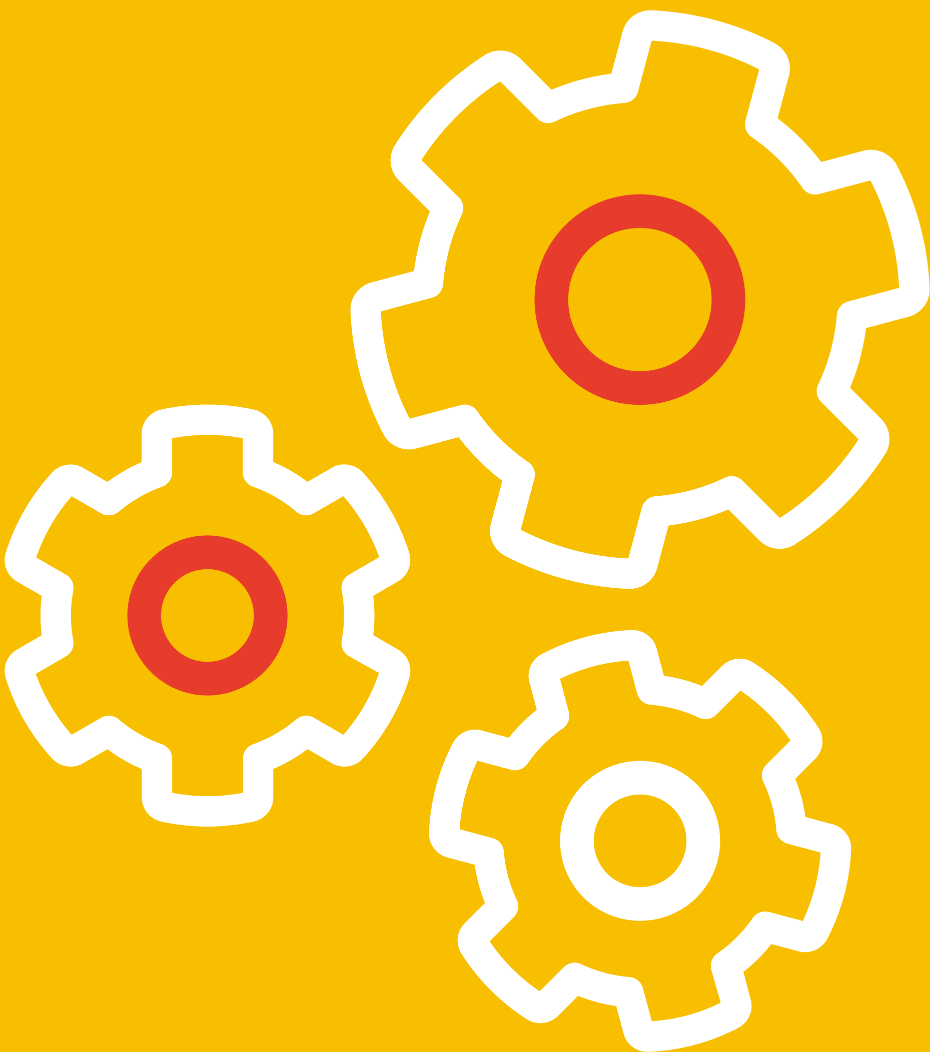
ASPIRES 3

Young People's STEM Trajectories, Age 10-22

ENGINEERING



Summary of Contents

1. Executive Summary

In this report, we share evidence from the ASPIRES research project, a fourteen-year, mixed methods investigation of the factors shaping young people's trajectories in, through and out of STEM education (science, technology, engineering and mathematics), with a particular focus on access to STEM degrees. The study collected survey data from over 47,000 young people and conducted over 760 qualitative interviews with a longitudinal sample, which tracked 50 young people (and their parents/carers) between the ages of 10 and 22.

The project also conducted secondary analyses of UK National Statistics and Higher Education Statistics Agency (HESA) data sets on England domiciled students, aged 18 to 24. This report focuses on analyses of survey data collected at age 21/22 and longitudinal interviews conducted from age 10 to 22, to shed light on the factors shaping STEM trajectories, particularly at degree level.

Key Findings

Who studies engineering at degree level in England?

Analyses of HESA and National Statistics data show that:

- **Participation in engineering at A level is very low** and is not required to access engineering degrees. Rather, advanced qualifications in Mathematics and Physics are the main gatekeepers to undergraduate study in the field – although this may be changing with the introduction of T levels;
- In contrast, **the percentage of students taking engineering at degree level remains stable and high,** being consistently the most popular STEM degree subject between 2015 and 2021 (excluding medicine). For instance, in 2020/21, engineering undergraduates comprised 26.9% of all STEM undergraduates and 5.0% of all undergraduates;
- **Participation in engineering degrees remains heavily male-dominated.** For instance, in 2020/21 in England, only 14.6% of engineering undergraduates were female, one of the lowest of all the STEM fields;
- However, **engineering is more inclusive in terms of race/ethnicity and socio-economic background**. For instance, in 2020/21, 9.4% of engineering students were Black compared with 7.8% of all STEM students and 8.3% of non-STEM students. In the same year, 18.5% of engineering students were from the most deprived IMD quintile, compared with 17.4% of all STEM students and 19.2% of non-STEM students;
- **Rates of non-completion are relatively high among engineering degree students, compared with other STEM degrees.** Between 2015 and 2020, on average 7.9% of first year engineering undergraduates aged 18 to 24 in England withdrew from their degree course with no award during their first year. This was just over one and a half times more than in maths and almost double the percentage recorded among physics and chemistry students, but slightly lower than among computing students. Students from Black backgrounds recorded higher rates of non-completion compared with white students (12.8% vs. 6.6% on average);
- Most withdrawals happen within the first year but ASPIRES survey data suggests that a notable proportion of **students in later years of study** also **express concerns about completion, including around a quarter (24%) of engineering students.** This figure is higher than found in maths and chemistry (18%), but lower than in computing degrees (37%);
- Across all degree subject areas, **concerns about completion most often related to academic issues** (identified by 43% of STEM students and 35% of non-STEM students who expressed concerns), and were **most frequently expressed by women, minoritised students, and students from low IMD backgrounds.** 29% of both STEM and non-STEM students worried about financial issues. Problems related to or exacerbated by the COVID pandemic constituted the third most commonly mentioned issue (18% of STEM and 19% non-STEM students), although the impact of the pandemic was particularly frequently raised by those on engineering degrees.

