

Secondary education and engineering

Summary of key findings to
accompany excel resource
(Chapter 2)

In recent years, EngineeringUK has published a suite of data tables accompanying chapters in the State of Engineering report related to STEM education. Going forward, the excel resource for each chapter will be updated individually as the data becomes available and published alongside a summary of the key findings. This report looks at the secondary education landscape, including trends in entries and achievements for GCSEs/National 5s and A-Levels/Highers across the UK.

Secondary education is an important part of the pipeline into engineering careers. Performance in STEM qualifications at this level is one of the main ways to predict whether young people will continue into the relevant higher education. This can then help to predict whether there will be enough people ready to work in the engineering sector in the future.

However, there are challenges for the engineering sector even at this early stage of the educational pathway. There is a critical shortage in STEM teachers, and a lack of presence of engineering on the curriculum. We have also seen a decline in entries for some of the STEM subjects that would facilitate a future career in engineering, and an underrepresentation of girls in the key STEM subjects that would allow the engineering workforce to become more gender diverse.

Context

It is important to bear in mind when reading these results that there are some differences in the most recent two periods of data (2020/21 and 2021/22) due to the Covid-19 pandemic and lockdown restrictions that were implemented.

- Alternative assessment methods were used instead of summer examinations across the UK in 2020 and 2021.
- Grades were awarded based on a combination of teacher judgement and provision of evidence to demonstrate students' performance.
- Given that the approach to determining grades was vastly different compared to pre-pandemic years, grade distributions are also different and therefore cannot be compared in a meaningful way to results from previous years.

We must also take into consideration that the secondary school age population in the UK is increasing, following a mini baby boom in the mid 2000's. This is now leading to funding pressures within schools as these children move into secondary schools and class sizes increase.

- The number of secondary school students in state schools has grown by 8.5% over 5 years, from 3.8 million students in 2015/16 to 4.1 million in 2020/21.
- This growth is not uniform across the United Kingdom, and in fact, Wales has seen a 2.5% decline in secondary aged pupils over the same time period.

Additionally, there is a severe shortage of trainee teachers coming through initial teacher training routes for some STEM subjects. This is a long-standing problem and means that STEM subjects are being taught by non-specialist teachers in many cases. Despite initiatives to recruit more graduates into STEM teaching roles, there is still a problem with the recruitment and retention.

- In 2021/22 only 22% of the target for physics teachers was met and 23% of the target for design and technology teachers.
- Other STEM subjects are well oversubscribed, such as biology, which has recruited 117% of its target.

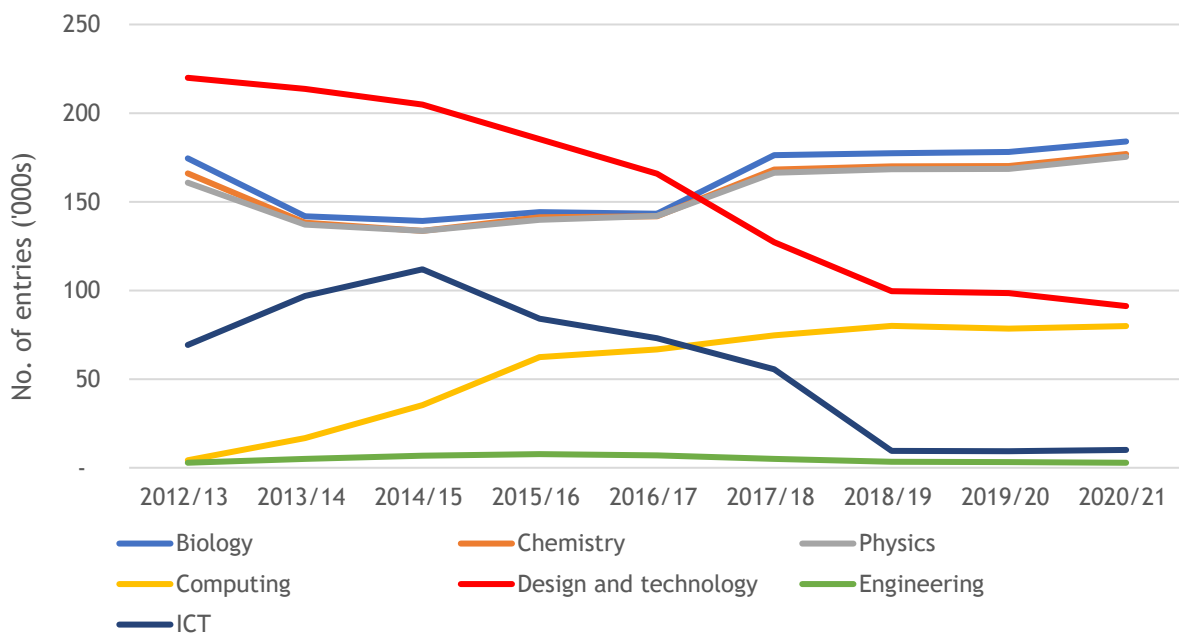
STEM GCSEs (England, Wales and Northern Ireland)

