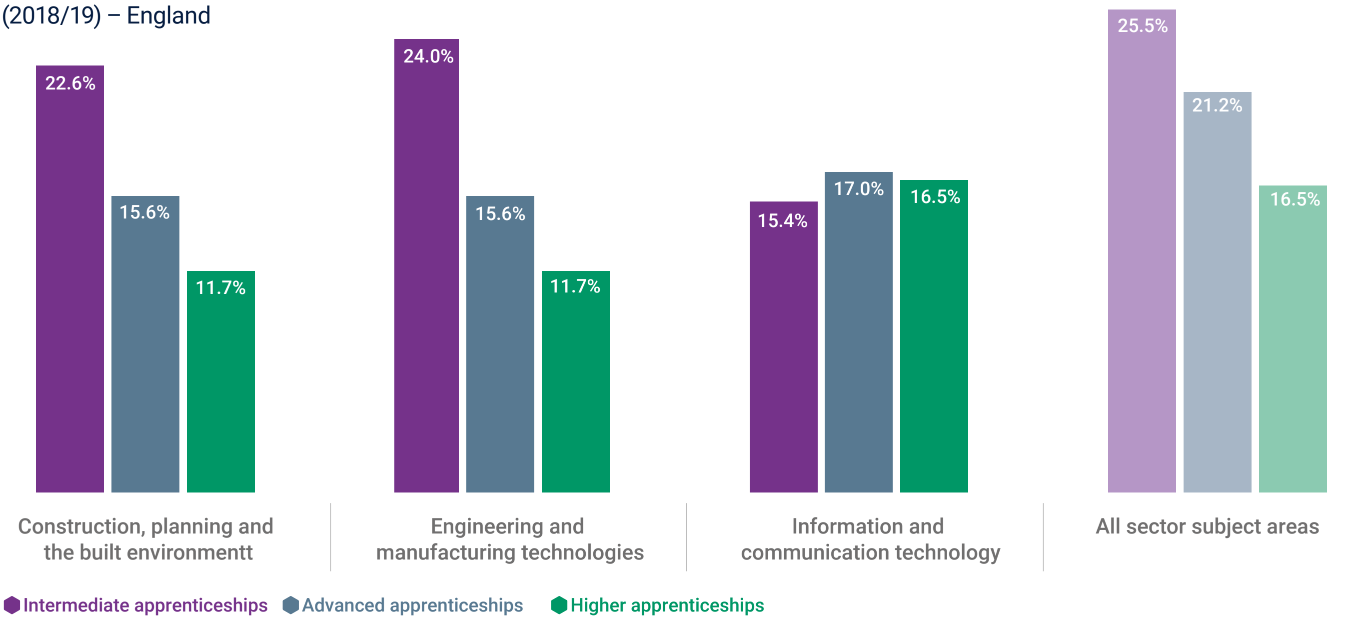
Apprenticeships and social mobility

Because apprenticeships are undertaken by people from a broad age range, it isn't possible 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 apprentices into 'deprivation quintiles' based on where they live.[3.137]

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.

3.134 ONS. 'UK business; activity, size and location: 2018' custom analysis of IDBR data, 2018.
3.135 EngineeringUK. 'Engineering UK: The state of engineering 2018', 2018.
3.136 Higher Education Commission. 'Degree apprenticeships – up to standard?', 2019.
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).

Figure 3.24 Apprentices from the most deprived areas as a share of engineering-related sector subject area starts by level (2018/19) – England



Source: DfE. 'Apprenticeship starts by IMD Quintile, sector subject area and level 2018/19 (FOI request)' data, 2019.

Figure 3.24 shows that those starting engineering-related apprenticeships in 2018 to 2019 were less likely than the overall apprenticeship cohort to come from the most deprived areas, especially within the ICT sector subject area.

There was also a large variation by level. Those starting intermediate apprenticeships in construction, planning and the built environment, and engineering and manufacturing technologies were far more likely to live in deprived areas than those starting higher apprenticeships. This means that the decline in intermediate apprenticeships may have severe implications for those who are in real need of work-based learning.

Those from the most deprived areas were underrepresented in higher level engineering-related apprenticeships in 2018 to 2019.

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%).

Figure 3.25 Changes in apprenticeship achievement rates within sector subject areas and levels, over time (2014/15 to 2018/19) – England

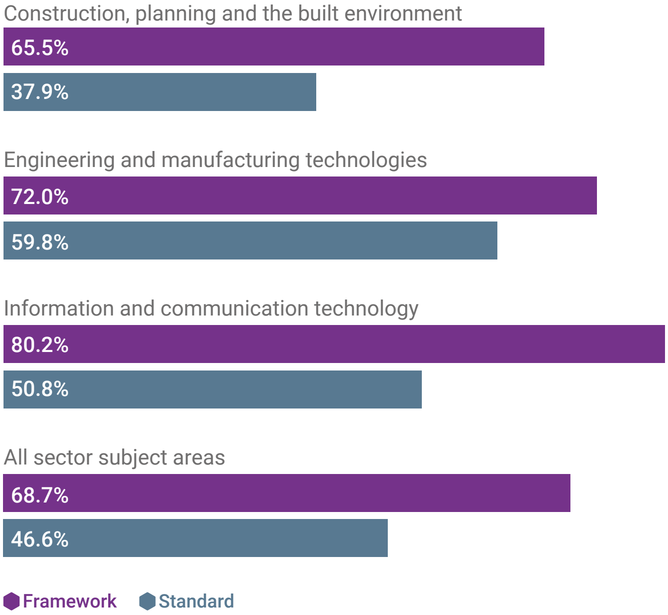
Sector subject area	Level	Achievement rates in 2018/19 (%)	Change over 1 year (%p)	Change over 5 years (%p)
Construction, planning and the built environment	Intermediate	61.2%	-2.8%p▼	-5.6%p▼
	Advanced	74.1%	-3.2%p▼	-3.2%p▼
	Higher	60.1%	12.0%p▲	-7.4%p▼
	All levels	64.4%	-2.4%p▼	-4.8%p▼
Engineering and manufacturing technologies	Intermediate	68.9%	-1.0%p▼	-2.9%p▼
	Advanced	74.0%	-0.8%p▼	-3.6%p▼
	Higher	68.3%	-1.6%p▼	-9.7%p▼
	All levels	71.2%	-0.7%p▼	-1.1%p▼
Information and communication technology	Intermediate	82.1%	11.8%p▲	5.8%p▲
	Advanced	63.9%	-9.7%p▼	-12.6%p▼
	Higher	52.6%	-12.2%p▼	-17.0%p▼
	All levels	67.2%	-4.4%p▼	-8.4%p▼
All engineering-related sector subject areas	**Intermediate**	**67.7%**	**-0.6%▼**	**-5.3%▼**
	Advanced	**72.0%**	**-2.9%▼**	**-6.5%▼**
	Higher	**56.1%**	**-7.9%▼**	**-16.3%▼**
	All levels	**71.5%**	**0.7%▲**	**-3.6%▼**
All sector subject areas	**Intermediate**	**64.0%**	**-3.0%▼**	**-7.2%p▼**
	Advanced	**66.2%**	**-2.0%p▼**	**-5.4%p▼**
	Higher	**59.7%**	**-3.9%p▼**	**-8.8%p▼**
	All levels	**64.7%**	**-2.7%▼**	**-5.7%p▼**

Source: DfE. 'National achievement rate tables 2014/15 to 2018/19' data, 2016 to 2020.
To view achievement rates from 2014/15, see **Figure 3.25** in our Excel resource.

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.

Figure 3.26 Achievement rates in engineering-related frameworks and standards (2018/19) – England



Source: DfE. 'National achievement rate tables 2018/19' data, 2020.

In 2018 to 2019, apprenticeship standards had considerably lower achievement rates than apprenticeship frameworks.

Figure 3.26 shows that across all subject areas, achievement rates are considerably lower for the new apprenticeship standards, especially in construction (27.6 percentage points difference in achievement rates between frameworks and standards) and ICT (29.4 percentage points difference). This raises some cause for concern, given that all new apprenticeships will be standards from August 2020. While far fewer had completed apprenticeship standards than frameworks in the 2018 to 2019 calculations, there were almost 65,000, meaning that the success rates should be judged as a true test of the new style of apprenticeship.

If these rates continue, there will be large swathes 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.

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.[3.138] However, the apprenticeship levy does apply across all nations of the UK, with each devolved administration receiving a proportional 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).[3.139]

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.[3.140] 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.[3.141] There are 3 main types of apprenticeship available in Scotland:[3.142]

- 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 prioritised for 16 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 workforce in Scotland.

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.

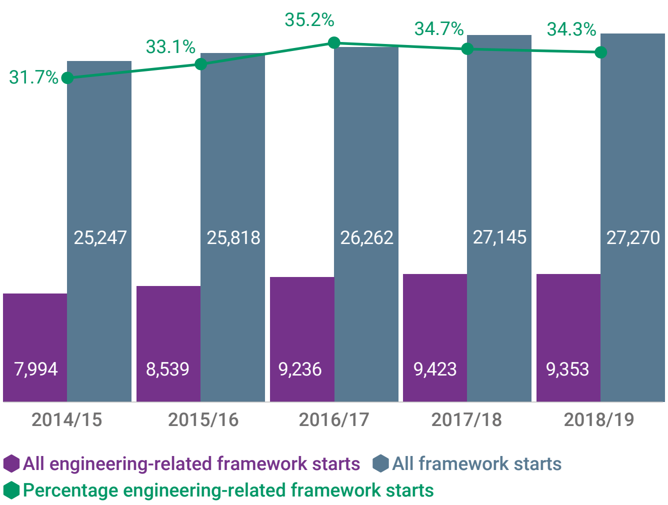
3.138 SQA. 'A guide to apprenticeships in the UK' [online], accessed 14/04/2020.
3.139 Fair Work, Employability and Skills Directorate. 'Scottish apprenticeships: seven things you need to know' [online], accessed 05/04/2020.
3.140 Skills Development Scotland. 'The Scottish apprenticeship advisory board' [online], accessed 27/02/2020.
3.141 Scottish Government. '30,000 Modern Apprenticeships by 2020' [online], accessed 05/04/2020.
3.142 Skills Development Scotland. 'Apprenticeships' [online], accessed 27/02/2020.

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 apprentices 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

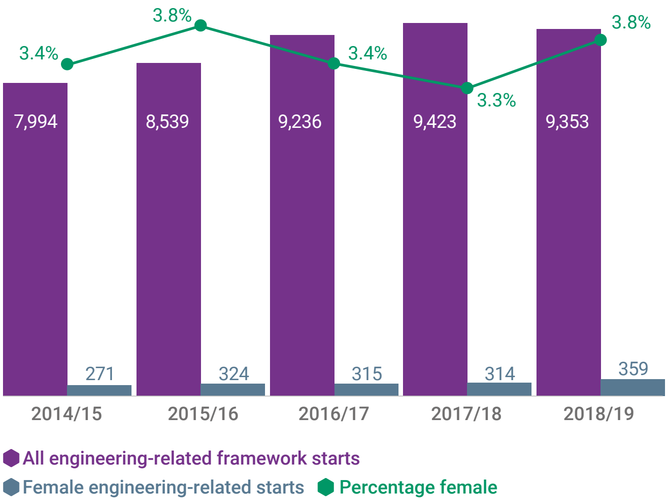


Source: Skills Development Scotland. 'Modern apprenticeship statistics Q4 2018/19' data, 2019.
In Scotland, apprenticeships are not broken down by sector subject area, so we have determined whether an apprenticeship is engineering-related based on the framework.
To view engineering-related apprenticeship starts and achievements by framework and level from 2014/15, see **Figure 3.27-3.27a** in our Excel resource.

Furthermore, in Scotland there has been no real decline in engineering-related apprenticeships – or apprenticeships overall – indicating that the levy has not affected Scotland in the same way as it has England. On the contrary, engineering apprenticeship starts have increased by almost 1,500 over a 5-year period, which is a 16.8% rise since 2014 to 2015. The rate of increase for engineering-related starts has been faster than the overall increase in apprenticeship starts in Scotland, meaning that Scotland now has a higher proportion of engineering apprentices than 5 years ago. However, the share has marginally decreased since its highest point in 2016 to 2017 (**Figure 3.27**).

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.

Figure 3.28 Female apprentices as a share of engineering-related apprenticeship starts over time (2014/15 to 2018/19) – Scotland



Source: Skills development Scotland. 'Modern apprenticeship statistics Q4 2018/19' data, 2019.
To view female apprentices starting engineering-related frameworks by age group and from 2014/15, see **Figure 3.28** in our Excel resource.

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.[3.143, 3.144]

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 73.3% 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**).

3.143 Skills Development Scotland. 'Modern Apprenticeship statistics, Quarter 4 2018-19' data, 2019.
3.144 For a full analysis of engineering-related starts and achievements by women in Scotland, please see **Figure 3.28a** in our Excel resource.
3.145 **Figure 3.28a** in our Excel resource also contains more information on achievement rates in Scotland.

Figure 3.29 Engineering-related apprenticeship starts by age group (2018/19) – Scotland

	16-19		20-24		25+		All ages
	No.	%	No.	%	No.	%	No.
All engineering-related frameworks	4,219	45.1%	1,497	16.0%	3,622	38.7%	9,353
All frameworks	11,720	43.0%	6,710	24.6%	8,840	32.4%	27,270

Source: Skills Development Scotland. 'Modern apprenticeship statistics Q4 2018/19' data, 2019.
To view this table with engineering-related frameworks, see **Figure 3.29** in our Excel resource.

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 further along in their careers are choosing to study an engineering apprenticeship, either as a way of re-training or upskilling. 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 apprenticeship programme using the existing 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".[3.146]

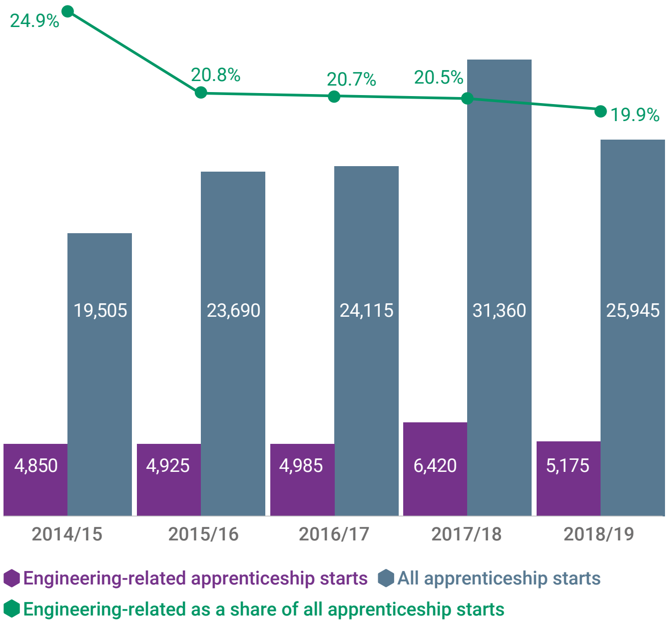
The Welsh government has committed to increasing apprenticeships in skills shortage areas such as engineering.

In 2017, the Welsh government committed to delivering 100,000 apprenticeship places by 2022[3.147] and recent evidence suggests it is on course to meet that target.[3.148] In the 2017 policy plan, the government also committed to increasing numbers of apprentices in 'skills shortage areas' such as engineering, and generally increasing STEM apprenticeships more widely.[3.149]

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 apprenticeships, and level 4 and above apprenticeships are called highers.

In Wales, there were 5,175 engineering-related apprenticeship starts in 2018 to 2019, a 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 year before. 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.