What shapes young people's engineering trajectories?

Analyses of the ASPIRES survey and longitudinal interview data found that:

- **Subject liking/interest/passion was the most common primary reason – given by 50% of engineering students – for choosing their subject.** This was also the top reason given by STEM students generally for their degree choices, apart from in mathematics;
- **Positive views of engineering jobs** were also influential (27%) and were cited by a higher percentage of engineering students compared with those in many other STEM fields;
- The percentage of students attributing their degree choice to **family encouragement was higher in engineering than for other degree subjects** and largely related to having family members who worked in engineering;
- Among suitably qualified young people who chose otherwise, **dislike/lack of interest/ hatred of engineering was the most common reason given for not pursuing it at degree level (60%).** This was particularly high compared with most other STEM degree options and primarily reflected **negative views of engineering**;
- **Gendered perceptions of engineering were a key reason why many suitably qualified young women did not pursue the discipline**, along with not seeing oneself as 'good enough' or 'clever enough' to continue with engineering. Gendered perceptions were mentioned far more often in relation to engineering compared with other STEM degree areas and included the fact that engineering is so male-dominated, perceptions of it being unwelcoming for women and a lack of encouragement given to girls to pursue engineering;
- Analysis of longitudinal interview data from age 10 to 22 shows that **interactions of identity, capital and field are key** factors shaping students' subject engagement and trajectories. In particular:
  - A 'wrap-around' of engineering-related social, cultural and economic capital over time is important for making an engineering identity and trajectory possible and desirable;
  - The extent of 'fit' experienced between a young person's identity and the field of engineering strongly shapes participation, particularly in relation to gender, where the masculine culture of the field and experiences of peer sexism restrict women's progression and participation;
  - Participation is restricted by common educational practices that make some students (but particularly those from underrepresented demographics) feel 'not clever enough' to continue with engineering (either directly or via key feeder subjects);
  - Positive perceptions of engineering jobs are a relatively important motivation for degree study in this field.
- **Generally, engineering degree students reported fairly positive views of their degree experiences although there remains a sizeable minority who expressed less positive views.** There were some differences in views between engineering degree students and those taking apprenticeships.
- The proportion of students who expressed worries about completing their degrees was roughly comparable in engineering (24%) with the average (27%) across all STEM and high-status medicine degrees, with concerns most frequently reflecting academic issues, followed by financial concerns. Problems related to or exacerbated by the COVID pandemic constituted the third most commonly mentioned concern, but were particularly frequently raised by those on engineering degrees;

- As a general pattern, those from underrepresented groups – **women, racially-minoritised students, and students from low IMD backgrounds – were the most likely to express concerns about completion**. There was a particularly notable gender gap in engineering, where **the percentage of women engineering degree students who expressed concerns about completion was four times that of men**;
- **Women on STEM degrees were significantly more likely to report experiencing sexism in their educational setting compared with those on non-STEM degrees.** Of those women reporting such experiences, **the percentage experiencing sexism was highest in engineering and physics**;
- **Sexism was most frequently attributed to male peers and usually involved everyday gendered microaggressions**;
- **Engineering students tend to be focused on entering the workforce and staying within their field of specialism.** The majority (71.4%) of those who were studying for, or had recently completed, an engineering degree were planning to go into full-time work (compared with 69.5% of all STEM students). 82% planned to stay within engineering, which was considerably higher than found among students in most other STEM subjects.

Key Recommendations

From the overall study findings, we identify six main recommendations for policymakers and practitioners who want to support increased and more diverse participation in engineering specifically, and STEM more generally. Five of these (listed below) apply directly to supporting young people’s engineering trajectories (whereas the remaining recommendation derives from wider study findings, reported elsewhere, relating to GCSE science qualification routes).

1. Support and value young people’s engineering and STEM identities over time and across contexts, focusing particularly on young women’s identities.