It is essential that we inspire more young people to take up STEM subjects in secondary school and provide them with positive learning experiences. Good attainment in subjects such as maths, physics, computer science, design and technology and other sciences will allow them the option to explore further education and a career in engineering. This is crucial for 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.

Engineering is not studied as a subject in its own right in the majority of secondary education institutions in England, Wales and Northern Ireland. Instead, students wishing to take academic routes into engineering careers must understand which of the available secondary school qualifications will facilitate their entry. Tables 2.2 to 2.6 in the excel resource look at the entries and attainment for a variety of STEM subjects, with the key points summarised below.

- Entries into single science subjects continue to rise. There has been a 4.0% increase in entries into physics, 3.9% increase in chemistry and 3.3% increase in biology entries over 1 year. This is relatively high compared to an approximately 2% increase in the population of 16-year-olds.
- Entries into computing have risen again following a dip. Entries in the subject had been rising steadily over the past 5 years but dipped in 2019/20 by 2.0%. In 2020/2021 we see entries return to 2018/19 levels, with around 80,000 students taking the subject.
- Entries into design and technology and engineering continue a concerning decline. Over the past 5 years, entries into engineering GCSE have fallen by 63.2% and entries into design and technology have fallen by 50.8%.

Figure 1: Trend in entries into selected GCSE STEM subjects, 2012/13 to 2020/21, England, Wales and Northern Ireland

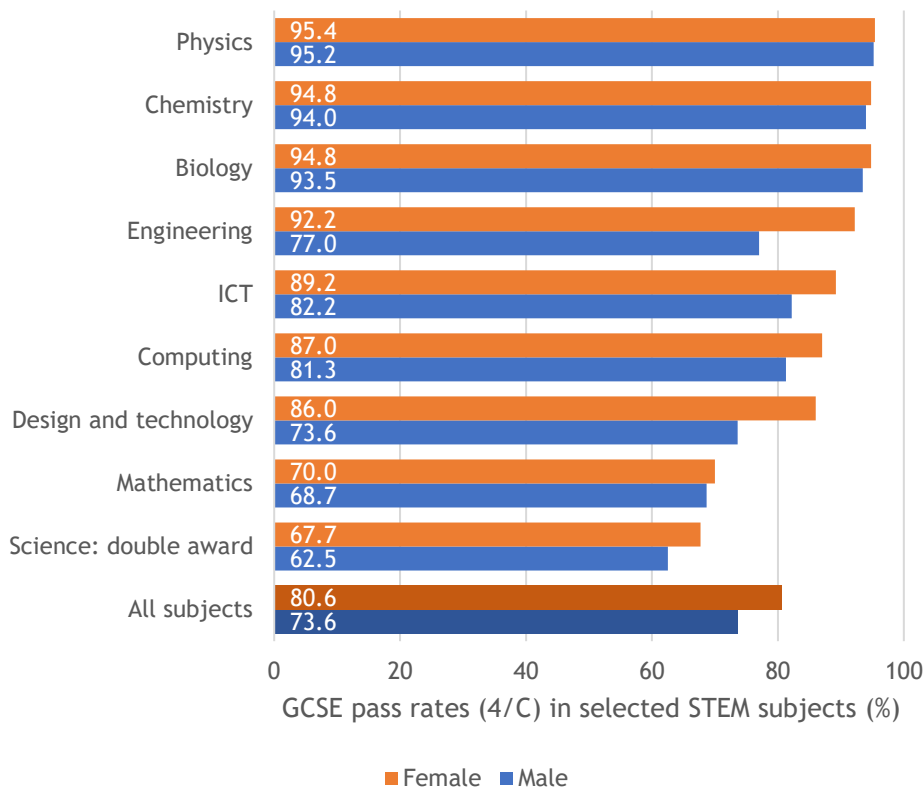


Source: JCQ. 'GCSE (Full Course) Results, Summer' data, 2013 to 2021. Table 2.2 in the Excel Resource.