Figure 3.30 Engineering-related apprenticeships as a share of all apprenticeship starts over time (2014/15 to 2018/19) – Wales



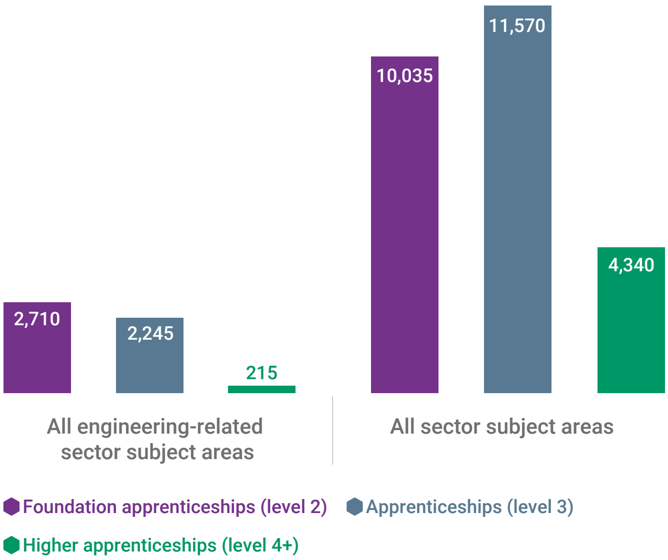
Source: Stats Wales. 'Learning programmes for foundation apprenticeships, apprenticeships and higher apprenticeships 2014/15 to 2018/19' data, 2020.
There is no Information and communication technology data for 2018 to 2019. There are some IT courses included in Business administration apprenticeships, but these are not included under engineering related apprenticeship starts.
Numbers are runded to the nearest 5.
To view apprenticeship starts and leavers by sector subject area and from 2014/15, see **Figure 3.30-3.30a** in our Excel resource.

3.146 Business Wales. 'Apprenticeship levy' [online], accessed 05/04/2020.
3.147 Welsh Government. 'Aligning the apprenticeship model to the needs of the Welsh economy', 2017.
3.148 Business News Wales. 'Target of creating 100,000 apprenticeships in Wales set to be exceeded' [online], accessed 14/04/2020.
3.149 Welsh Government. 'Aligning the apprenticeship model to the needs of the Welsh economy', 2017.

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.[3.150]

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. However, 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". [3.151] The landscape could therefore change significantly, with more higher level engineering-related starts in future.

Figure 3.31 Engineering-related and all apprenticeship starts by level (2018/19) – Wales

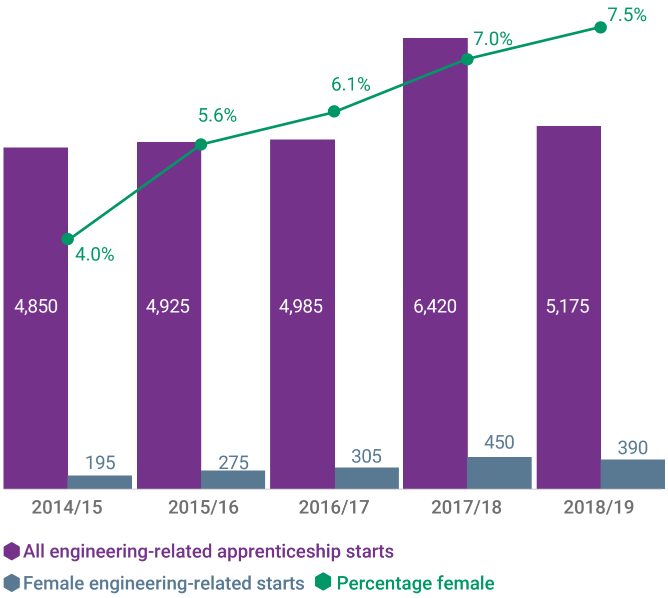


Source: Stats Wales. 'Learning programmes for foundation apprenticeships, apprenticeships and higher apprenticeships 2018/19' data, 2020.
To view apprenticeship starts and leavers by sector subject area, level and from 2014/15, see **Figure 3.31-3.31a** in our Excel resource.

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.

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

Figure 3.32 Female apprentices as a share of engineering-related apprenticeship starts over time (2014/15 to 2018/19) – Wales



Source: Stats Wales. 'Learning programmes for foundation apprenticeships, apprenticeships and higher apprenticeships 2014/15 to 2018/19' data, 2020.
There is no information and communication technology data for 2018 to 2019. There are some IT courses included in business administration apprenticeships, but these are not included under engineering related apprenticeship starts.
Female engineering related starts do not include information and communication technology.

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 leavers 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.

3.150 Stats Wales. 'Learning programmes for foundation apprenticeships, apprenticeships and higher apprenticeships 2014/15 to 2018/19' data, 2020.
3.151 Estyn. 'Higher apprenticeships in work-based learning', 2018.

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. 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 apprenticeship participants in Northern Ireland.

Figure 3.33 Apprenticeship participation by framework, level and gender (2019) – Northern Ireland

Framework	Level 2		Level 2/3		Level 3		All levels	
	Female	Total	Female	Total	Female	Total	Total	% Female
Construction	4	461	–	4	–	–	465	0.9%
Construction crafts	–	–	–	74	1	234	308	0.3%
Construction technical	–	–	–	–	–	32	32	0.0%
Electrical and electronic servicing	–	12	–	2	–	2	16	0.0%
Electrical distribution and transmission engineering	–	–	1	35	–	8	43	2.3%
Electrical power engineering	1	11	–	–	–	–	11	9.1%
Electrotechnical	–	–	1	358	6	1,139	1,497	0.5%
Engineering	3	333	21	279	4	229	841	3.3%
Food manufacture	136	345	3	4	145	297	646	44.0%
Furniture production	1	24	–	–	1	7	31	6.5%
Heating, ventialllation, air conditioning and refridgeration	–	38	–	1	–	21	60	0.0%
IT user	2	4	1	2	3	9	15	40.0%
IT and telecoms professional	6	23	–	–	12	83	106	17.0%
Land based service engineering	–	5	–	–	–	25	30	0.0%
Light vehicle body and paint operations	–	–	–	11	–	35	46	0.0%
Mechanical engineering services (plumbing)	1	235	–	57	1	183	475	0.4%
Print production	–	–	–	–	–	21	21	0.0%
Printing industry	2	28	–	–	–	–	28	7.1%
Vehicle body and paint	–	71	–	3	–	–	74	0.0%
Vehicle fitting	–	8	–	–	–	–	8	0.0%
Vehicle maintenance and repair	1	143	6	288	3	194	625	1.6%
Vehicle parts	–	4	3	15	–	15	34	8.8%
All engineering related frameworks	**157**	**1,745**	**36**	**1,133**	**176**	**2,534**	**5,412**	**6.8%**
Total	**1,009**	**3,465**	**108**	**1,278**	**1,228**	**4,065**	**8,812**	**26.6%**
Engineering-related apprenticeships as a share of all frameworks	**15.6%**	**50.4%**	**33.3%**	**88.7%**	**14.3%**	**62.3%**	**61.4%**	

Source: Northern Ireland Department for the Economy 'ApprenticeshipsNI statistics from August 2013 to October 2019' data, 2020.
Northern Ireland's Department for the Economy defines a participant as an individual on ApprenticeshipsNI (a type of contract). An individual can participate on ApprenticeshipsNI more than once.
This table shows the numbers of apprentices who were participating in engineering-related frameworks as of October 2019.
'-' denotes that there were no apprentices at this level.

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

Figure 3.33 shows that in 2019, 61.4% of all apprenticeship participants were on engineering-related apprenticeships. This is a far greater share than for England, Scotland or Wales, and is likely to reflect the types of vocational training available. This 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.[3.152] 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[3.153] – 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 apprenticeship participants who were women in Northern Ireland was also relatively low, at just 28.8%.

In electrotechnical, the most popular apprenticeship 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).

3.152 Northern Ireland Department for the Economy. 'Success through STEM', 2011.
3.153 Northern Ireland Departmnet for the Economy. 'Northern Ireland skills barometer summary report', 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 being driven by training and education providers who may not have created the right solutions for employers. This is not because providers were not aligning with business needs, but instead that they were perhaps more focussed on meeting the needs of the learners.

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,[3.154] 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 seems to be a lack of evidence suggesting an individualised approach can realise these wider ambitions. There should therefore be more centralised coordination, strategy and input at sector and sub-sector level, particularly where there are credible sector bodies in existence that are gathering data to identify future needs for their employers.

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3.154 RaEng. 'Engineering skills for the future: the 2013 Perkins Review revisited', 2019.
3.155 EngineeringUK. 'Demand tables' [online], accessed 24/03/2020.
3.156 RaEng. 'Engineering skills for the future: the 2013 Perkins Review revisited', 2019.

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

In the engineering sector, 90% of businesses have fewer than 10 people. This means it's difficult for them to think about broader skills needs.

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.[3.155] 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.[3.156]

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 IfATE'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 (SICs) 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 stronger 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.

4 - Higher education

Engineering and technology was the second most popular STEM subject area for EU-domiciled students studying in the UK in 2018 to 2019.

Female share of engineering and technology HE entrants in 2018 to 2019: First degree (17.6%), Other undergraduate (12.7%), Postgraduate taught (28.1%), Postgraduate research (26.5%).

Key points

The UK left the European Union in January 2020 without a clear implementation plan for university students or staff, meaning the future landscape of higher education (HE) is unclear. In the academic year 2018 to 2019, engineering and technology was the second most popular STEM subject area for EU domiciled students (12,465 enrolled). Thus, the engineering sector should pay close attention to any updated Brexit policies and how they may affect student uptake.

The continued underrepresentation of women, disabled students and those from low participation neighbourhoods indicates more work needs to be done to effectively address challenges related to access and equality in engineering and technology HE.

Engineering and technology entrants

Trends in engineering and technology HE participation vary widely by level of study. Over the past 10 years, engineering and technology entries have increased at first degree undergraduate and postgraduate research level (by 5.6% and 10.4%, respectively), but have declined at other undergraduate and postgraduate taught level (by 55.5% and 4.9%, respectively). However, barring other undergraduates, entrant numbers remained fairly static between 2017 to 2018 and 2018 to 2019.

The large decline in engineering and technology entries at other undergraduate level mirrors trends across HE more widely, where there has been a 64.9% decrease in the past 10 years. 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.

Mechanical engineering remained the most popular first degree choice for new students in 2018 to 2019 (25.5% of entrants), a position it has held since 2011 to 2012. Over the same time period, there has been a rise in popularity of general engineering and a drop in numbers of entrants to electrical and electronic engineering courses. The most common principal subject for other undergraduates was general engineering (26.8%), followed by electronic and electrical engineering (21.8%).

Subject popularity differed again at postgraduate level, with the largest proportions of postgraduate taught entrants choosing either civil engineering (18.9%) or electronic or electrical engineering (18.9%). The most popular subject for postgraduate research entrants was general engineering (27.2% of entrants).

Diversity among engineering and technology HE students

There remains a stark gender disparity in engineering and technology HE courses. Only 1 in 5 (20.7%) engineering and technology entrants were women in 2018 to 2019, whereas they accounted for more than half (57.2%) of the student population overall. This gender difference varied significantly by level of study, with postgraduate courses attracting a far higher proportion of women than undergraduate courses (28.1% of postgraduate taught entrants but just 17.6% of first degree entrants). Despite these low numbers, engineering and technology has managed to attract more women across all levels of study since 2010 to 2011 (increase of 4.8 percentage points). This indicates that some of the initiatives in place to attract women into engineering may be working. However, if trends continue at the same rate, gender equality on these courses will not be attained for 3 decades.

The proportion of engineering and technology entrants from minority ethnic backgrounds continues to rise, with a 29.9% share in 2018 to 2019. This is higher than among the overall student population, where just 25.6% were from minority ethnic backgrounds in 2018 to 2019. Although participation figures are encouraging, students from minority ethnic backgrounds are less likely to achieve a 'good' degree classification than their White peers. In 2018 to 2019, 72.9% of minority ethnic engineering and technology qualifiers achieved a first or upper second class degree, compared with 83.4% of White qualifiers. Achievement levels varied among different ethnic groups, with only 64.3% of Black students achieving a first or upper second, compared with 75.7% of Asian qualifiers.

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 only been 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.

4.1 – Context

The higher education (HE) sector in the United Kingdom is extremely rich and varied, providing prospective students with a 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.[4.1, 4.2] Furthermore, the sector supported more than 940,000 jobs,[4.3] making it an integral part of both the education system and the country as a whole.

The HE system forms the 'final stage' of formal education in the UK, following on from secondary education and technical education, both of which are covered in previous chapters of this report. Within this section, the composition of students – both those studying engineering degrees and those on other courses – will be explored, with a particular focus on ensuring participation in HE remains open to all those in the UK, regardless of background.

For the engineering sector in particular, the HE system has a key role to play in increasing the engineering talent pipeline. It isn't mandatory to hold a degree in engineering to become a chartered engineer, but it has been noted by the Engineering Council that the "application process for Chartered Engineering registration is more straightforward for those with exemplifying academic qualifications"[4.4] (with academic qualifications in this context meaning either an engineering bachelor's degree plus a relevant master's degree, or a master's in engineering degree).

In 2018 to 2019, there were 165,180 students enrolled in engineering and technology degrees, a similar number to previous years.[4.5]

Equality and diversity in higher education

In recent years, there have been significant efforts to widen participation within engineering and technology courses, and in HE more generally. This has been delivered alongside a vast expansion to the UK HE system since the early 1990s, both in terms of overall numbers of students and the proportion of young people that are studying for a degree.[4.6]

Overall student numbers in 2018 to 2019 were lower than in their peak in 2010 to 2011. However, although HE expansion may have stalled, participation by those from diverse backgrounds is higher than it has ever been.

The UK higher education population is more diverse in 2018 to 2019 than it has ever been.

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 12.0%,[4.7] and although overall figures have not 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 12.0% of those working in engineering occupations in the UK.[4.8]

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.[4.9]

While those from minority ethnic backgrounds are well represented in engineering HE, (29.9% of engineering and technology entrants to HE, compared with 23.6% of all students and 14.0% of the population in England and Wales)[4.10, 4.11] the proportion of minority ethnic people working in engineering occupations (9.0%) is low.[4.12] The overall proportion of engineers that come from low socioeconomic backgrounds (24%) is also low.[4.13]

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 in the education pipeline than university. Nevertheless, those responsible for delivering engineering courses in HE must do their utmost to ensure that applicants from all backgrounds continue to see engineering and technology as an attractive and viable option.

The main effort to address diversity issues across all subjects came with the introduction in January 2018 of the Office for Students (OfS – described in greater detail below). 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 up to £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 decision 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, progressing more generally) are rooted in much earlier experiences that shape their motivations, capability and opportunities.

The rationale for increasing the diversity of engineering and

4.1 Figures for 2014 to 2015 were the most recent available.
4.2 Universities UK. 'The economic impact of universities in 2014-15', 2017.
4.3 Ibid.
4.4 Engineering Council. 'Chartered Engineer' [online], accessed 22/01/2020.
4.5 HESA. 'HESA student record 2018/19' data, 2020.
4.6 ONS. 'How has the student population changed?', 2016.
4.7 HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 2020.
4.8 EngineeringUK. 'Gender disparity in engineering', 2018.
4.9 HESA. 'HESA student record 2018/19' data, 2020.
4.10 Ibid.
4.11 UK Government. 'Population of England and Wales' [online], accessed 30/04/2020.
4.12 EngineeringUK. 'Social mobility in engineering', 2018.
4.13 Ibid.

technology students is not only based on a very pertinent need for social justice and equality; there is also a strong business case. If the engineering sector is to address its longstanding skills shortage,[4.14] it is critical that it attracts as wide a talent pool as possible. And the benefits of increasing the diversity of engineering and technology students in HE is not simply a matter of numbers. Research has consistently shown that a more diverse talent pool brings with it increased creativity and new ideas (essential for an innovative, solutions-based industry) as well as enhanced motivation, retention, group problem solving and financial performance.[4.15, 4.16, 4.17]

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.