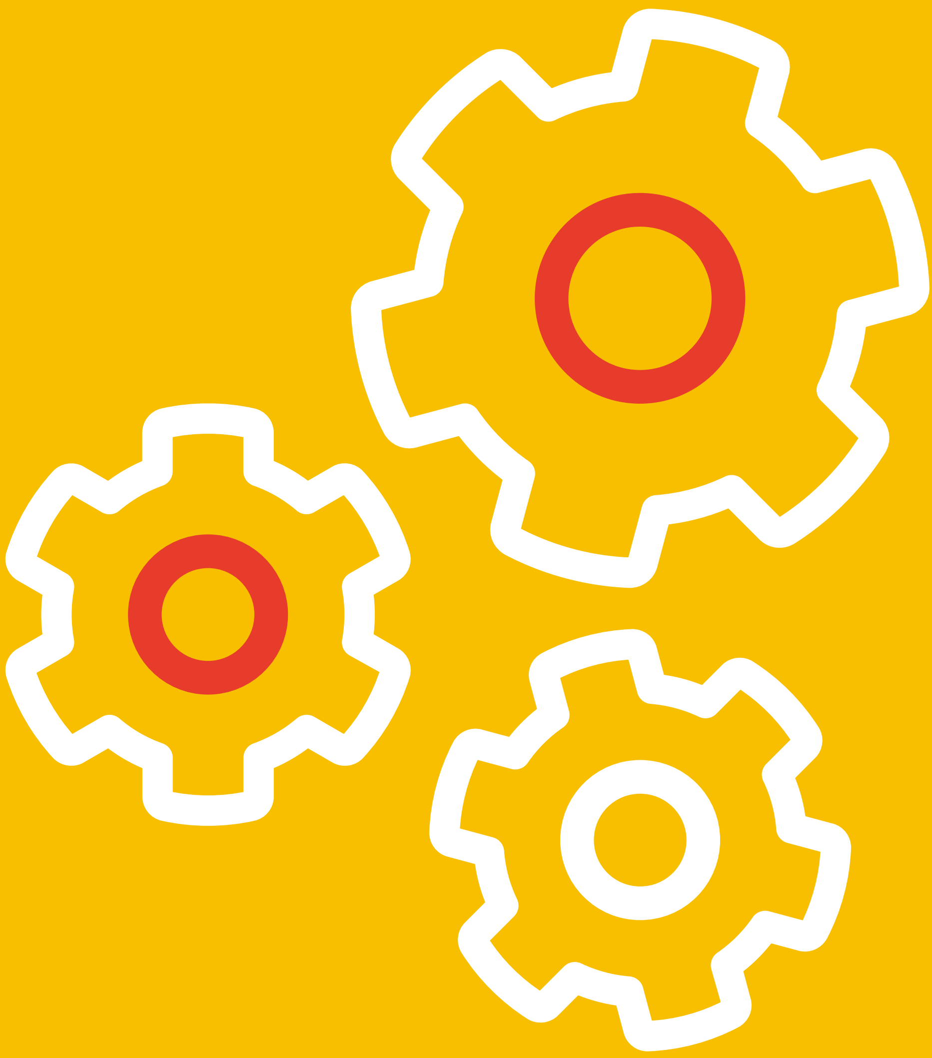
2. Challenge ideas of STEM competence (but particularly in relation to mathematical areas) as being based on ‘natural talent’.

3. Challenge peer sexism and create more gender-equitable cultures within engineering degrees and outreach programmes.

4. Support more equitable experience and retention on engineering degrees, particularly among young women and students from underrepresented communities.

5. Engineer greater access to key forms of social and cultural capital for young people from underrepresented communities, especially women, to support social mobility in engineering and beyond.

These are discussed in more detail at the end of report, with suggestions on how they might be operationalised.



Engineering

2. What are the patterns in participation in undergraduate engineering?

In the UK, as in many other high-income industrialised countries, **there are concerns about an engineering sector skills gap and a lack of diversity among those with engineering qualifications and skills, particularly a lack of women, who constitute only around 9% of the engineering workforce.**[1] These participation issues are seen to negatively impact the UK's economic and environmental sustainability, and constitute social justice concerns in their own right.[2]

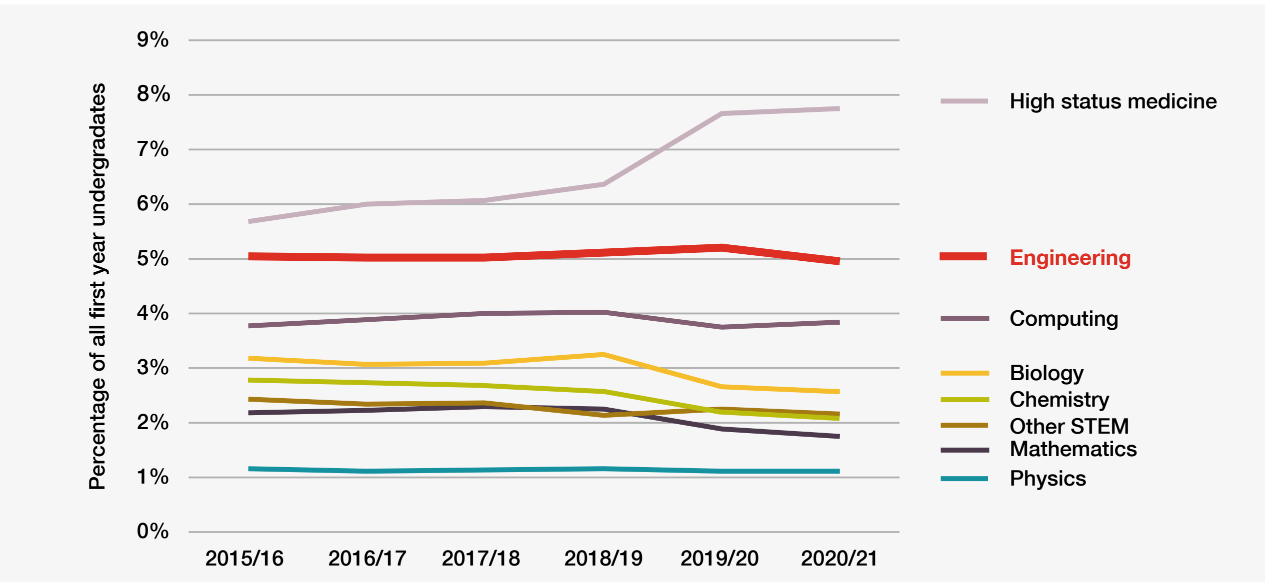
Engineering is not part of the UK National Curriculum. An A level exists in Engineering but it has relatively low take-up and is not required to access engineering degrees. Rather, advanced qualifications in Mathematics and Physics have traditionally been the main gatekeepers to undergraduate study in the field, although this may change following the introduction of T levels in 2020.

In this report, we summarise key findings from the ASPIRES study which add to the weight of evidence that these patterns in participation are structural, rather than due to individual failings, such as an innate lack of confidence or ability. We propose that engineering participation cannot be improved simply through interventions designed to increase interest in engineering or purely by supporting attainment in feeder subjects. We also outline some of the changes that we think are needed, focusing on where changes might usefully be made to the systems, cultures and practices of engineering education in order to support increased and diversified participation.