Note the chart does not include mathematics and double science entries, which have much larger number of students entering.

- Levels of students attaining grades of 4/C or above fell slightly in most STEM subjects compared to 2019/20 but remain far higher compared to before the pandemic. Across all GCSE subjects, the proportion of students awarded 4/C and above has increased by nearly 10 percentage points (%p) between 2018/19 and 2020/21. Some STEM subjects have much larger grade inflation over the same period such as engineering (+26.6%p), computing (+19.8%p) and design and technology (+13.4%p).
- Stark gender differences remain. There are far fewer girls compared to boys taking non-EBacc subjects such as engineering (13.9% female), computing (20.7% female) and design and technology (29.2% female).
- Girls were more likely than boys to be awarded grades of 4/C and above in all STEM subjects, however the gender gap tends to be much smaller for some STEM subjects compared to others. In physics and chemistry, the gender gap is marginal (less than 1% difference). A-C/9-4 attainment is much higher for girls compared to boys in non-EBacc STEM subjects such as design and technology (+12.4%p) and Engineering (+15.2%p).

Figure 2: GCSE pass rates (4/C) in selected STEM subjects by gender, 2020/21, England, Wales and Northern Ireland



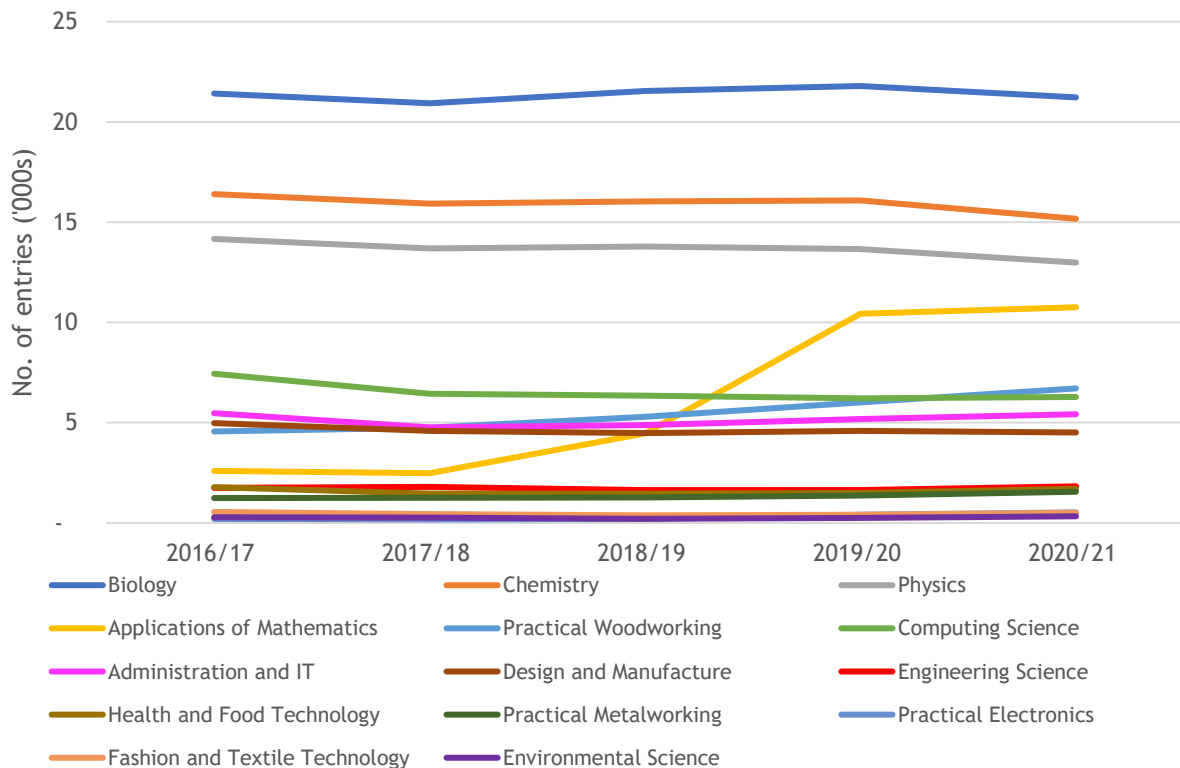
Source: JCQ. 'GCSE (Full Course) Results, Summer' data, 2013 to 2021. Table 2.6 in the Excel Resource.