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 providing the engineering sector with the qualified and inclusive workforce it needs.

This chapter will explore in detail students from these groups – with a particular focus on how engineering and technology compares with the overall student population. It will also investigate the differences between students studying at different levels and the complex factors involved when examining the interplay between gender, ethnicity, socioeconomic status, disability and nationality.

Key policy developments

Brexit

On 31 January 2020, the UK left the European Union. The one year transition period lasts until new rules take effect on 1 January 2021, after the UK and the EU have finished negotiating additional arrangements.[4.18]

Although the impact of Brexit cannot be fully understood until the final trading arrangements have been decided, the UK's decision to leave the EU has already had an adverse effect on the university sector. An article in the Guardian,[4.19] for example, reported that "almost 11,000 EU academics had left since the 2016 referendum". Other studies have found that the decision has affected the degree to which the UK is seen as a desirable place to study, with 40% of EU students aged 15 to 17 indicating they were less likely to study in the UK because of Brexit.[4.20]

Many in 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.[4.21] 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 educational export total.[4.22] 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).[4.23]

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.

Higher Education and Research Act

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).

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 OFFA officially closed in April 2018,[4.27] all of its duties

4.14 EngineeringUK. 'Engineering UK: The state of engineering 2018', 2018.
4.15 McKinsey & Company. 'Diversity matters', 2015.
4.16 Harvard Business Review. 'How diversity can drive innovation' [online], accessed 11/02/2020.
4.17 CIPD. 'Diversity and inclusion at work: facing up to the business case', 2018.
4.18 UK Government. 'Transition period' [online], accessed 02/02/2020.
4.19 The Guardian. 'Lib Dems warn of Brexit brain drain as EU academics quit' [online], accessed 03/02/2020.
4.20 QS. 'International Student Survey 2019', 2019.
4.21 Global Business Outlook. 'The implications of Brexit for the UK higher education system' [online], accessed 02/02/2020.
4.22 DfE. 'UK Revenue from education related exports and transnational education activity in 2017', 2019.
4.23 Ibid.
4.24 HESA. 'HESA student record 2018/19' data, 2020.
4.25 EngineeringUK. 'Engineering UK: The state of engineering 2018', 2018.
4.26 UK Government legislation. 'The higher education and research act 2017' [online], accessed 30/04/2017.

have been subsumed by OfS. The change in title reflects numerous other changes due to growing recognition that "simply getting 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 disadvantage following them long after they have left higher education", according to a recent paper from the Higher Education Policy Institute (HEPI).[4.28]

OfS superseded the Higher Education Funding Council of England (HEFCE) as the main regulator of English HE and is responsible for holding universities to account for the quality of teaching they provide.[4.29]

OfS also is responsible for regulating university access agreements, discussed in the equality and diversity section above. As part of this, OfS is working closely with HE providers and HESA to ensure there is sufficient data on protected characteristics of students, including gender, ethnicity and socioeconomic status.

Funding changes

In addition to changes in regulation that came about following the HERA, there have also been several changes to student finance over the past 10 years. Crucially, the rise in the maximum possible value for tuition fees passed by the coalition government in 2010 – which came into effect for the first time in the academic year 2012 to 2013 – impacted student numbers significantly (as displayed in **Figure 4.1** in section 4.2).

The majority of students from low-income backgrounds would have widened the range of universities they applied for if they had received a maintenance grant.

Several years after the rise in fees, in the 2015 summer budget the Conservative government announced its intention to abolish student grants and replace them with maintenance loans requiring repayment.[4.30] This particularly impacted those with a low household income, because instead of receiving a bursary that they would not have to pay back, they now needed to procure an extra loan.

The government justified this at the time by saying that for "students on incomes of £25,000 or less, the loan for living costs in 2016/17 will be 10.3% higher than the combined maximum maintenance grant and loan in 2015/16".[4.31] However, there is clear evidence that students from low income backgrounds now accumulate the largest student loan debts,[4.32] with many of those from the poorest backgrounds accruing debts of £57,000 (plus interest) from a 3-year degree.[4.33]

The large – and often crippling – debts experienced by these students is a prohibiting factor to widening participation. A 2017 survey by the National Education Opportunities Network (NEON) found that if they had been able to receive a maintenance grant, 57% of respondents would have considered attending a wider range of institutions and 61% would have reduced the amount of paid work done during term time.[4.34]

The second point is important, because students from disadvantaged backgrounds may need to work part-time during term time This may lead to lower academic outcomes for those students, widening the gap in attainment between students whose socioeconomic status differs (see section 4.6 for more detail). Research conducted recently by upReach for the Social Mobility Commission highlighted the potential adverse effects of working while studying. Students doing paid work reported that it had an impact on their studies (73%), their wider participation in university life (70%) and their wellbeing (53%).[4.35]

About the data

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 oversas.
- **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 covers 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.

4.27 UK Government. 'Office for Fair Access' [online], accessed 03/02/2020.
4.28 HEPI. 'Introducing our manifesto for the new director of fair access and participation', 2018.
4.29 UK Government. 'New universities regulator comes into force' [online], accessed 03/02/2020.
4.30 House of Commons Library. 'Abolition of maintenance grants in England from 2016/17', 2017.
4.31 UK Government legislation. 'Explanatory memorandum to the education (student support) (amendment) regulations 2015', 2015.
4.32 EPI. 'Post-18 education and funding: Options for the government review', 2019.
4.33 IFS. 'Higher Education funding in England: past, present and options for the future', 2017.
4.34 NEON. 'Does cost matter? How the HE finance system affects student decision making', 2017.
4.35 upReach. 'Impact of part time jobs at university', 2019.

In addition, qualifiers in the academic year 2018 to 2019 cannot be compared with entrants, because the former may have started in various different years. Where we present analysis of degree attainment, we use the first degree undergraduate qualifier population.

Due to the availability of historical HESA data, where we present time series going back further than the academic year 2014 to 2015, we compare engineering and technology entrants to the overall HE student population. Although there are limitations in this approach, there are benefits to examining results over a longer time period, so this is still a useful comparison.

All totals presented are rounded to the nearest 5, in accordance with HESA policy on data disclosure. This means that the sum of any subtotals in a figure may not match the total.

Exclusions

GDPR rules mean HESA now has to seek permission on how the data it collects from HE providers can be used. Data use was categorised according to the types of organisations that would use it and the reason for its use.[4.36] This change affected the HESA data that EngineeringUK receives, with 3 HE providers opting not to provide data to organisations in our category: Falmouth University; University of Worcester; and London South Bank University. However, data from these providers is still available in high-level aggregations published on the HESA website. Where possible, we have used published HESA data to present analysis on engineering students.

Detailed data on entrants and qualifiers broken down by principal subject and personal characteristics, including gender, ethnicity, POLAR4 status and disability, is not publicly available. So in order to include analysis such as detailed subject breakdowns and attainment in engineering and technology degrees by specific characteristics, we have used raw HESA data that excludes the 3 providers mentioned above – a decision we believe is justified because of the value of that analysis.

As some of the figures in this chapter use the published data and some use the raw data (the latter is indicated in a figure's footnotes), totals presented in figures using published and raw data may not match.

The numbers of engineering and technology students affected are:

- first degree undergraduate entrants – 590 students excluded from the raw data (1.6% of the total)
- other undergraduate entrants – 155 students excluded from the raw data (3.1% of the total)
- postgraduate taught entrants – 90 students excluded from the raw data (0.5% of the total)
- postgraduate research entrants – 20 students excluded from the raw data (0.4% of the total)

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**).[4.37] 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.[4.39] This puts the UK on an extremely competitive footing globally and is undoubtedly is 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

Figure 4.1 Engineering and technology student numbers over time (2009/10 to 2018/19) – UK

	Engineering and technology students		All students	
Year	No.	Change over 1 year (%)	No.	Change over 1 year (%)
2009/10	156,985		2,493,420	
2010/11	160,885	2.0%	2,501,295	0.3%
2011/12	162,020	1.0%	2,496,645	0.0%
2012/13	158,115	-2.0%	2,340,275	-6.0%
2013/14	159,010	1.0%	2,299,355	-2.0%
2014/15	161,445	2.0%	2,266,075	-1.0%
2015/16	163,255	1.0%	2,280,825	1.0%
2016/17	165,155	1.2%	2,317,880	1.6%
2017/18	164,975	-0.1%	2,343,095	1.1%
2018/19	165,180	0.1%	2,383,970	1.7%

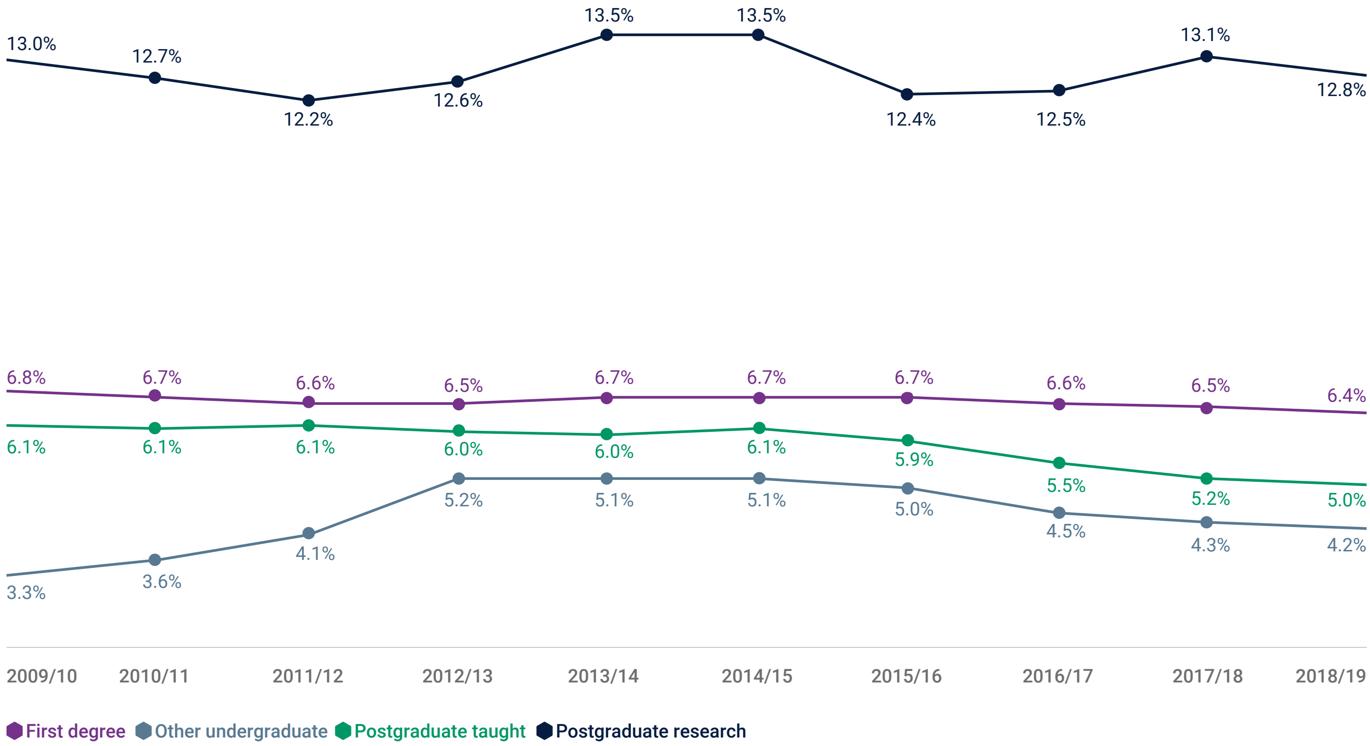
Source: HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 2020.

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,[4.39] 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**).

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 UK Government. 'Changes to tuition fees and higher education' [online], accessed 22/01/2020.

Figure 4.2 Engineering and technology entrants as a share of overall HE entrants by level of study (2009/10 to 2018/19) – UK



Source: HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 2020.

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.[4.40]

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**.

Figure 4.3 Engineering and technology principal subjects in HE

Engineering principal subjects	Technology principal subjects
(H0) Broadly based programmes within engineering and technology	(J1) Minerals technology
(H1) General engineering	(J2) Metallurgy
(H2) Civil engineering	(J3) Ceramics and glass
(H3) Mechanical engineering	(J4) Polymers and textiles
(H4) Aerospace engineering	(J5) Materials technology not otherwise specified
(H5) Naval architecture	(J6) Maritime technology
(H6) Electronic and electrical engineering	(J7) Biotechnology
(H7) Production and manufacturing engineering	(J9) Others in technology
(H8) Chemical, process and energy engineering	
(H9) Others in engineering	

Source: HESA. 'JACS 3.0: Principal subject codes' [online], accessed 25/03/2020.
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.

4.40 OfS. 'Supporting STEM subjects' [online], accessed 22/01/2020.

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 experts 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 times 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). [4.41] 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.[4.42]

Some of the current engineering degree codes have ties to the UK Standard Occupational Classification (SOC) codes with professional engineering.[4.43] 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 labour 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 the majority of our 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 statutory regulatory 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.

4.41 HESA. 'JACS 3.0: Detailed (four digit) subject codes' [online] accessed 15/04/2020.
4.42 HESA. 'The Higher Education Classification of Subjects (HECoS)' [online], accessed 22/01/2020.
4.43 The UK SOC codes include: 2121, Civil engineers; 2122, Mechanical engineers; 2123, Electrical engineers; 2124, Electronic engineers; 2126, Design and development engineers; 2127, Production and process engineers.

It is worth noting that these degree levels closely follow – but are 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 7) 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 outlined 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**).

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

	HESA level of study			
Qualification level	**Postgraduate research**	**Postgraduate taught**	**First degree**	**Other undergraduate**
Doctorate (level 8)	90.3%	–	–	–
Masters (level 7)	9.7%	100.0%	24.8%	–
Bachelor's (level 6)	–	–	74.1%	6.4%
Below degree level	–	–	1.1%	93.6%
Total	4,720	17,445	36,615	4,795

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 to organisations outside the HE sector and regulatory bodies in the academic year 2018 to 2019.
Qualification levels 6, 7 and 8 refers to qualification levels in England, Wales and Northern Ireland only.

At 64,425, the number of HE entrants across all levels to engineering and technology has remained fairly static over the last year.