We begin with an overview of the patterns of participation in undergraduate engineering using analyses of data supplied by the Higher Education Statistics Agency (HESA).[3]

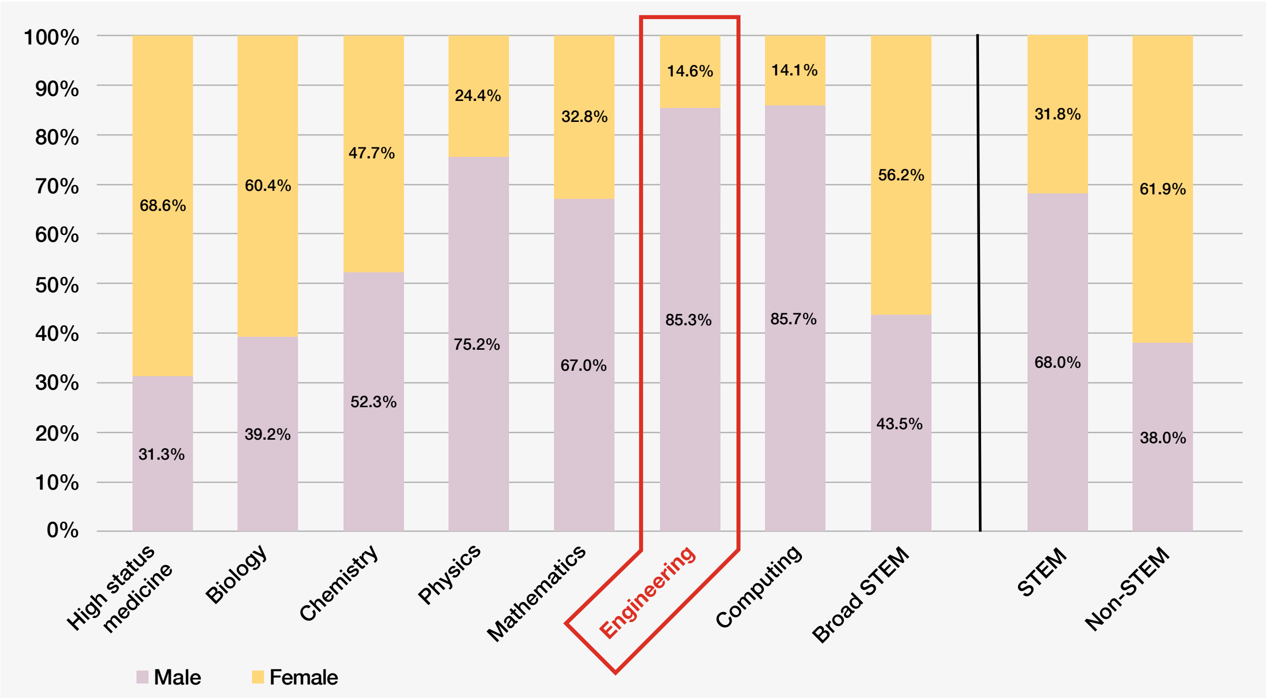
National data from the UK Higher Education Statistics Agency (HESA) show that engineering is consistently the most popular type of STEM degree in England. As Figure 1 shows, this has been a relatively stable trend from 2015 to 2021. In 2020/21, engineering undergraduates comprised 26.9% of all STEM undergraduates and 5.0% of all undergraduates.

Figure 1: Participation in STEM disciplines at undergraduate level from 2015/16 to 2020/21



Engineering is also one of the most gender imbalanced degree routes, with 14.6% female and 85.3% male students in 2020/21 academic year. This trend has remained stable over time between 2015 and 2021 (average 13.5% women), falling well below the average for both STEM and non-STEM degrees, at 31.7% and 61.2%, respectively. Only computing has a similarly low representation of female students, with 14.1% of the cohort being female in 2020/21 (and an average of 12.6% between 2015 and 2021).

Figure 2: Breakdown by gender of first-year undergraduates in England in 2020/21



However, **engineering degree participation is more inclusive in terms of race/ethnicity and socio-economic background**. For instance, in 2020/21, 9.4% of England domiciled engineering students were Black compared with 7.8% of all STEM students and 8.3% of non-STEM students (see Figure 3). In the same year, 18.5% of engineering students were from the most deprived IMD quintile (IMD1), compared with 17.4% of all STEM students and 19.2% of non-STEM students (see Figure 4). Between 2015 and 2021, STEM and non-STEM degree routes record a trend of increasing proportions of IMD1 and IMD2 students, although engineering was notable in that the percentage of IMD1 and IMD2 students dropped in 2018/19 and 2020/21.

Figure 3: Breakdown by race/ethnicity of first-year undergraduates in England in 2020/21

