Engineering UK 2020

Educational pathways into engineering

EngineeringUK

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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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.

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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.

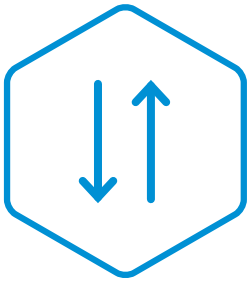
Engineering-related apprenticeships have followed a similar pattern. There was **a small year-on-year increase** (4%) in the academic year to 2018 to 2019, but there has still been an overall decrease of 4% since 2014 to 2015. The smaller drop for engineering-related areas means that their share of apprenticeship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

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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.