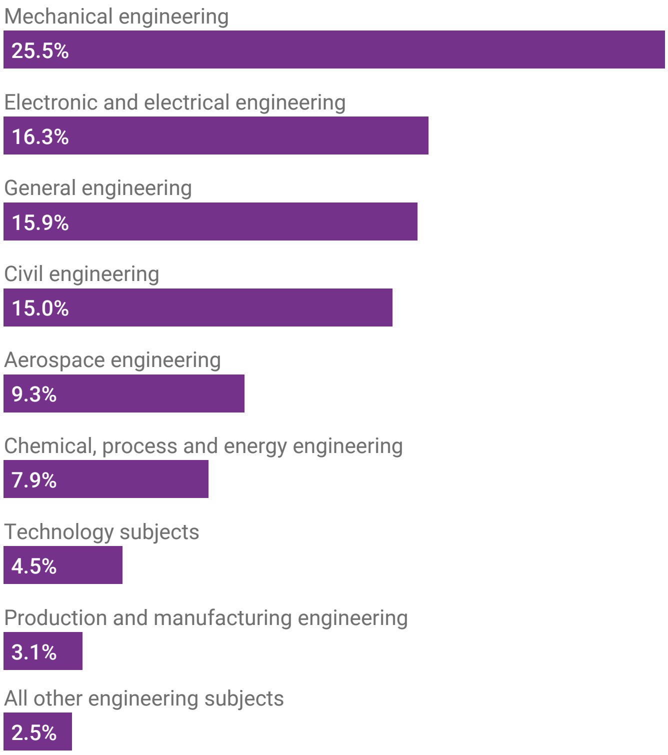
In 2018 to 2019, there were 64,425 entrants into engineering and technology courses, which represented a less than 0.1% increase on the previous year. First degree undergraduate entrants made up the largest proportion (57.7%), followed by postgraduate taught entrants (27.2%), other undergraduate entrants (7.7%) and postgraduate research entrants (7.4%).[4.44]

Mechanical engineering entrants 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%).

Figure 4.5 Engineering and technology first degree entrants by principal subject (2018/19) – UK



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 8 separate principal subjects within technology detailed in **Figure 4.3**.

4.44 HESA. 'HESA student record 2018/19' data, 2020.

Interestingly, the distribution of first degree entrants across the different engineering subjects doesn't match that of the engineering workforce by occupation. Instead, civil engineering is the subsector that accounts for the largest number of employees within professional engineering (92,500),[4.45] followed by mechanical engineering (79,300) and design and development engineering (77,000).[4.46] It's possible that the future composition of the engineering workforce will therefore look slightly different to today's make-up with, for example, a greater number of mechanical engineers than at present (though, of course, not all graduates will choose to work in the discipline they studied).

Although mechanical engineering is the most popular first degree for engineering and technology entrants, there are more professional civil engineers than mechanical engineers.

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.

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 2017 to 2018. As with other university subjects, the number of engineering and technology first degree entrants fell between 2011 to 2012 and 2012 to 2013 (a drop of 10.8%), coinciding with the rise in tuition fees.

Since 2012 to 2013, overall engineering first degree entries have risen by 14.9%, which is marginally lower than the overall rise in first degree undergraduate entrants at 18.1%.[4.47]

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.

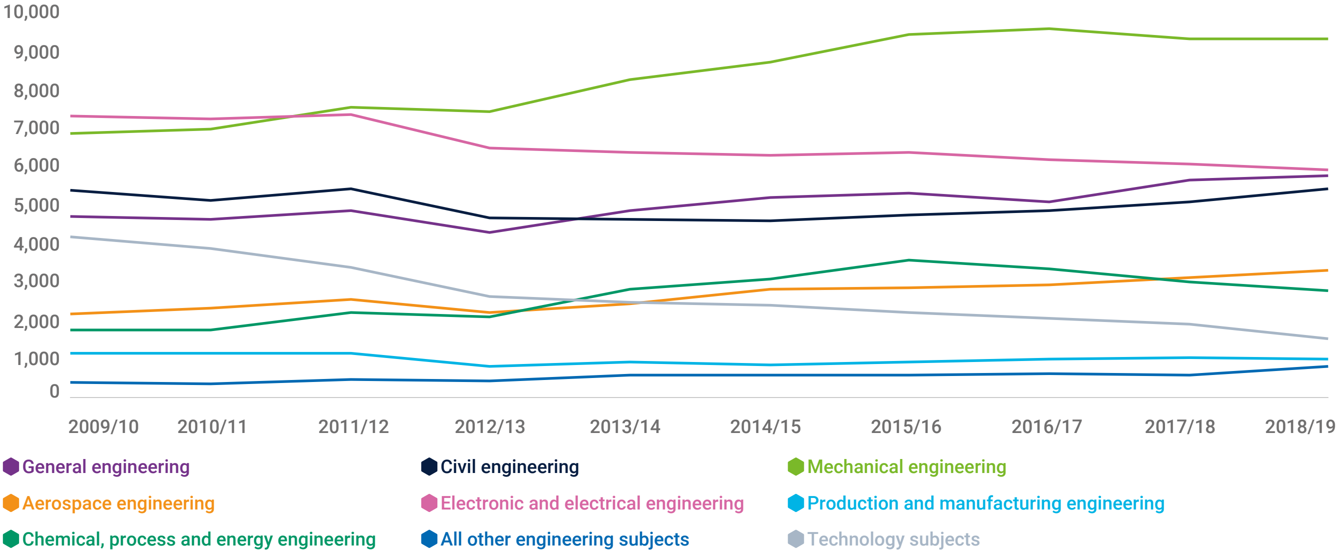
Since 2012 to 2013, there has been a 24.8% increase in the number of mechanical engineering first degree entrants. In this same time period, general and aerospace engineering have both also seen a rise in uptake, whereas there has been a decline in the numbers of first degree entrants opting for electronic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

Of particular note is the steep decline of first degree entrants into technology subjects – there has been a 61.4% decrease over the last 10 years and a 18.3% decrease in the past year alone. This may be reflective of the drop in students taking technology subjects in schools outlined in **Chapter 2**.

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.

4.45 The most common engineering occupation was 'engineering professionals not elsewhere classified'.
4.46 Nomis. 'Annual Population Survey Employment by Occupation – Oct 2018 to Sep 2019', 2020.
4.47 HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 2020.

Figure 4.6 Engineering and technology first degree entrants over time by principal subject (2009/10 to 2018/19) – UK

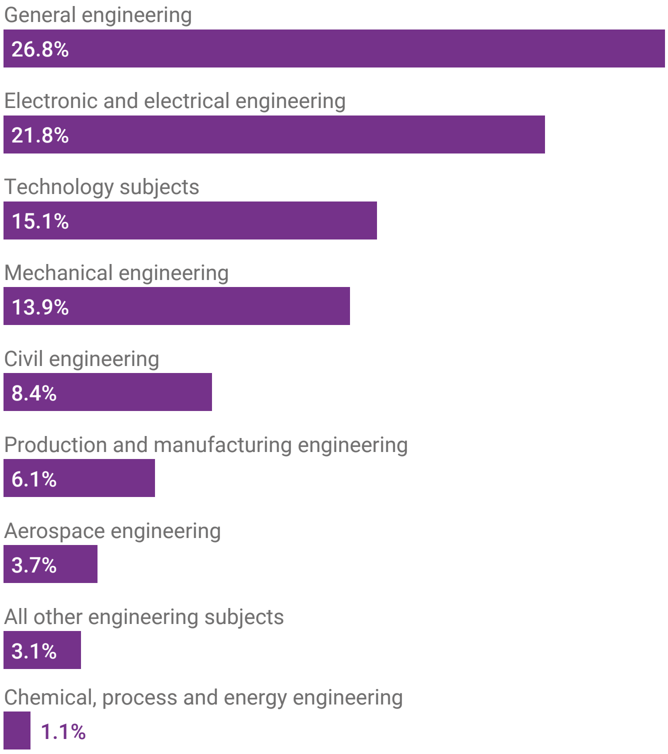


Source: HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 2020.
Due to small numbers on courses, students studying 'Broadly based programmes within engineering and technology', 'Naval architecture' and 'Others in engineering' are grouped into 'All other engineering subjects'.
'Technology subjects' includes the 8 separate principal subjects within technology detailed in **Figure 4.3**.
To view numbers associated with this chart and engineering and technology first degree qualifiers over time by gender, ethnic group, POLAR4 status, disability and domicile, see **Figure 4.6-4.6a** in our Excel resource.

Other undergraduate entrants

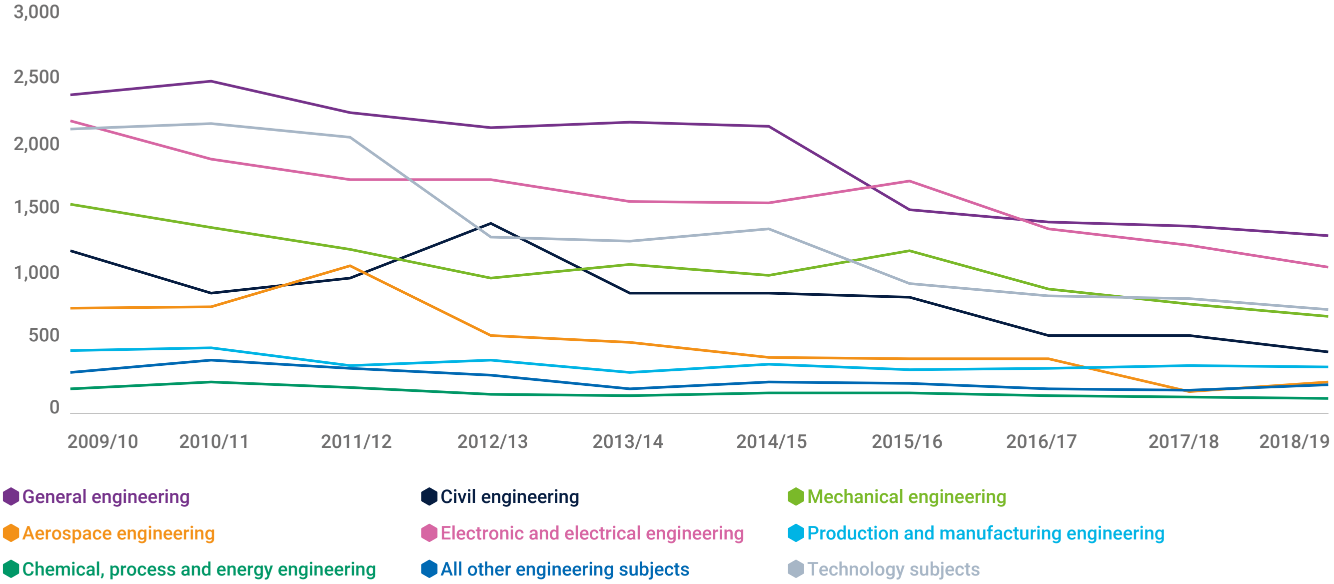
In the academic year 2018 to 2019, there were 4,950 other undergraduate entrants to engineering and technology subjects. Among these entrants, the distribution across different subjects is very different from that observed at first degree level, with more than a quarter (26.8%) studying general engineering and a further 21.8% studying electronic and electrical engineering. It's possible this reflects the nature of the types of qualifications associated with this level of study. For example, HNC and HND qualifications or foundation degrees are generally more vocationally focused and may be broader in terms of the range of topics they cover.

Figure 4.7 Engineering and technology other undergraduate entrants by principal subject (2018/19) – UK



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 subjectsincludes the 8 separate principal subjects within technology detailed in **Figure 4.3**.

Figure 4.8 Engineering and technology other undergraduate entrants over time by principal subject (2009/10 to 2018/19) – UK



Source: HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 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 8 separate principal subjects within technology detailed in **Figure 4.3**.
To view numbers associated with this chart and engineering and technology other undergraduate qualifiers over time by gender, ethnic group, POLAR4 status, disability and domicile, see **Figure 4.8-4.8a** in our Excel resource.

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 55.5%) with a decrease of 8.3% in just one year since 2017 to 2018. The decline has been starkest 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 undergraduates 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).[4.48] A 2019 House of Commons briefing on HE student numbers noted that this fall coincided with the steep decline in part-time HE entrants overall;[4.49] the large majority of those studying at other undergraduate level do so on a part-time basis and are often older than first degree entrants.[4.50]

The decline in part-time and mature students has been lamented by many in the HE sector. For instance, in an article by Claire Callendar, a professor of HE policy at UCL Institute of Education, she notes that these types of students are "central to the national skills strategy for reskilling and upskilling the workforce, and for widening HE participation".[4.51]

In section 4.6 we show that for engineering and technology subjects, other undergraduate entrants are more likely to come from disadvantaged backgrounds than those on other levels of study.

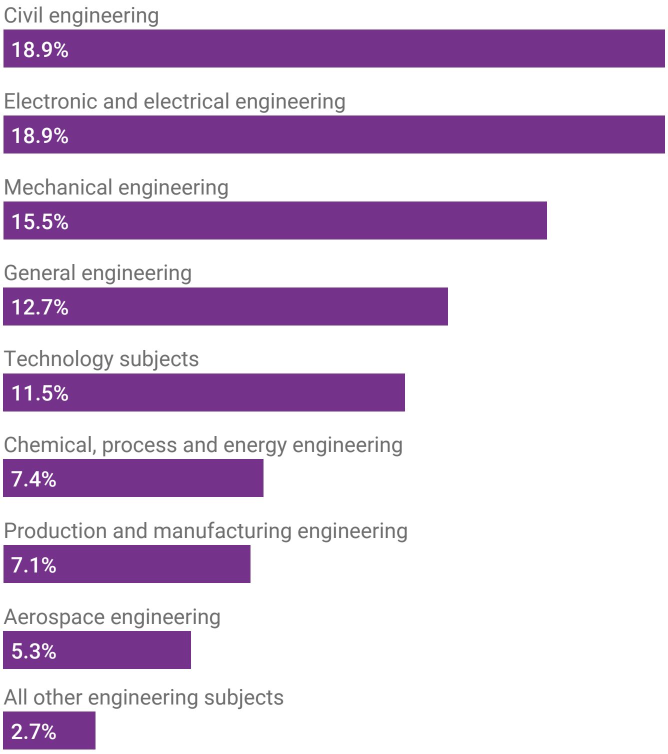
Postgraduate taught entrants

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.[4.52]

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 the large gap in popularity between mechanical engineering and other subjects at first degree level.

4.48 HESA. 'HESA student record 2014/15 to 2018/19', 2016 to 2020.
4.49 House of Commons Library. 'Higher education student numbers', 2019.
4.50 AdvanceHE. 'Equality in higher education statistical report 2019' data, 2019.
4.51 WONKHE. 'Stop the decline in part-time undergraduate study' [online], accessed 22/04/2020.
4.52 Imperial College London, for example, offers MSc courses in electrical engineering that are accredited by the Institution of Engineering and Technology (IET) on behalf of the Engineering Council as meeting requirements for further learning for registration as a chartered engineer.

Figure 4.9 Engineering and technology postgraduate taught entrants by principal subject (2018/19) – UK



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 8 separate principal subjects within technology detailed in **Figure 4.3**.

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 18,445 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 2.1% increase.