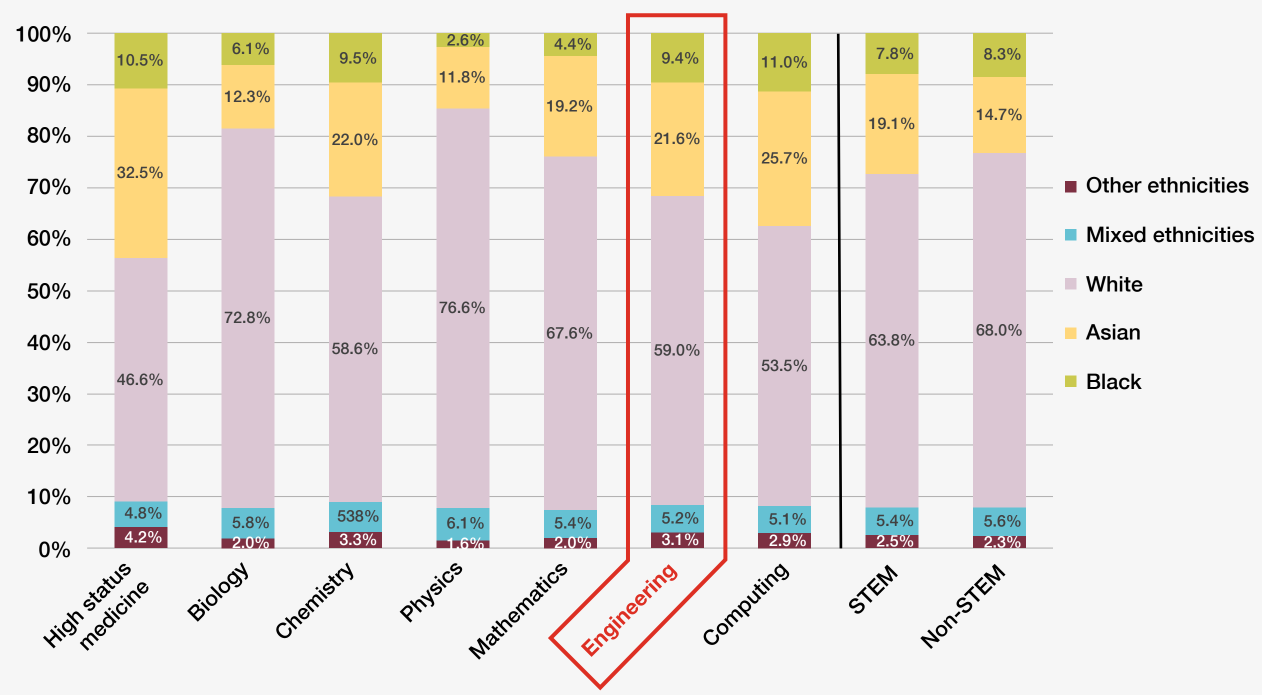
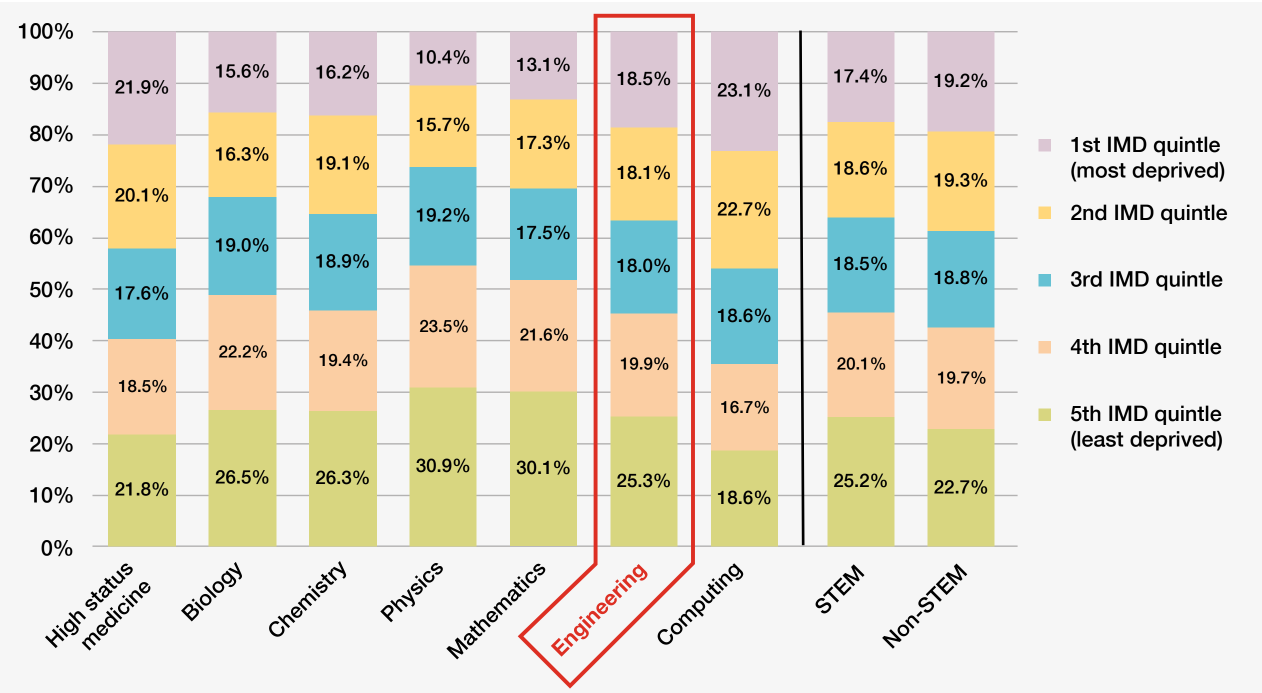


Figure 4: Breakdown by IMD quintile of first-year undergraduates in England in 2020/21



Between 2015 and 2020, on average **7.9% of first-year engineering undergraduates from England aged 18 to 24 left their course with no award during, or at the end of, their first year;** 3% left during, or at the end of, their second year; and 1% during, or at the end of, their third year. These **non-completion rates are higher in engineering** than the average for the same time period for all STEM degrees (6.5%), with only non-completion rates in computing being higher than engineering (9.4%).

Male students were more likely to leave their engineering course during, or at the end of, the first year than female students (7.0% vs. 4.1%, respectively, in 2019/20). In 2019/20, those in engineering from Black (9.9%) and other (10.7%) ethnic backgrounds had higher rates of non-completion than Asian (6.3%), Mixed Ethnicity (6.6%) and White (5.8%) backgrounds. Those in engineering from the IMD1 and IMD2 quintiles (16.8%) left their engineering degrees at a higher rate than those from higher-income backgrounds (10.4%).