STEM National 5s (Scotland):

In Scotland, pupils take National 5 qualifications at age 15 or 16, which are broadly equivalent to GCSEs in the other UK nations. Students typically study between 6 and 8 National 5s, ranging from traditional academic subjects, including maths and sciences, to more practical subjects, such as electronics and woodworking. They are assessed through a mix of coursework and exams and are graded from A to D (plus 'No award'), with grades A to C equivalent to GCSE grades 9 to 4. In tables 2.7 and 2.8 in the excel resource and below, we look at the trend in entries into STEM National 5 subjects since 2016/17.

- Some STEM subjects have seen a relatively large yearly increase in entries in 2020/21, including environmental science (+29.1%) and practical electronics (+26.1%).
- There appear to have been some changes in the study of mathematics. Applications of mathematics has seen an overwhelming increase from 2,604 in 2016/17 to 10,758 in 2020/21. On the other hand, entries into mathematics have fallen by 11.6% from 42,188 to 32,506 over the same period.
- Some engineering related subjects saw very large increases in pass rates since before the pandemic including environmental science (+33.5%p) and design and manufacture (+15.8%p).

Figure 3: Trend in National 5 entries in selected STEM subjects, 2016/17 to 2020/2021, Scotland



Source: SQA. 'Attainment Statistics' data, 2017 to 2021. Table 2.7 in the Excel Resource.

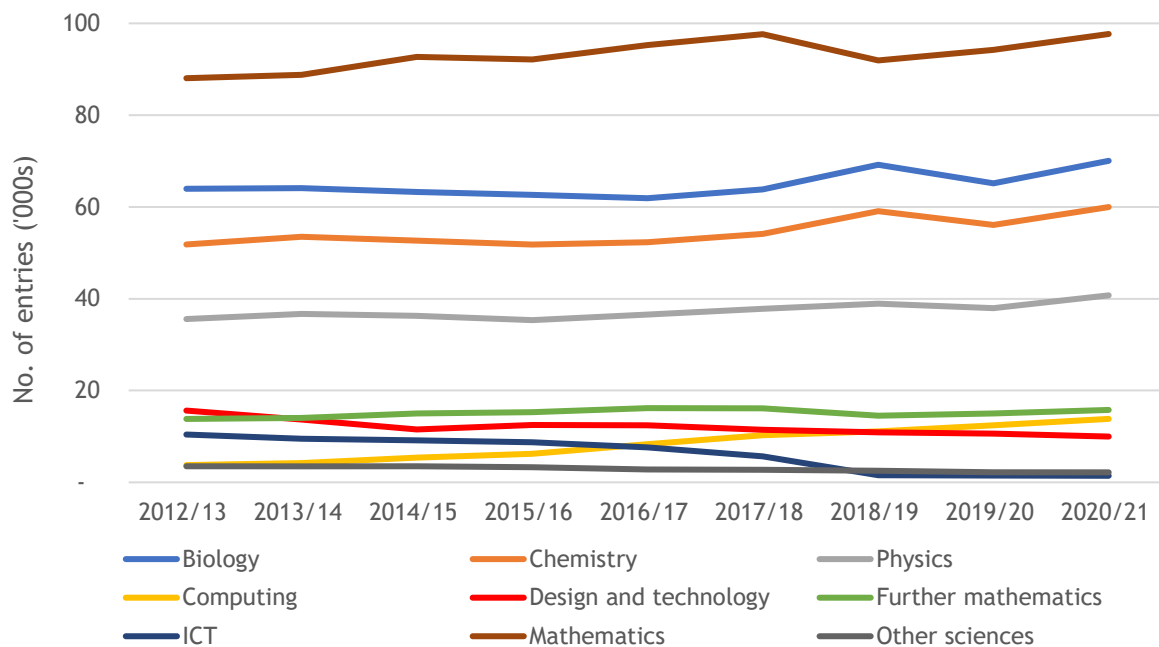
Note the chart does not include mathematics, which has much larger number of students entering.