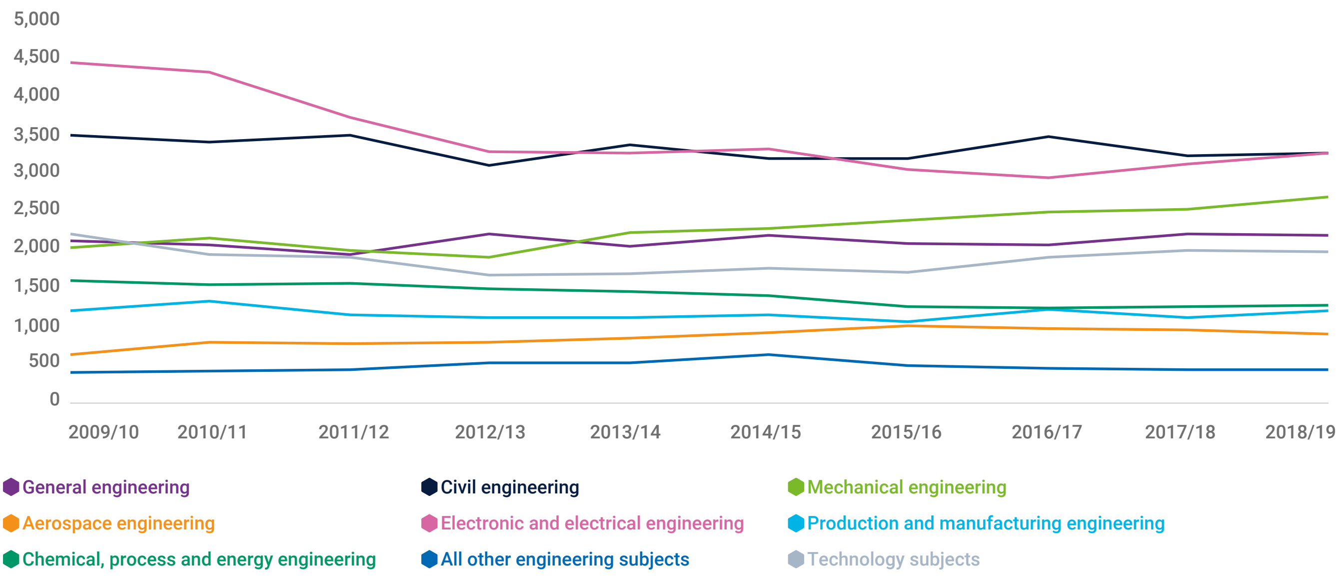
Nevertheless, this is worrying for the engineering sector, especially given that across all of HE, postgraduate taught entries have risen by 15.6% over the same period.[4.53]

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 1,935 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.

Figure 4.10 Engineering and technology postgraduate taught entrants over time by principal subject (2009/10 to 2018/19) – UK



Source: HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 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 8 separate principal subjects within technology detailed in **Figure 4.3**.
To view numbers associated with this chart and engineering and technology postgraduate taught qualifiers over time by gender, ethnic group, POLAR4 status, disability and domicile, see **Figure 4.10-4.10a** in our Excel resource.

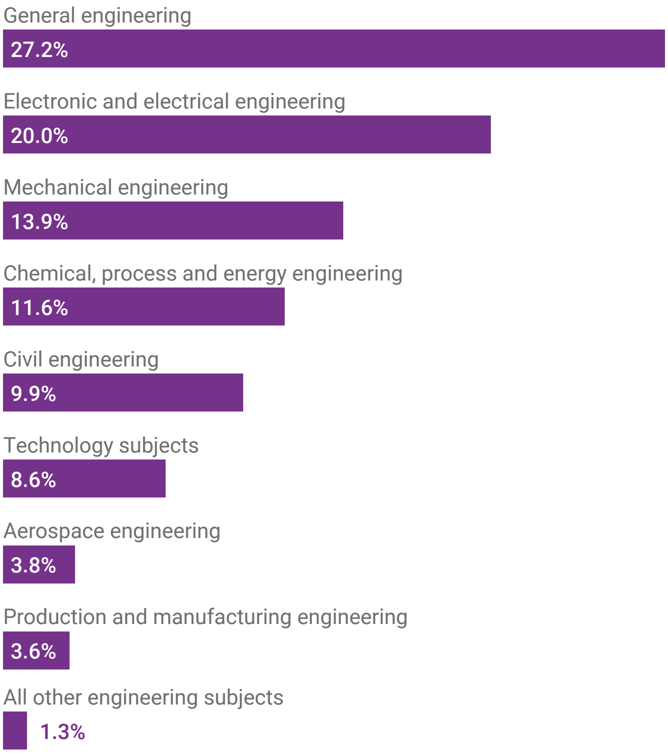
4.53 HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 2020.

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.[4.54] 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).[4.55]

Figure 4.11 Engineering and technology postgraduate research entrants by principal subject (2018/19) – UK



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 8 separate principal subjects within technology detailed in **Figure 4.3**.

In contrast to postgraduate taught and undergraduate entrants, where specialist engineering subjects make up the largest proportions of students, the most common postgraduate research degree for engineering and technology postgraduate research entrants in 2018 to 2019 was general engineering (27.2%). 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.

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.

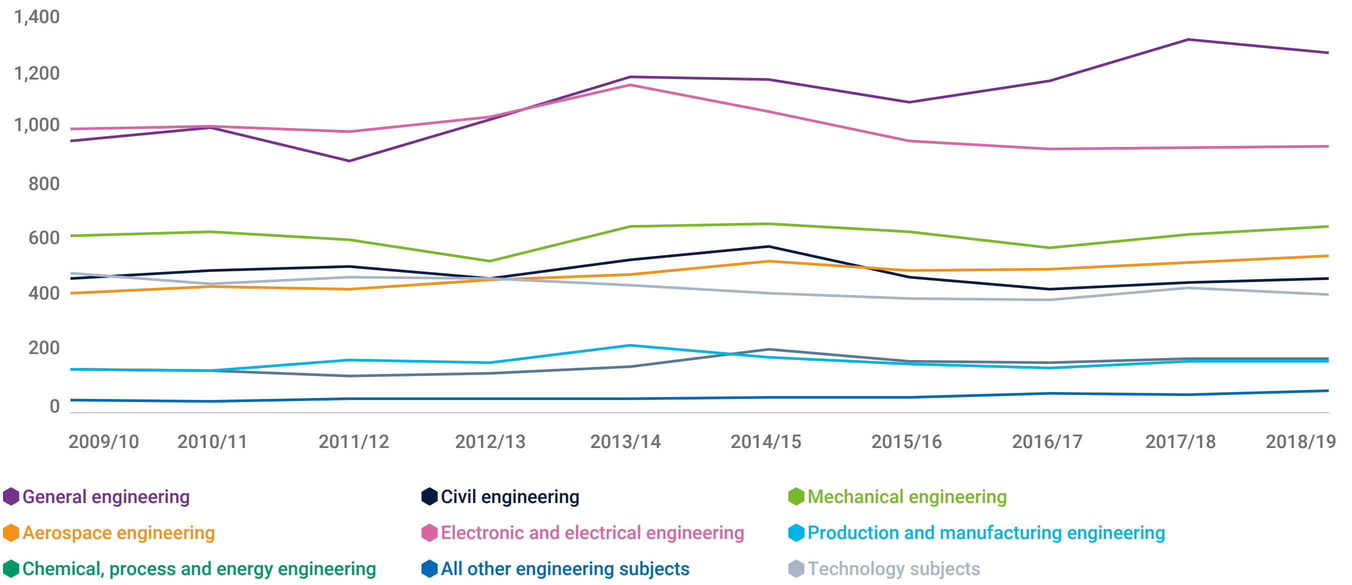
The majority of the rise over the last 10 years came from entrants to general engineering courses, which has seen a larger increase (33.0%) overall than other postgraduate research engineering subjects, although numbers fell by 3.7% between 2017 to 2018 and 2018 to 2019.

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,[4.56] 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.

4.54 The LEO data links education, tax and benefits data to chart the transition of graduates from higher education into the workplace.
4.55 DfE. 'Graduate outcomes (LEO): postgraduate outcomes in 2016 to 2017' data, 2019.
4.56 Nomis. 'Annual Population Survey employment by occupation – Oct 2011 to Sep 2019' [online], accessed 28/01/2020.

Figure 4.12 Engineering and technology postgraduate research entrants over time by principal subject (2009/10 to 2018/19) – UK



Source: HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 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 8 separate principal subjects within technology detailed in **Figure 4.3**.
To view numbers associated with this chart and engineering and technology postgraduate research qualifiers over time by gender, ethnic group, POLAR4 status, disability and domicile, see **Figure 4.12-4.12a** in our Excel resource.

4.4 – Engineering and technology students by gender

As discussed in the introduction, the representation of women in engineering and technology HE is particularly low, which is in stark contrast to the high proportion of women in HE overall.

Efforts to increase engineering participation by women are made more difficult by existing stereotypes of the profession that may be ingrained from an early age. For example, girls aged between 11 and 19 were more likely than boys to say that engineering was "dirty, greasy or messy" and were more likely than boys to report low levels of self-efficacy in the subject than boys, according to EngineeringUK's Engineering Brand Monitor.[4.57]

About the data

The gender data in this chapter includes only those classified as 'male' or 'female' within the HESA record. This means that those who were recorded as 'other' are excluded from the analysis. This is because the numbers indicating 'other' were extremely low.

We recognise that gender is not binary and that there are several different terms associated with the 'other' gender. However, for the purposes of this analysis – to outline the gender imbalance in engineering HE – we feel that using only male and female respondents is appropriate.

Participation

As **Figure 4.13** shows, 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.[4.58] **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.[4.59] 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.[4.60]

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).

4.57 EngineeringUK. 'Engineering Brand Monitor 2019', 2019.
4.58 HEPI. 'Boys to Men: The underachievement of young men in higher education – and how to start tackling it', 2016.
4.59 UCAS. 'End of cycle report 2019' data, 2019.
4.60 Ibid.

Figure 4.13 Female students as a share of engineering and technology entrants and HE students overall over time (2009/10 to 2018/19) – UK

	Engineering and technology entrants		All students	
Year	Total	Female (%)	Total	Female (%)
2009/10	69,085	16.3%	2,493,415	56.6%
2010/11	68,060	15.9%	2,501,285	56.4%
2011/12	68,025	16.2%	2,496,630	56.4%
2012/13	61,930	16.6%	2,339,850	56.2%
2013/14	64,430	17.3%	2,299,125	56.1%
2014/15	65,900	18.0%	2,265,705	56.2%
2015/16	65,545	18.3%	2,280,350	56.5%
2016/17	64,435	19.2%	2,316,855	56.7%
2017/18	64,375	19.7%	2,341,385	57.0%
2018/19	64,385	20.7%	2,381,410	57.2%

Source: HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 2020.
Total figures and percentages calculated using these figures do not include those who indicated their gender as 'other'.

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 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 at HE level will not achieve gender parity for at least another 3 decades.

If the proportion of women in engineering continues to increase at its current rate, there will not be gender equality until after 2050.

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 international collaborations.

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.[4.61]

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.

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).[4.62]

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 into postgraduate courses than into undergraduate courses. Across all engineering and technology subjects in 2018 to 2019, women made up over one quarter of postgraduate entries (28.1% of postgraduate taught and 26.5% of postgraduate research) compared with just 17.6% of first

4.61 RSE. 'Tapping all our talents', 2018.
4.62 HESA. 'HESA student record 2018/19' data, 2020.

degree entries and 12.6% of other undergraduate entries (**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, for example, offering a fully funded PhD specifically for exceptional female engineering candidates.[4.63]

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 for women (28.7% 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 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. Veterinary sciences, agriculture and related subjects, biological sciences, and medicine and dentistry all have a higher-than-average proportion of women in HE.[4.64, 4.65]

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 to feel that a career in these areas is not for them. Indeed, a 2015 paper suggested that underrepresentation can itself perpetuate future underrepresentation, and that if girls do not see computer scientists and engineering as people they identify with, they may be more reluctant to enter these fields.[4.66]

This is pertinent in the HE sector, as there are large imbalances within STEM subjects in academia. Just 34.8% of academic staff in biological, mathematical and physical sciences are women, and only 21.0% of engineering and technology academic staff are women.[4.67] Women are also less likely to be promoted into leadership positions and they leave academia in larger proportions than men at every step of the postgraduate ladder.[4.68, 4.69]

There has been a lot of work within the HE sector to attempt to address some of the gender imbalances in STEM academia. One of the most prominent is the Athena SWAN Charter, which was introduced in 2005. More information on this Charter is included in the case on page 117.

Figure 4.14 Female HE entrants by subject area, principal subject and level of study (2018/19) – UK

	First degree undergraduate		Other undergraduate		Postgraduate taught		Postgraduate research	
Principal subject	**Total**	**Female (%)**	**Total**	**Female (%)**	**Total**	**Female (%)**	**Total**	**Female (%)**
Chemical, process and energy engineering	2,865	28.7%	50	29.2%	1,285	30.5%	550	32.9%
Technology subjects	1,670	28.2%	750	17.8%	2,015	41.9%	410	33.8%
All other engineering subjects	930	26.2%	145	24.3%	460	19.6%	60	19.5%
General engineering	5,785	22.6%	1,230	16.3%	2,205	30.8%	1,280	28.6%
Civil engineering	5,395	20.2%	380	12.7%	3,270	33.8%	465	28.0%
Production and manufacturing engineering	1,135	19.1%	295	8.7%	1,240	29.8%	170	22.8%
Aerospace engineering	3,450	15.1%	185	8.7%	935	17.2%	180	12.2%
Electronic and electrical engineering	5,985	13.3%	1,055	6.7%	3,300	28.1%	945	23.1%
Mechanical engineering	9,370	10.8%	685	8.7%	2,720	12.3%	660	20.6%
All engineering and technology	**37,185**	**17.6%**	**4,935**	**12.7%**	**17,525**	**28.1%**	**4,735**	**26.5%**
All STEM	**256,890**	**51.3%**	**50,705**	**67.6%**	**124,100**	**58.8%**	**24,040**	**46.0%**
All subjects	**568,475**	**56.3%**	**105,555**	**66.0%**	**335,080**	**61.5%**	**37,010**	**49.0%**

Source: HESA. 'HESA student record 2018/19' data, 2020.

Total figures and percentages calculated do not include those who indicated their gender as 'other'.Totals and percentages for 'All engineering and technology', 'All STEM' and 'All subjects' use the published HESA data, whereas those for the detailed engineering subjects exclude 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. This means that the subtotals for engineering subjects do not sum to the 'All engineering and technology' total. 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 separate principal subjects within technology detailed in **Figure 4.3**. To view a more detailed breakdown of HE entrants by subject area, gender and level of study, see **Figure 4.14** in our Excel resource. **Figure 4.14** also includes comparisons for all university subjects.

4.63 University of Manchester Department of Mechanical, Aerospace and Civil Engineering. 'Funding for postgraduate research' [online] accessed 15/04/2020.
4.64 HESA. 'HESA student record 2018/19' data, 2020.
4.65 For a full subject comparison by gender, please view **Figure 4.14a** in the Excel resource.
4.66 Cheryan, S. et al. 'Cultural Stereotypes as Gatekeepers: Increasing Girls' Interest in Computer Science and Engineering by Diversifying Stereotypes', Front. Psychol., 2015.
4.67 HESA. 'HESA staff record 2018/19' data, 2020.
4.68 The Guardian. 'Universities need to promote more women to professor' [online], accessed 31/01/2019.
4.69 Royal Society of Biology. 'Women in academic STEM careers', 2013.

Case study – Athena SWAN Charter

Ruth Gilligan, Assistant Director for Equality Charters, Advance HE

Founded in 2005, the Athena SWAN (Scientific Women's Academic Network) Charter was set up as a framework and award scheme to recognise excellence in STEM employment for women in UK HE. It is highly successful, having grown from 10 founding university members to 167 in the UK and Ireland. The methodology is recognised internationally for its success in effecting cultural and systemic change that leads to gender equality, and there are now local iterations in Australia, the US and Canada.

The Charter is owned and managed by Advance HE (previously the Equality Challenge Unit).

In response to demand from the HE sector, the Athena SWAN Charter expanded its focus in 2015 to include arts, humanities, social science, business and law (AHSSBL) disciplines and to address any form of gender imbalance. The expanded Charter now considers professional and support staff alongside students and academic and research staff, and requires institutions to consider trans people and intersectionality (specifically intersections of race with gender).

Athena SWAN member institutions commit to 10 underpinning principles.[4.70] Their progress in addressing gender equality is recognised through awards that recognise the steps they take.