3. Prior research base and conceptual approach

Research into engineering engagement identifies a range of factors shaping engineering trajectories, including: subject interest and passion; strong mathematics and physics identities; support and recognition from family, teachers and significant others; relevant out-of-school experiences, including 'tinkering'; perceived job opportunities; and the possibility of working on sustainability issues such as climate change and water supply.[4]

Previous research has drawn attention to how women's underrepresentation in engineering is linked to sexism and a masculine culture (both in higher education and the workplace) that creates a 'chilly climate' for women, deterring entry, restricting progression and exacerbating attrition at all levels.[5] Consideration has also been given to the negative impact of gendered perceptions and representations of engineers;[6] and to a lack of support, expertise, and recognition by family, teachers and significant others for girls' progression.[7] However, existing interventions to promote participation in engineering have tended to focus on changing individuals, for instance by increasing knowledge of what engineering is and what engineering jobs are like, and/or presenting a more inclusive image of the field, rather than changing engineering education practices and cultures.

The ASPIRES project is informed by sociological and educational research that shows how **interactions of identity and capital (social and cultural resources) shape young people's pathways through schooling and into further and higher education, and employment.**[8] Young people can accrue capital from home, family, school and other educational contexts.[9]

In the ASPIRES research, we explore how **engineering-related capital is translated into resources and practices that help produce and sustain young people's high interest, attainment and aspirations.** We show that **interactions of identity and capital are key to producing and sustaining engineering trajectories** and that **where there is close alignment between engineering-related identity, resources and the field of engineering, young people are more likely to feel competent and interested in engineering, and so are more likely to choose to continue with the subject**.

Importantly, we also argue that **the strongly gendered nature of the field of engineering entails particular challenges for women's participation and the extent to which women experience engineering as fitting, or not, with their ways of being and sense of what is normal, possible and desirable 'for people like me'.**

4. What data did the ASPIRES project collect?

ASPIRES is a mixed methods study that focuses on young people from a single cohort, born between September 1998 and August 1999. It comprises survey data from over 47,000 young people from this cohort, and qualitative interview data from a longitudinal tracking of 50 participants from the same cohort (with their parents/carers) between the ages of 10 and 22, totalling over 800 interviews. Table 1 summarises the quantitative and qualitative data collected at each stage of the research.

Table 1: Summary of ASPIRES project data collection

	ASPIRES			ASPIRES2			ASPIRES3
Data point	1	2	3	4	5	Interim catch up	**6**
Year	2009/10	2011/12	2012/13	2014/15	2016/17	2017/18	**2020/21**
Age	10/11	12/13	13/14	15/16	17/18	18/19	**21/22**
School Year **Educational stage**	Year 6 End of Key Stage 2 – Final year of primary school	Year 8 Key Stage 3 – Second year of secondary school	Year 9 End of Key Stage 3 – Third year of secondary school	Year 11 End of Key Stage 4 / GCSEs – Final year of secondary school	Year 13 End of Key Stage 5 / College	1st year university, work, gap year, other	**First year after completing university / continuation of university studies or work**
Number of survey participants / schools	9,319 279 primary schools	5,634 69 secondary schools	4,600 147 secondary schools	13,421 340 secondary schools	7,013 265 schools / colleges	N/A	**7,635** **N/A**
Number of interviews with young people	92	85	83	70	61	60	**50**
Number of interviews with parents	84 parents of 79 children	Parents not interviewed	73 parents of 66 young people	67 parents of 63 young people	65 parents of 61 young people	Parents not interviewed	**35 parents**

The ASPIRES3 survey comprised a large-scale postal survey of young people in England and was conducted by obtaining a sample of young people born between 1st September 1998 and 31st August 1999 who were registered on the Open Electoral Roll. Following data cleaning, the overall achieved sample of 7,635 young people was roughly proportional to (though not fully representative of) official government population estimates in England for 21- and 22-year-olds based on sex, ethnicity, region, Index of Multiple Deprivation, Urban/Rural classification and long-lasting health conditions.[10]

The postal survey sample of 7,635 young people included 3,388 current and/or recently completed degree students, of whom 118 were in engineering degrees (based on HESA degree classifications[11]). A further 39 young people were doing, or had done, engineering apprenticeships and 67 were in other engineering routes including work.[12] Among this group of 224 young people pursuing engineering:

- **There was a higher percentage of men on all three of the main engineering routes**, with the lowest female representation in engineering apprenticeships (7.7%), followed by other engineering routes (13%), and engineering degrees (22%).
- **37% of engineering degree students came from racially minoritised backgrounds**, compared to 15% on apprenticeships and 12% on other engineering routes.
- **There were higher percentages of young people from the most socially deprived quintiles (IMD1 and IMD2) on non-degree routes** (44% of apprenticeships and 45% of other routes), compared with degree students (39%). Engineering degree students were more likely to have a university-educated parent (50%), compared with those taking apprenticeships (28%) or on other engineering routes (34%).

5. Why do suitably qualified students take – or not take – an engineering degree?

Figures 5 and 6 summarise the open-ended responses from the final ASPIRES survey of:

- The reasons STEM degree students gave for their subject degree choice, classified into: subject interest/passion; feeling 'good at engineering'; positive views of engineering jobs; family encouragement; and other;
- The reasons young people who had taken A level subjects that would have enabled them to apply for STEM degrees gave for their decision not to pursue these subjects, classified into: subject dislike/hatred; feeling 'bad at engineering'; negative views of engineering jobs; family discouragement; do not want to go to university; and other.