STEM A levels (England, Wales and Northern Ireland)

Engineering related degree courses require good grades in A-Level STEM subjects, with the majority requiring 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. In tables 2.9 to 2.16 in the excel resource, we summarise entries and attainment in a number of STEM subjects that could lead to further academic study in an engineering-related field, such as a degree, which is the most common route into engineering.

- Maths, biology, chemistry and physics remain within the top ten most popular A level subjects to study, with maths being the most taken A level subject. Physics has moved up one place in the 2020/21 popularity rankings from 9th position to 8th.
- Entries into computing A level have increased by 11.3% in the latest year to 2020/21, continuing its steady upwards trend in popularity. There have also been notable rises in entries for biology (+7.6%), physics (+7.4%) and chemistry (+6.9%).

Figure 4. Trend in A level entries over time in selected STEM subjects, 2012/13 to 2020/21, England, Wales and Northern Ireland

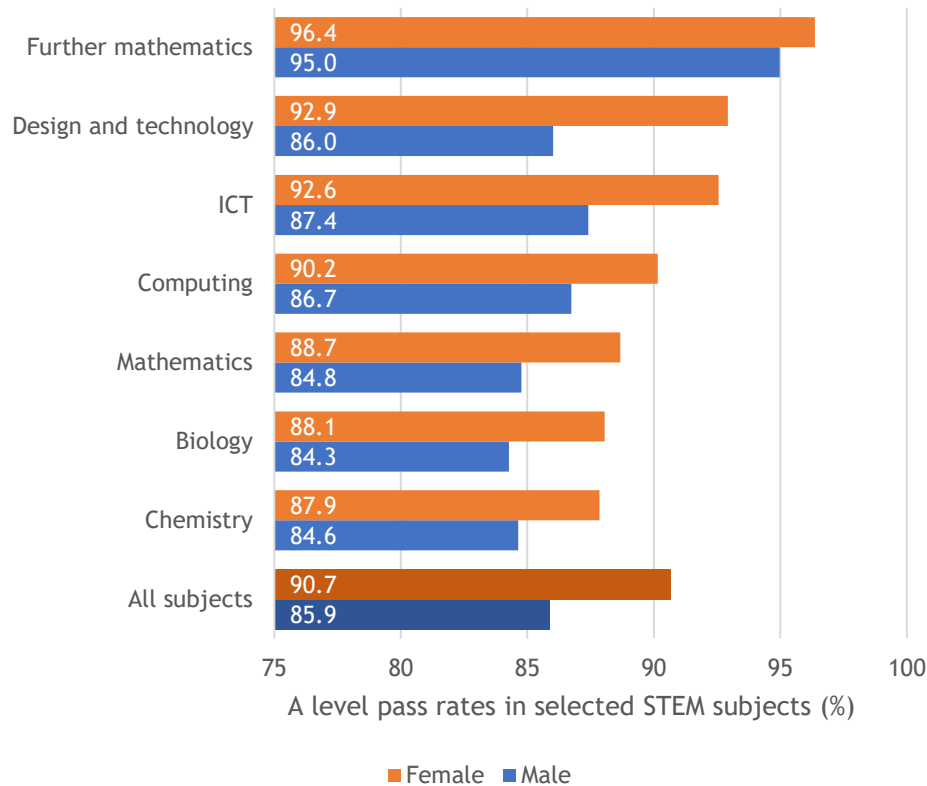


Source: JCQ. 'GCE A Level & GCE AS Level Results Summer' data, 2012 to 2021. Table 2.10 in Excel Resource.

- A*-C pass rates have risen substantially in all A Level STEM subjects compared to pre-pandemic levels following changes in assessment methods during the pandemic. Pass rates increased by 12.7%p across all subjects between 2018/19 and 2020/21. Some STEM subjects had even more notable increases across the same time period, including computing (+23.9%p) and design and technology (+19.9%p). There were smaller increases in further maths (+8.8%p) and maths (+10.7%p).
- Girls remain in the minority of entrants across all STEM subjects except for biology (63.7% female) and chemistry (54.6% female). Computing has the smallest proportion of female entrants of all STEM subjects at 14.7%. The number of girls taking computing has increased by 13.0% over the past year.