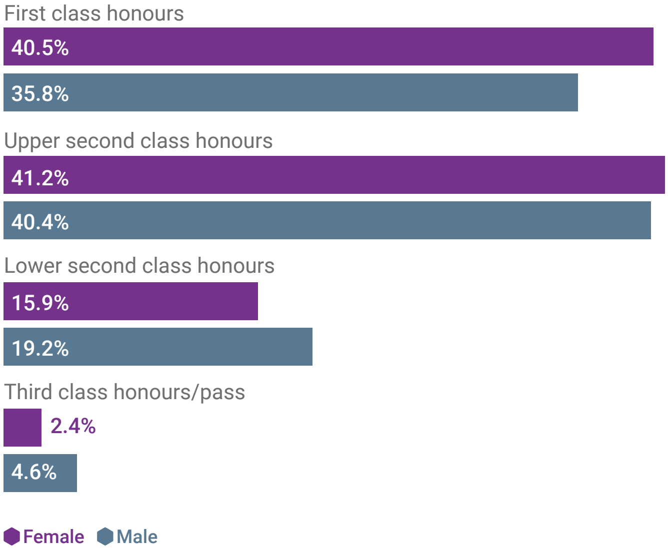
A recent impact evaluation carried out by Ortus Economic Research and Loughborough University in 2019 found strong evidence that the Charter's processes and methodologies have supported cultural and behavioural change, not just around gender equality, but equality and diversity in all its forms.[4.71] Additionally, in submitting departments, researchers observed a trend towards more gender balanced promotions to senior lecturer/reader and associate professor. In recruitment, they saw an increasing trend in the percentages of women shortlisted and appointed.

In 2020, Advance HE will implement a transformation plan to update the Athena SWAN framework and processes in response to recommendations from an independent 2019 impact evaluation and feedback from participating institutions.

Attainment

In **Chapter 2**, we showed that girls outperform boys across almost all STEM subjects at both GCSE and A level, and that this difference is largest in elective STEM subjects. At GCSE, for example, the gender gap in pass rates for engineering was 19.6 percentage points in the academic year 2018 to 2019, and for design and technology the gap was 15.9 percentage points. This tendency of women to outperform their male peers was also found among those qualifying with a first degree in engineering and technology in 2018 to 2019 (**Figure 4.15**).

Figure 4.15 Engineering and technology first degree qualifiers by degree class and gender (2018/19) – UK



Source: HESA. 'HESA student record 2018/19' data, 2020.
Percentages calculated do not include those who indicated their gender as 'other'.
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 to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019.

The gender gap in engineering subjects narrows in HE compared with earlier stages of education (see **Chapter 2**). This isn't surprising, given that a good deal of academic selectivity has already taken place by this point – in other words, those doing university degrees will be the highest academic performers and so differences between subgroups will naturally be less pronounced. Nevertheless, women graduating from engineering and technology first degrees had higher average results than men, with 81.7% attaining a first or upper second class honours, compared with 76.2% of men – an attainment gap of 5.5 percentage points.

We can see this trend across all HE subjects, with 78.9% of women achieving a first or upper second class degree in 2018 to 2019 compared with 73.8% of men.[4.72] But it is still important to note for engineering students. The fact that women in engineering and technology are higher achieving than men further strengthens the case for encouraging more women into the workforce.

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.

4.70 ECU. 'About Advance HE's Athena SWAN Charter' [online], accessed 18/03/2020.
4.71 Ortus Economic Research and Loughborough University. 'An Impact Evaluation of the Athena SWAN Charter', 2019.
4.72 HESA. 'HESA student record 2018/19' data, 2020.

4.5 – 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,[4.73] 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[4.74]) 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 9.0% of engineering professionals were from minority ethnic backgrounds,[4.75] 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

	Engineering and technology entrants							All students	
Year	Total (UK domiciled)	White total (%)	Minority ethnic total (%)	*Black (%)*	*Asian (%)*	*Mixed (%)*	*Other (%)*	Total (UK domiciled)	Proportion minority ethnic (%)
2009/10	**41,665**	78.7%	21.3%	*6.8%*	*10.3%*	*2.7%*	*1.5%*	2,013,100	18.1%
2010/11	**40,010**	79.0%	21.0%	*6.7%*	*10.3%*	*2.7%*	*1.3%*	2,017,950	18.4%
2011/12	**41,720**	78.0%	22.0%	*6.6%*	*10.9%*	*2.9%*	*1.6%*	2,014,885	18.8%
2012/13	**36,415**	76.7%	23.3%	*6.8%*	*11.5%*	*2.9%*	*2.2%*	1,876,235	19.6%
2013/14	**37,300**	75.8%	24.2%	*7.1%*	*12.1%*	*3.0%*	*2.1%*	1,830,230	20.2%
2014/15	**38,445**	74.7%	25.3%	*7.1%*	*12.7%*	*3.1%*	*2.4%*	1,795,910	21.0%
2015/16	**39,435**	72.6%	27.4%	*7.4%*	*13.9%*	*3.5%*	*2.6%*	1,812,990	21.8%
2016/17	**39,010**	71.2%	28.8%	*7.9%*	*14.5%*	*3.7%*	*2.7%*	1,844,770	22.7%
2017/18	**38,515**	70.3%	29.7%	*7.8%*	*15.1%*	*3.8%*	*3.0%*	1,854,853	23.6%
2018/19	**36,830**	70.1%	29.9%	*7.5%*	*15.4%*	*4.1%*	*2.9%*	1,869,210	25.6%

Source: HESA. 'HESA student record 2009/10 to 2018/19' data, 2011 to 2020.
Totals and percentages presented in this figure for 2018/19 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.

4.73 The most recent available national ethnicity data is the 2011 Census, which shows that from 1991 to 2011 the percentage of the population of England and Wales that identified as White British decreased from 93% to 80%.
4.74 DfE. 'Schools, pupils and their characteristics: January 2019' data, 2019.
4.75 EngineeringUK. 'Social mobility in engineering', 2018.

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.[4.76] Just 27.8% of STEM first degree entrants were from minority ethnic backgrounds and 26.7% of all first degree entrants.

Chemical, process and energy 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.[4.77] 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.[4.78] 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.[4.79]

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		Other undergraduate		Postgraduate taught		Postgraduate research	
Principal subject	**Total**	**Minority ethnic (%)**	**Total**	**Minority ethnic (%)**	**Total**	**Minority ethnic (%)**	**Total**	**Minority ethnic (%)**
Chemical, process and energy engineering	1,970	45.3%	35	0.0%	435	49.1%	220	33.6%
Aerospace engineering	2,485	39.6%	160	8.6%	235	32.3%	60	22.6%
Electronic and electrical engineering	3,420	34.0%	955	5.2%	495	41.0%	310	27.1%
All other engineering subjects	680	32.4%	95	4.4%	180	18.6%	35	15.2%
Civil engineering	3,965	31.6%	355	13.4%	920	39.7%	170	23.8%
General engineering	4,685	31.3%	765	7.7%	850	25.9%	500	22.9%
Mechanical engineering	6,815	30.9%	605	6.1%	745	35.8%	300	24.7%
Technology subjects	1,190	21.1%	570	8.9%	935	19.2%	215	13.8%
Production and manufacturing engineering	880	17.9%	280	51.6%	265	35.6%	70	30.9%
All engineering and technology	**24,900**	**32.5%**	**3,265**	**10.6%**	**4,125**	**32.5%**	**1,660**	**25.1%**
All STEM	**213,930**	**27.8%**	**44,320**	**17.4%**	**78,910**	**21.5%**	**13,290**	**19.1%**
All subjects	**460,140**	**26.7%**	**84,280**	**15.9%**	**187,035**	**23.0%**	**20,520**	**19.3%**

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 8 separate principal subjects within technology detailed in **Figure 4.3**.
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.

4.76 HESA. 'HESA student record 2018/19' data, 2020.
4.77 Runnymede Trust. 'Occupational aspirations of children from primary school to teenage years across ethnic groups', 2018.
4.78 EngineeringUK. 'Engineering Brand Monitor 2019', 2019.
4.79 HESA. 'HESA student record 2018/19', 2020.

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.[4.80]

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.[4.81, 4.82]

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 translate into 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.[4.83]

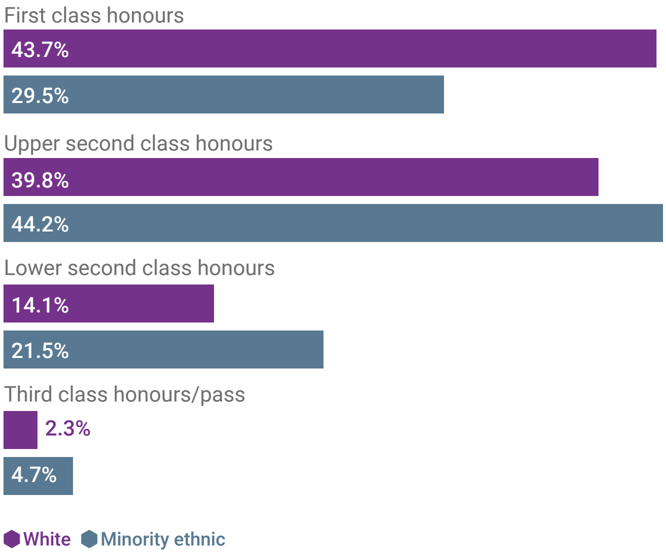
Attainment

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.[4.84]

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.[4.85] 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.[4.86]

There are similar issues when looking at degree attainment specifically for engineering and technology qualifiers. Of those qualifying from first degree engineering and technology courses in 2018 to 2019, 83.5% 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



Source: HESA. 'HESA student record 2018/19' data, 2020.
Percentages in this chart are calculated using total UK domiciled engineering and technology qualifiers from higher education in 2018/19.
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 to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019.
To view a detailed breakdown by ethnicity, see Figure 4.18 in our Excel resource.

Figure 4.18 shows that the difference in proportions of White students and minority ethnic students receiving first class degrees is particularly stark, with 43.7% of White students achieving a first, compared with just 29.5% of those from minority ethnic backgrounds.

Furthermore, using only the broad 'minority ethnic' category masks significant variation between ethnic groups. Just 65.9% of Black students who qualified in engineering in 2018 to 2019 attained a first or upper second class degree, compared with 76.1% of Asian students.[4.87]

This observation holds across HE more widely. Just 58.9% of Black students attained a first or upper second class degree in 2018 to 2019, compared with 70.6% of Asian students and 80.5% of White students.[4.88] However, what this also shows is that those from minority ethnic backgrounds are higher achieving and the ethnicity attainment gap is lower in engineering and technology subjects than across HE as a whole.

4.80 Codiroli Mcmaster, N. 'Who studies STEM subjects at A level and degree in England? An investigation into the intersections between students' family background, gender and ethnicity in determining choice', Br. Educ. Res. J., 2017.
4.81 Ibid.
4.82 Strand, S. 'The limits of social class in explaining ethnic gaps in educational attainment'. Br. Educ. Res. J., 2011.
4.83 EngineeringUK. 'Engineering UK: The state of engineering 2018', 2018.
4.84 OfS. 'Topic briefing: Black and Minority Ethnic (BME) students', 2018.
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.
4.88 HESA. 'HESA student record 2018/19' data, 2020.

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.[4.89] 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 tacking the BME attainment gap".[4.90]

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).

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.[4.91]

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 experts 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.

4.89 Universities UK. 'Black, Asian and Minority Ethnic student attainment at UK universities: #closing the gap', 2019.
4.90 HEPI. 'The White elephant in the room: ideas for reducing racial inequalities in higher education', 2019.
4.91 AdvanceHE. 'Degree attainment gaps' [online], accessed 26/03/2020.

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. [4.92, 4.93] 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.

At present, those from disadvantaged backgrounds fare worse in the HE system in terms of access to HE, degree outcomes and retention. Analysis currently underway by Liverpool University for the Royal Academy of Engineering shows that engineering and technology students from disadvantaged backgrounds are more likely than other students to drop out of their degree before completing it. [4.94]

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,[4.95] 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.[4.96] 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".[4.97] 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 students 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)[4.98] 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 in this section. 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.

4.92 EPI. 'Key drivers of the disadvantage gap', 2018.
4.93 DfE. 'Post-16 education outcomes for disadvantaged students', 2018.
4.94 RaEng. 'UK UG Engineering Students' demographics and qualifications: from admissions through progression to graduation', forthcoming.
4.95 ONS. 'Census geography' [online], accessed 20/04/2020.
4.96 OfS. 'Young participation by area' [online], accessed 03/02/2020.
4.97 NEON. 'Working class heroes: understanding access to higher education for white students from lower socio-economic backgrounds', 2019.
4.98 ONS. 'The National Statistics Socio-economic classification (NS-SEC)' [online], accessed 30/04/2020.

Participation

Figure 4.19 UK domiciled engineering and technology HE entrants from low participation neighbourhoods over time (2014/15 to 2018/19) – UK

	Engineering and technology entrants		All entrants	
Year	UK domiciled entrants (No.)	Low participation neighbourhood (%)	UK domiciled entrants (No.)	Low participation neighbourhood (%)
2014/15	41,260	11.0%	723,582	12.0%
2015/16	37,960	10.9%	728,784	12.1%
2016/17	35,620	11.3%	745,358	12.1%
2017/18	35,965	11.0%	743,372	12.3%
2018/19	35,705	11.3%	732,357	12.6%

Source: HESA. 'HESA student record 2014/15 to 2018/19' data, 2016 to 2020.
Totals and percentages presented in this figure for 2018/19 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.

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 or guardians with a degree (64.6% compared with 57.6%, respectively) and to have parents working in higher managerial, administrative and professional occupations (57.3% and 53.4%, respectively)[4.99, 4.100]

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.[4.101] 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.[4.102]

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.[4.103]

Entrants into engineering and technology courses were more likely to have university-educated parents or parents working in professional and managerial roles than the overall HE population.

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).

4.99 HESA. 'HESA student record 2018/19' data, 2020.
4.100 Percentages include only those aged 21 and under, and exclude those who said their parents occupations was 'Not classified' or 'unknown', and exclude those who's parental education status was unknown.
4.101 UCAS data shows only the rates of entry for UK-domiciled 18 year olds.
4.102 UCAS. 'End of cycle report 2019' data, 2019.
4.103 Ibid.

Figure 4.20 UK domiciled HE entrants from low participation neighbourhoods by subject area, principal subject and level of study (2018/19) – UK

	First degree undergraduate		Other undergraduate		Postgraduate taught		Postgraduate research	
Principal subject	**Total**	**Low participation neighbourhood (%)**	**Total**	**Low participation neighbourhood (%)**	**Total**	**Low participation neighbourhood (%)**	**Total**	**Low participation neighbourhood (%)**
All other engineering subjects	565	14.0%	85	15.1%	160	12.3%	25	5.9%
Electronic and electrical engineering	3,365	13.0%	960	18.0%	485	14.0%	315	9.2%
Technology subjects	1,180	13.0%	570	15.6%	900	10.3%	215	8.9%
General engineering	4,535	12.4%	810	20.5%	845	10.7%	495	10.3%
Civil engineering	3,760	10.4%	350	16.2%	895	9.4%	165	7.9%
Production and manufacturing engineering	840	10.0%	285	14.0%	255	14.1%	70	8.8%
Mechanical engineering	6,600	9.4%	565	17.8%	735	10.9%	280	12.2%
Aerospace engineering	2,440	8.5%	160	11.3%	230	7.0%	60	1.6%
Chemical, process and energy engineering	1,915	7.6%	35	24.3%	435	8.7%	215	10.7%
All engineering and technology	**25,195**	**10.6%**	**3,820**	**17.4%**	**4,935**	**10.6%**	**1,835**	**9.1%**
All STEM	**206,920**	**13.6%**	**43,925**	**16.4%**	**77,005**	**10.9%**	**13,190**	**8.7%**
All subjects	**446,690**	**13.0%**	**82,345**	**15.4%**	**182,890**	**10.9%**	**20,435**	**8.8%**

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 8 separate principal subjects within technology detailed in Figure 4.3.
Totals and percentages presented in this figure for 2018/19 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, POLAR4 status and level of study, see Figure 4.20 in our Excel resource. Figure 4.20 also includes comparisons for all university subjects.