Figure 5: The reasons STEM degree students gave for their subject degree choice

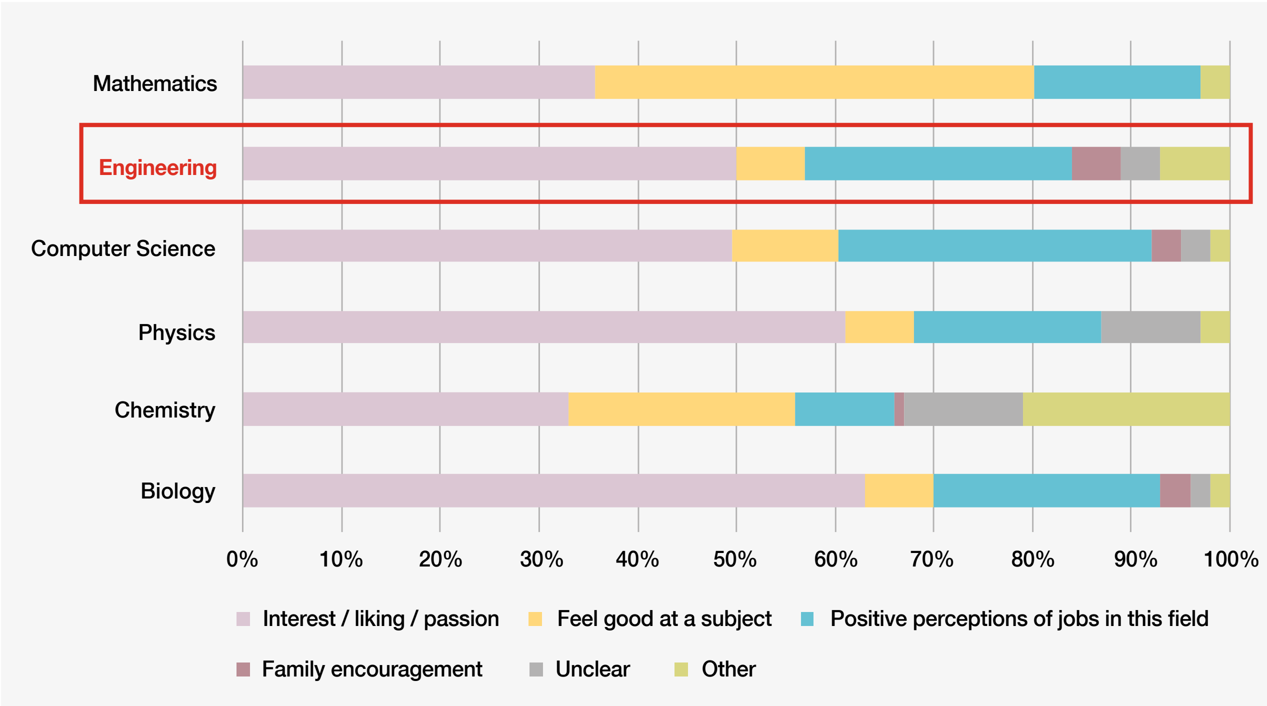
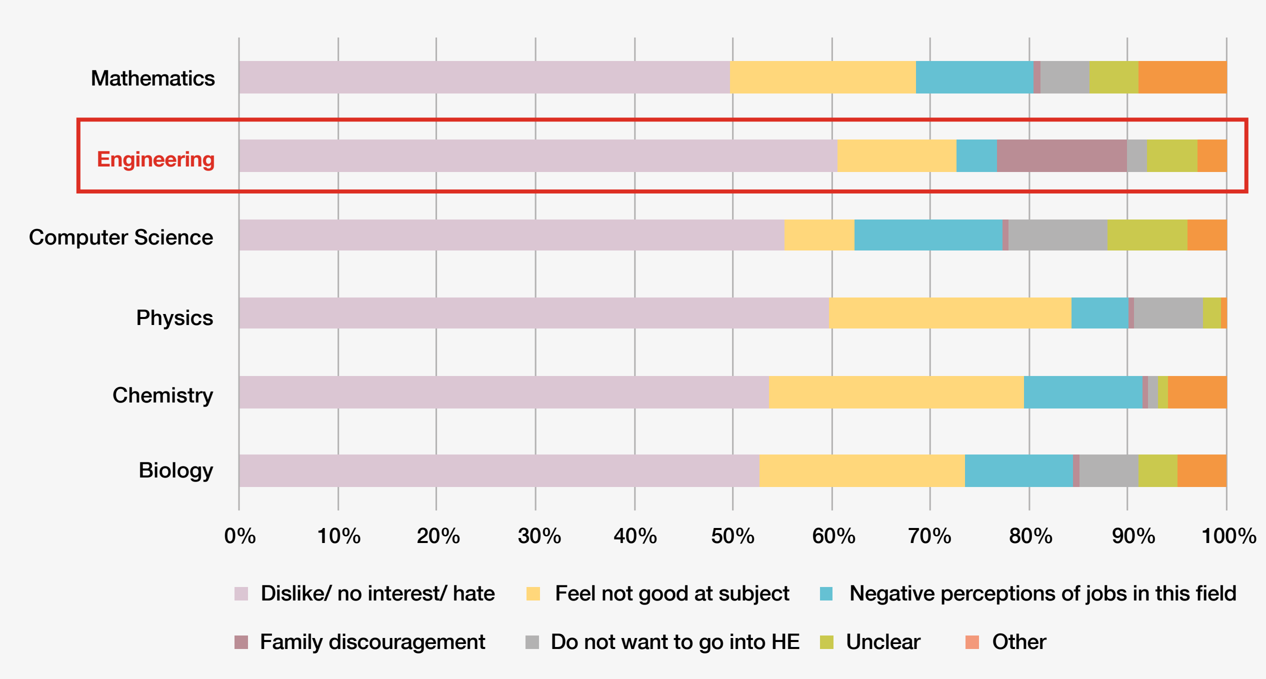


Figure 6: The reasons young people who had taken A level subjects that would have enabled them to apply for STEM degrees gave for their decision not to pursue these subjects



Analysis showed that **among those who went on to study for a degree** in a STEM discipline:

- **Subject liking/interest/passion was the most common primary reason given by 50% of engineering students for choosing their subject.** It was also the most common reason expressed by STEM students in all disciplines except mathematics;
- The second most common reason given by engineering students for their degree choice related to **positive views of engineering jobs** (27%). This was also the second most popular reason given by students in physics (19%), biology (23%) and computing (32%);
- A smaller number cited being 'good at' engineering (7%), family encouragement (5%) and a mix of other factors (7%). The percentage citing **family encouragement was higher in engineering than for other degree subjects** and largely related to having family members who worked in engineering.