- Girls were more likely to achieve A*-C grades compared to boys in all A level STEM subjects in 2020/21. The greatest gender difference was in design and technology, where 90.2% of girls received a grade A*-C, compared to 86.0% of boys. Of the science subjects, physics has the largest gender gap, with 88.4% of girls receiving a grade of C or above, compared to 84.3% of boys.

Figure 5. A level pass rates in selected STEM subjects by gender, 2011/12 to 2020/2021, England, Wales and Northern Ireland



Source: JCQ. 'GCE A Level & GCE AS Level Results Summer' data, 2012 to 2021. Table 2.13 in Excel Resource.

STEM Highers (Scotland)

Much like the National 5s, STEM Highers and Advanced Highers cover a range of subjects with wider scope than the more traditionally academic subjects studied in the rest of the UK. Highers are broadly equivalent to the legacy AS levels, and Advanced Highers are slightly more advanced study than A-Levels, both with a grading system of A-D. Tables 2.17 to 2.20 in the excel resource explore the trends in attainment in STEM related subjects in Scotland.

- There has been a drop in entries for some STEM Higher subjects in 2020/21 compared to the previous year, including chemistry (-1.9%) and biology (-0.5%). Other STEM subjects had large increases in entries, including design and manufacture (+16.8%) and engineering science (+11.0%).
- Similarly, Advanced Highers in design and manufacture and engineering science have seen large increases in entries. Having attracted more than double the number of students in 2020/21 compared to 2019/20, both subjects have recovered following a dip in entries in recent years.

- Like the rest of the UK, grading systems used during the pandemic have resulted in a large increase in the proportion of students awarded grades A-C. Between 2018/19 and 2020/2021 A-C grades have increased by 27.0%p in design and manufacture Higher qualifications, by 22.2%p in computing science and 17.9%p in engineering science.
- Looking at Advanced Highers and those achieving the top A grade, engineering science has seen the largest year-on-year increase with 12.2%p higher attainment in 2020/21 compared to the previous year, followed by mathematics with a 10%p higher attainment of A grades.

STEM Teachers

Teacher shortages have been a longstanding issue in the UK, and with pupil numbers increasing at a faster rate than teacher recruitment, it continues to be a problem, particularly in STEM subjects where the teacher vacancy rates are the highest. Furthermore, rates of teacher specialism (i.e. those that have a qualification higher than A level in the subject they are teaching) vary between subjects. This is linked to student attainment and enjoyment¹ and is therefore an important part of encouraging young people to explore further education and careers in STEM and engineering. Tables 2.21 to 2.26 in the excel resource, look at the numbers of teachers and vacancies for various subjects and incentives being used to encourage recruitment and retention in these roles.

- Since the Covid-19 pandemic started, the number of teachers teaching STEM subjects in state schools in England has decreased by nearly 5%. Notably, the number of design and technology teachers has dropped by 14.2% over 2 years, continuing an ongoing trend. There have been small decreases in the number of teachers of chemistry (-3.1%), physics (-1.6%) and biology (-0.8%) over the same time period.
- The highest teacher vacancy rates for 2019 were seen in information technology with 1.7 vacancies for every 100 filled roles, followed by all sciences, mathematics and design and technology all with 1.4 vacancies per 100 filled roles. This is high compared to a rate of 1.1 when looking at the total number of teacher vacancies.
- Mathematics has the highest percentage of specialist teachers with 75% or more of mathematics teachers holding a mathematics qualification, and this has been the case since 2014. On the other hand, only around a third (34.3%) of science teachers are specialist in their subject, along with less than half of physics (41.9%) and chemistry (47.5%) teachers.
- Bursaries and scholarships are available for postgraduate trainee teachers specialising in STEM subjects for the 2022/23 academic year in England. Bursaries of £24,000 and scholarships of £26,000 are available for physics, mathematics, computing, and chemistry. Bursaries of £10,000 are available for biology.

Further information

For further information about the secondary school education, government initiatives and case studies from schools and teachers, please see Chapter 2 of the 'Educational pathways into engineering' report (2020) on the EngineeringUK website.

¹ DfE. 'Specialist and non-specialist' teaching in England: Extent and impact on pupil outcomes', 2016.