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.

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.

Other undergraduate courses offer those from traditionally lower participation areas the chance to pursue HE in a slightly different manner to the first degree courses that the majority of young people pursue. These courses can provide prospective engineers with another route into the workforce, and for that reason the engineering sector should work to halt their decline. Other undergraduate courses include the higher technical qualifications discussed in **Chapter 3**. So although numbers of entrants to these courses in HE are decreasing, there may be a sustained push from the FE sector to improve take up of these types of degree.

Perhaps reflecting the different nature of each engineering subject, the proportions of entrants from low participation neighbourhoods in 2018 to 2019 varied depending on the chosen subjects. First degree entrants from low participation neighbourhoods were more likely to study 'all other engineering subjects' (14.0% of entrants) and electronic and electrical engineering (13.0% of entrants), whereas just 7.6% of first degree entrants to chemical, process and energy engineering were from low participation neighbourhoods (**Figure 4.20**).

Comparison by university type

Differences between those from varying socioeconomic backgrounds can also be seen in the type of universities they attend. This is important because certain types of university – notably institutions that sit in the Russell Group[4.104] – have higher entry tariffs. They also tend to be more selective than others, attract the most funding and have a shared focus on research and a reputation for academic achievement.[4.105]

Furthermore, graduates from Russell Group universities have higher employment rates than other institutions. The 2016/17 Destinations of Leavers from HE survey of those graduating in 2012 to 2013 listed 15 Russell Group universities in the top 25 for rates of graduate employment.[4.106]

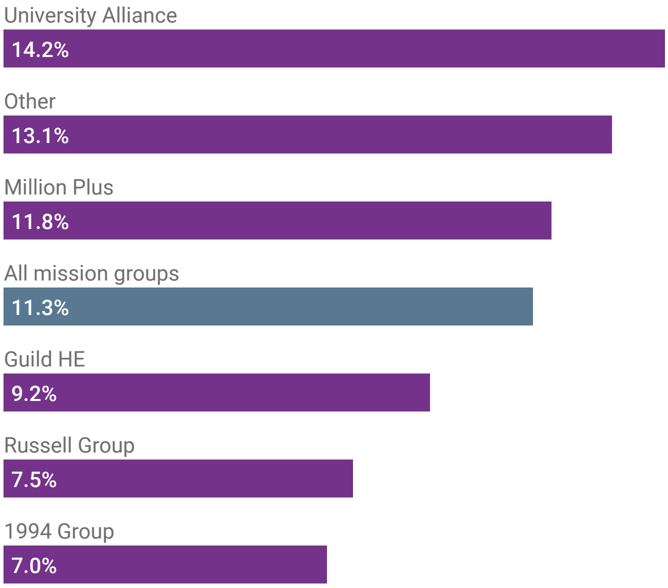
This is an issue because it may further perpetuate educational 'disadvantage gaps', which have been shown to start in early years education in England and continue through to secondary school.[4.107]

Given the strong demand for engineering skills, there is an opportunity for engineering to be a vehicle for social mobility. However, it is not enough to simply encourage more young people from disadvantaged backgrounds to study engineering in HE; we must also ensure that participation is widened across all universities, including those that are most selective.

For engineering and technology entrants in particular, there remains a difference in the types of universities that they attend depending on whether they are from low participation neighbourhoods (**Figure 4.21**). We refer to 'university mission groups', which are sometimes used within the higher education sector to distinguish groups of universities from one another. Members of the same mission group often have similar origins, size and ambitions, and not all universities are necessarily members of a particular group.

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



Source: HESA. 'HESA student record 2018/19' data, 2020.
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 to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019.
Universities classed 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 1994 group – a now defunct group of smaller, research focussed 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".[4.108]

The contrast in the composition of entrants to the different mission groups is interesting, especially given that University Alliance group universities were the most popular among engineering and technology entrants in the academic year 2018 to 2019. With 14.2% of their cohort being from low participation neighbourhoods, this group is still underrepresented within the University Alliance group, but they are comparatively overrepresented in terms of HE overall.

Chapter 1 outlined the fact that disadvantaged young people are more likely than their more advantaged peers to attend FE institutions. Although University Alliance institutions offer HE courses, they may be delivered with a greater vocational focus, furthering the perception that more 'academic' and selective courses are geared towards those from advantaged backgrounds.

4.104 The Russell Group consists of 24 'world class', 'research intensive' institutions in the UK that have a combined economic output of £32 billion and produce more than two thirds of the UK's world-leading research.
4.105 TheUniGuide. 'What is the Russell Group' [online], accessed 03/02/2020.
4.106 HESA. 'Destinations of leavers from higher education longitudinal survey', 2017.
4.107 EPI. 'Education in England: annual report 2019', 2019.
4.108 University Alliance. 'The voice of professional and Technical universities' [online], accessed 15/04/2020.

Attainment

Not only do students from low participation areas enter into engineering HE at lower rates than their more advantaged peers, they also tend to achieve lower degree classes (**Figure 4.22**). This means that even among those who decide to pursue engineering at the highest educational level, it is more difficult for people from disadvantaged backgrounds to subsequently enter into an engineering career.

Figure 4.22 UK domiciled engineering and technology first degree qualifiers by degree class and POLAR4 status (2018/19) – UK

Source: HESA. 'HESA student record 2018/19' data, 2020.
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 to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019.

Encouragingly, the attainment gap observed 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 qualifiers 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 Banerjee, for instance, concluded that "there are a range of factors linked to underachievement of disadvantaged pupils in school science and maths",[4.109] 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).[4.110] 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.

4.7 – Engineering and technology students by disability

In recent years, significant provision has been made to ensure rights and access for disabled people both in the workplace and in education. [4.111, 4.112]

For example, under the Equality Act 2010, HE institutions have a duty to make reasonable adjustments in relation to the provisions, criteria or practices, physical features and auxiliary aids available to address any disadvantage that disabled students may otherwise experience. In addition, they can treat a disabled person more favourably than a non-disabled person without this amounting to direct discrimination against the non-disabled person.

Disabled students are eligible to receive Disabled Students' Allowances (DSAs) to cover extra costs they may incur[4.113] (although the extent to which this is sufficient, particularly following cuts to the allowance in the academic years 2015 to 2016 and 2016 to 2017,[4.114] has been questioned within the sector).[4.115] More recently, the creation of a Disabled Students' Commission (DSC), a new independent and strategic group to advise HEIs on support for disabled students, was announced by the then Universities Minister in June 2019.[4.116]

Encouragingly, the number of students in HE recorded as disabled has increased every year, as has the number of disabled people in the workforce.[4.117] It is, however, not clear to what extent these increases represent a genuine rise in participation or whether they instead demonstrate an increased willingness to declare a disability, due to greater inclusivity, awareness and provision.

About the data

Our disability analysis is drawn from the HESA student record, which 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 indicates 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**).

4.109 Banerjee, P. A. 'A systematic review of factors linked to poor academic performance of disadvantaged students in science and maths in schools', Cogent Educ., 2016.
4.110 EPI. 'Education in England: Annual report 2019', 2019.
4.111 UK Government. 'Disability rights – Employment' [online], accessed 22/04/2020.
4.112 UK Government. 'Disability rights – Education' [online], accessed 22/04/2020.
4.113 UK Government. 'Disabled students allowances' [online], accessed 18/02/2020.
4.114 DfE. 'Evaluation of disabled students' allowances', 2019.
4.115 Policy Connect. 'Disabled Students' allowances: Giving students the technology they need to succeed', 2019.
4.116 Advance HE. 'Disabled students commission' [online], accessed 30/04/2020.
4.117 House of Commons Library. 'People with disabilities in employment', 2020.

Given this, it is important that engineering and technology departments work to cultivate 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.[4.118] (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.

Figure 4.23 Disabled students as a share of engineering and technology entrants and HE entrants overall over time (2014/15 to 2018/19) – UK

	Engineering and technology entrants		All entrants	
Year	Total	Disabled (%)	Total	Disabled (%)
2014/15	65,910	6.1%	988,798	9.0%
2015/16	65,545	6.3%	992,424	9.7%
2016/17	64,460	6.8%	1,013,484	10.5%
2017/18	64,395	7.3%	1,023,362	11.2%
2018/19	63,575	7.5%	1,032,236	12.0%

Source: HESA. 'HESA student record 2014/15 to 2018/19' data, 2016 to 2020.
Due to a change in HESA coding rules, students who registered their disability as 'unknown' are classified as having no disability.
Totals and percentages presented in this figure for 2018/19 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.

Figure 4.24 Disabled HE entrants by principal subject and level of study (2018/19) – UK

	First degree undergraduate		Other undergraduate		Postgraduate taught		Postgraduate research	
Principal subject	Total	Disabled (%)	Total	Disabled (%)	Total	Disabled (%)	Total	Disabled (%)
Technology subjects	1,670	14.2%	745	12.2%	2,020	8.7%	410	10.2%
Production and manufacturing engineering	1,135	11.9%	300	8.1%	1,245	2.3%	165	4.2%
General engineering	5,785	10.9%	1,235	5.7%	2,200	4.9%	1,280	6.3%
All other engineering subjects	935	9.9%	150	7.2%	465	4.6%	60	2.4%
Mechanical engineering	9,370	9.0%	690	5.5%	2,720	3.9%	660	5.3%
Electronic and electrical engineering	5,995	8.8%	1,060	5.8%	3,305	3.2%	945	5.8%
Civil engineering	5,400	7.8%	380	6.6%	3,270	4.2%	470	6.2%
Aerospace engineering	3,455	7.8%	185	9.8%	935	3.0%	180	5.0%
Chemical, process and energy engineering	2,865	6.8%	50	6.3%	1,290	5.5%	550	8.4%
All engineering and technology	**36,615**	**9.2%**	**4,790**	**7.1%**	**17,445**	**4.5%**	**4,720**	**6.5%**
All STEM	**253,015**	**13.9%**	**48,635**	**10.0%**	**122,205**	**9.3%**	**24,035**	**8.9%**
All subjects	**560,020**	**13.0%**	**103,385**	**9.6%**	**331,840**	**8.8%**	**36,995**	**9.2%**

Source: HESA. 'HESA student record 2018/19' data, 2020.
Due to a change in HESA coding rules, students who registered their disability as 'unknown' are classified as having no disability.
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 separate principal subjects within technology detailed in Figure 4.3.
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 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 in 2018/19 by subject area, disability status and level, see Figure 4.24 in our Excel resource. Figure 4.24 also includes comparisons for all university subjects.

4.118 ECU. 'Understanding the interaction of competence standards and reasonable adjustments', 2015.

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 (**Figure 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 (**Figure 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 entrants into engineering and technology courses is likely to impact the future engineering workforce. This is a concern because attracting more disabled people could bring real benefits to employers, 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:[4.119]

- "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 customers 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 status:[4.120] "At university, I 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 a disabled student's studies. Reasonable adjustments "remove or minimise disadvantages experienced by disabled people" and are applicable both within HE and the workplace.[4.121]

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 (76.0%) and non-disabled (77.9%) engineering and technology qualifiers achieving an upper second or first class degree. However, non-disabled students were more likely to achieve a first class degree than disabled students (37.9% compared with 34.9% respectively).[4.122]

4.8 – Intersectionality

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 intersect in ways that can have important consequences for their lives.

This 'intersectionality' 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 intersectionality can also be seen in relation to STEM. Research by Codiroli McMaster 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]

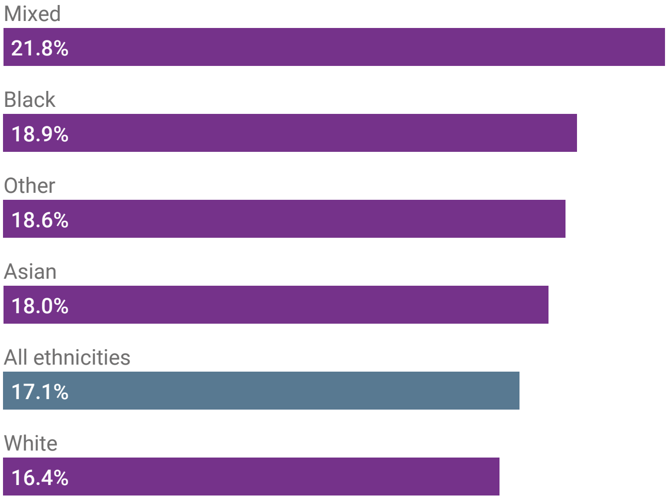
There is growing acknowledgement within the sector that this issue must be addressed. In 2017, the Equality Challenge Unit sought evidence on the diversity of staff and students related to intersectionality, which led to the development of a suite of case studies from universities and FE colleges.[4.125]

Participation

There is a clear 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 intersectionality among engineering and technology HE students.

4.119 IMechE. 'Changing attitudes to disability in engineering' [online], accessed 03/02/2020.
4.120 Equal engineers. 'Disability in engineering – support, challenges and reaching potentials' [online], accessed 22/04/2020.
4.121 Acas. 'Reasonable adjustments in the workplace' [online], accessed 22/04/2020.
4.122 HESA. 'HESA student record 2018/19' data, 2020.
4.123 Social Mobility Commission. 'Ethnicity, Gender and Social Mobility', 2016.
4.124 Codiroli Mcmaster, N. 'Who studies STEM subjects at A level and degree in England? An investigation into the intersections between students' family background, gender and ethnicity in determining choice', Br. Educ. Res. J., 2017.
4.125 ECU. 'Intersectional approaches to equality and diversity', 2018.

Figure 4.25 Female UK domiciled engineering and technology HE entrants by ethnicity (2018/19) – UK



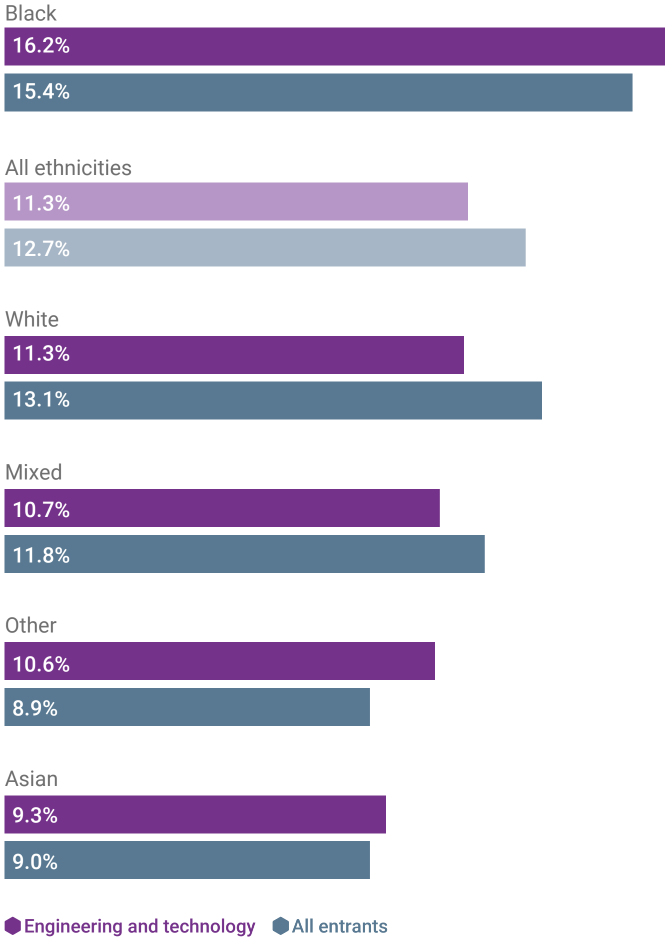
Source: HESA. 'HESA student record 2018/19' data, 2020.
Total figures and percentages calculated using these figures do not include those who indicated their gender as 'other'.
Percentages presented in this figure exclude engineering and technology students studying at 3 universities in the UK (Falmouth University, University of Worcester and London South Bank University), which opted out of providing detailed data to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019.

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 starkest 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 unemployed after receiving their degree, for example.[4.126, 4.127] 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.

Figure 4.26 UK domiciled HE entrants from low participation neighbourhoods by ethnicity (2018/19) – UK



Source: HESA. 'HESA student record 2018/19' data, 2020.
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 to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019.

Figure 4.26 shows that in terms of entrants from low participation neighbourhoods, engineering and technology students do not differ too much from overall student figures, but there are some notable differences.

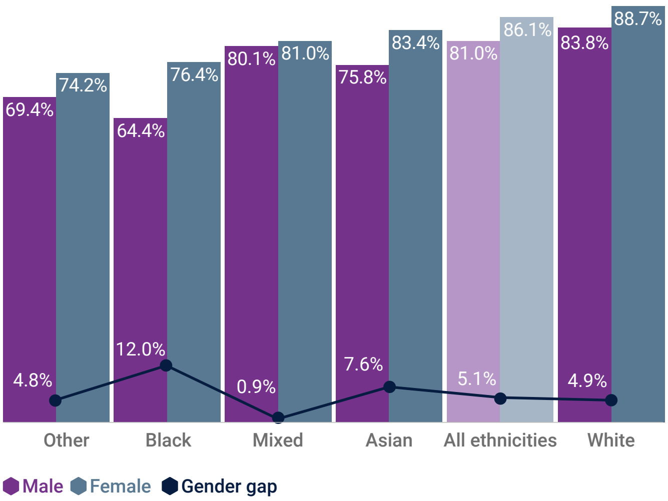
White entrants from low participation neighbourhoods tended to be slightly underrepresented on engineering and technology courses in 2018 to 2019, whereas Black and Asian students from low participation neighbourhoods, and those who indicated their ethnicity as Other, –were marginally overrepresented. As mentioned above, this could be due to an ambition among particular minority ethnic groups to pursue high return STEM subjects in order to protect against barriers in the labour market. This seems plausible for Black students and some Asian students, who tend to face challenging labour market prospects: evidence from 2019 showed that graduates with the lowest earnings were from the Other Black, Bangladeshi and Black Caribbean groups.[4.128]

4.126 Runnymede Trust. 'When education isn't enough: Labour market outcomes of ethnic minority graduates at elite universities', 2014.
4.127 Codiroli Mcmaster, N. 'Who studies STEM subjects at A level and degree in England? An investigation into the intersections between students' family background, gender and ethnicity in determining choice', Br. Educ. Res. J., 2017.
4.128 UK Government. 'Destinations and earnings of graduates after higher education' [online], accessed 22/04/2020.

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 ethnic graduates being second generation migrants whose parents experienced social demotion when they came to the UK.[4.129] Minority ethnic students, including those from lower socioeconomic backgrounds, could therefore be pursing STEM education at higher rate than their White counterparts in an attempt to enjoy the financial and wider benefits that STEM careers can offer.

Attainment

Figure 4.27 UK domiciled engineering and technology first degree qualifiers achieving a 1st or 2:1 degree by gender and ethnicity (2018/19) – UK



Source: HESA. 'HESA student record 2018/19' data, 2020.
Percentages in this chart are calculated using only male and female HE qualifiers, excluding those who indicated their gender as 'other'.
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 to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019.

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**).

Figure 4.28 UK domiciled first degree qualifiers achieving a 1st or 2:1 degree by gender and ethnicity (2018/19) – UK

Ethnicity	Male (%)	Female (%)	Gender gap (%)
White	80.0%	83.9%	3.8%
Black	55.9%	62.7%	6.8%
Asian	69.2%	73.9%	4.7%
Mixed	74.7%	79.8%	5.1%
Other	68.4%	69.3%	0.9%
All ethnicities	**77.0%**	**81.0%**	**4.0%**

Source: HESA. 'HESA student record 2018/19' data, 2020.
Percentages in this chart are calculated using only male and female HE qualifiers, excluding those who indicated their gender as 'other'.
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 to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019.

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.

4.9 – Engineering and technology students by domicile

The introduction to this chapter outlined some of the possible effects of the United Kingdom's departure from the European Union. It's important to understand in more detail what this will mean for engineering HE.

In this section, we refer to UK-domiciled students, 'other EU' students, and 'non-EU' students, where 'other EU' students refers to those studying in the UK who come from EU countries outside of the UK.

Compared with the overall make-up of HE students in the UK, engineering and technology has had a higher proportion of entrants from both other EU and non-EU countries over the last 10 years (**Figure 4.29**).

4.129 Li, Y. and Heath, A. 'Persisting disadvantages: a study of labour market dynamics of ethnic unemployment and earnings in the UK (2009-2015)', J. Eth. Mig. Studies, 2018.

Figure 4.29 HE entrants by domicile (2009/10 to 2018/19) – UK

	Engineering and technology entrants			All entrants		
Year	**Total**	**Other EU (%)**	**Non-EU (%)**	**Total**	**Other EU (%)**	**Non-EU (%)**
2009/10	69,085	9.5%	28.1%	1,185,260	5.4%	13.6%
2010/11	68,060	9.6%	30.3%	1,145,435	5.7%	15.2%
2011/12	68,025	9.3%	28.3%	1,117,335	5.8%	15.5%
2012/13	61,945	9.1%	30.9%	972,255	5.8%	17.7%
2013/14	64,445	8.9%	32.0%	995,740	5.7%	18.0%
2014/15	65,910	8.5%	31.6%	988,890	5.8%	17.6%
2015/16	65,560	8.5%	30.0%	992,125	6.0%	17.4%
2016/17	64,460	9.0%	29.4%	1,013,485	6.2%	17.0%
2017/18	64,395	8.6%	30.5%	1,023,360	6.1%	18.1%
2018/19	64,380	8.2%	32.4%	1,047,530	6.0%	17.9%

Source: HESA. 'HESA student record 2009/10 to 2018/19 data, 2011 to 2020.
This figure displays proportions of non-UK domiciled entrants into higher education. The remainder are UK domiciled.
HE entrants with unknown domicile have been excluded from this analysis.

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 can be found in the thought piece from Universities UK on page 133.

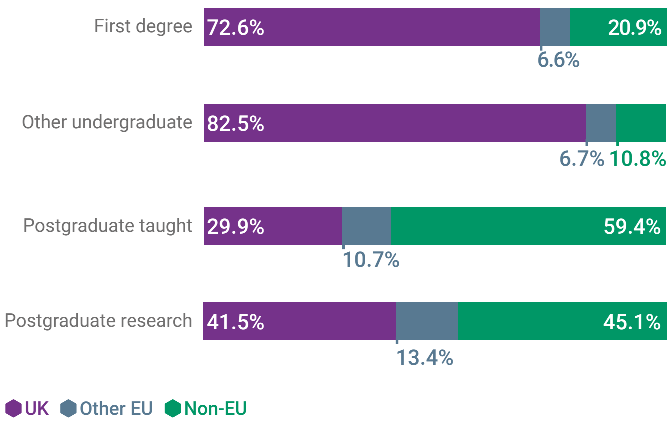
Level of study

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. Among 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.[4.130]

Figure 4.30 Engineering and technology entrants by level of study and domicile (2018/19) – UK



Source: HESA. 'HESA student record 2018/19' data, 2020.
HE entrants with unknown domicile have been excluded from this analysis.
To view a more detailed breakdown of HE entrants in 2018/19 by subject area, level of study and domicile, see **Figure 4.30** in our Excel resource.

Over half of all postgraduate entrants to engineering and technology courses were international.

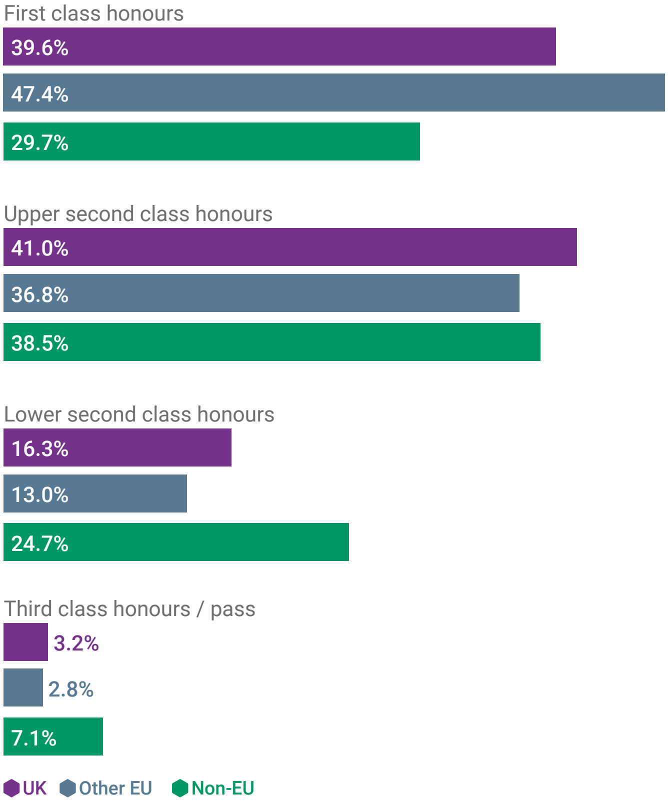
4.130 HESA. 'HESA student record 2018/19' data, 2020.

Attainment

As with the other personal characteristics we examine in this chapter, there were notable differences in attainment between students from the UK and those from other countries.

For example, the HESA data shows that non-EU nationals who qualified from engineering and technology first degrees in 2018 to 2019 received far lower degree classifications than their EU counterparts – both UK domiciled and other EU students (**Figure 4.31**). In 2018 to 2019, 80.6% of UK domiciled engineering and technology qualifiers achieved a first or upper second degree, compared with 84.2% of other EU students and just 68.2% of non-EU qualifiers.

Figure 4.31 Engineering and technology first degree qualifiers by degree class and domicile (2018/19) – UK



Source: HESA. 'HESA student record 2018/19' data, 2020.
HE entrants with unknown domicile have been excluded from this analysis.
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 to organisations outside of the HE sector and regulatory bodies in the academic year 2018 to 2019.

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 (39.6% 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.[4.131]

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.

4.131 Ibid.

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,[4.132] international staff make up nearly one third of all academics and over 55% of UK research publications are internationally co-authored.[4.133, 4.134]

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).[4.135] 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.

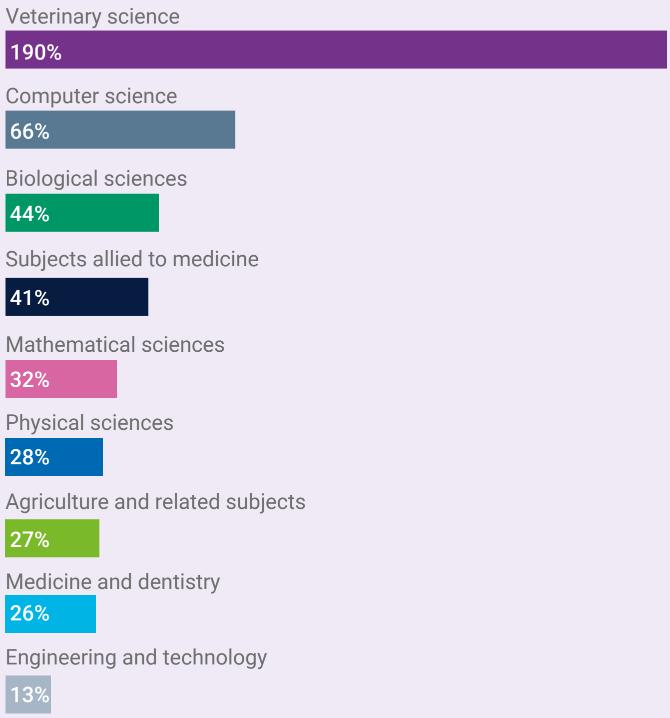
It was feared that this rupture would decimate EU student numbers, reducing the diversity of our learning environments and stifling the talent pipeline; that it would lessen UK universities' attractiveness to researchers looking to forge a career in knowledge creation; and that it would jeopardise access to the Horizon 2020 programme, compromising UK researchers' 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%.[4.136] 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 engineering and technology showing the smallest increase.

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.

Change in other EU student numbers in STEM subjects between 2014/15 and 2018/19



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4.132 OECD. 'Education at a glance 2019 - OECD indicators', 2019.
4.133 HESA. 'HESA staff record 2018/19' data, 2019.
4.134 Elsevier. 'SciVal database' data, 2020.
4.135 Ibid.
4.136 HESA. 'HESA student record 2014/15 to 2018/19' data, 2016 to 2020.

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-UK) 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.

Change in other EU staff numbers between 2014/15 and 2018/19	
Agriculture, forestry and veterinary science	+31%
Architecture and planning	+40%
Biological, mathematical and physical sciences	+14%
Engineering and technology	+28%
Medicine, dentistry and health	+25%

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,[4.138] 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

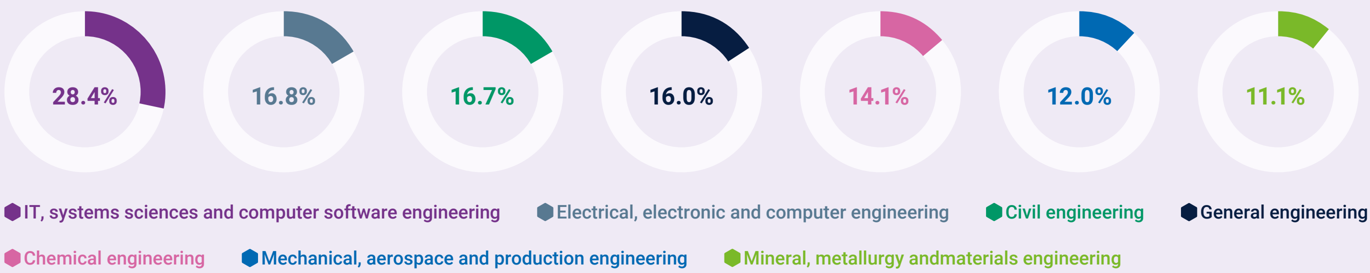
UK universities have benefitted massively from EU programme funding for research and mobility in recent years. According to the HESA finance return for 2017 to 2018, 11.8% of total university research income for STEM subjects came from EU government sources, with some engineering subjects receiving an even higher proportion. [4.139]

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 makeup 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.

Share of total research income from EU government sources in 2017/18



4.137 HESA. 'HESA staff record 2018/19' data, 2020.
4.138 UCEA. 'Higher Education workforce report 2019', 2019.
4.139 HESA. 'HESA finance record 2017/18' data, 2019.

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