Looking at the reasons given by suitably qualified young people for *not* pursuing degrees in particular STEM subjects, analysis showed that:

- **Subject dislike/lack of interest/hatred was the most commonly given primary reason for not pursuing an engineering degree (60%).** This was also the primary reason given by students in relation to all other STEM subjects, but was particularly high here and in physics (61%). Of those engineering students who cited this as a primary reason, **40% attributed this to negative views of engineering** and 20% said it was because they were more interested in another subject. This represented a greater skewing towards negative views of the subject than was found for other degree subjects. For example, just a quarter of those who did not pursue physics for this reason cited negative views of physics as their reason, with the majority saying that they preferred another subject;

- **The next most commonly cited reasons for not pursuing engineering related to gendered perceptions of engineering (13%) and seeing oneself as not good at engineering (12%).** Gendered perceptions were particularly prominent in relation to engineering, compared with other STEM degree areas (where it was mentioned by <1% of respondents) and included feeling that engineering was male-dominated and unwelcoming for women, and that a lack of encouragement was given to girls to pursue engineering (typical open-ended survey responses being "Not enough female role models"; "It is very male dominated, so it was a worry that I wouldn't fit in"; "I would have loved to. But as a girl was not encouraged to take physics at A Level so couldn't do an engineering degree");

- **Just 4% of responses related to negative views of engineering jobs.** This was lower than was found for most other STEM degree areas, which accounted for 11-15% of responses in all STEM disciplines apart from physics (6%), suggesting that young people generally had reasonably positive views of engineering jobs, regardless of whether they did, or did not, pursue engineering degrees.

As discussed next, the qualitative interview data help us to understand how interactions between young people's identity and capital in relation to the field of engineering education shaped their trajectories into, and away from, engineering degrees.

6. What factors shape engineering trajectories?

Analyses of the longitudinal qualitative data show how **students' choices are influenced by the extent of the fit between their identity, capital and the field of engineering, which shapes the extent to which engineering pathways are felt to be 'for people like me', or not**.

Analyses of the ASPIRES data show how a range of factors come together to shape pathways into, and out of, engineering. These include how **engineering-related capital and experiences during school years are important for developing, and sustaining, an interest and aspiration towards engineering**; the particular importance of the degree of '**fit' between a young person's gender identity and the masculine field of engineering** (particularly in relation to women's participation and progression); the issue of **'not feeling clever enough'** and **perceptions of engineering jobs**.

These issues are exemplified by two case studies of Laylany and Victoria, both White British young women from working-class or lower-middle-class backgrounds, who pursued mechanical and electrical engineering trajectories respectively, albeit with different outcomes.

Factor 1: A 'wrap-around' of engineering-related social, cultural and economic capital over time is important for making an engineering identity and trajectory possible and desirable

As detailed in the ASPIRES final project report in relation to other STEM fields, early and sustained access to STEM-related capital over time was found to be important for developing and sustaining interest, identity and aspiration in relation to a given STEM discipline – a finding that was also evidenced in relation to engineering.

As exemplified by Laylany's case study, **engineering-related capital can take a variety of forms**, from her early home tinkering, encouraged by her mother, via the motivation and inspiration she gained from meeting two women engineer guest speakers while at college, to her work placement with an engineering firm that led to her being offered full-time employment with the company. Across the study, engineering capital largely included:

- **Engineering-related social and cultural capital** gained from:
  - Knowing, and being encouraged to continue with engineering by, family/friends/social contacts with engineering qualifications, knowledge and/or jobs;
  - Undertaking informal engineering-related activities in one's free time through hobbies and tinkering;
  - Participating in engineering-related programmes, activities and outreach through organisations and/or institutional culture.
- **Economic capital** in the form of bursaries or grants to pursue engineering qualifications.

For instance, family engineering capital typically took the form of **family members with engineering qualifications or jobs** in the field. This was mentioned by a number of respondents, but particularly men, as a main reason for pursuing a degree in the subject (e.g. "Family history in engineering" – White man, IMD1; "Family engineering business" – White man, IMD5).

From a young age, many young people who pursued engineering talked about their participation in formal and informal activities (e.g. hobbies, tinkering) that involved engineering. As one engineering degree student explained on the survey: "I loved doing engineering. It's the sort of work I do as a hobby anyway, and I'm good at it" (White man, IMD3). Bob – a mixed White/South Asian, middle-class young man from the longitudinal sample – also exemplifies the value of capital for shaping aspirations over time.

From a young age, Bob had aspired to be an engineer, reflecting his enjoyment of engineering-related activities in his leisure time at home by building circuits and construction kits. His family had extensive STEM capital (including STEM degrees and jobs) and provided valuable resources, support and knowledge over the years to support his STEM engagement and trajectory. His interest in electronic engineering led to him building a computer at home with his father, which eventually developed into an interest in coding and computer science, which he again pursued, not just at school, but also in his leisure time (e.g. learning and practicing coding). Bob went on to successfully complete a computing degree and subsequent employment in the field.

The case studies of Laylany and Victoria illustrate how sustained access to engineering capital over time played a key role in developing and maintaining their engineering aspirations, particularly through **long-term participation in engineering-related programmes**, such as Air Cadets (a volunteer-military youth organisation sponsored by the Royal Air Force[13]). Over several years, the twice-weekly Air Cadets sessions introduced them to aeronautical engineering and built their skills and understanding in numerous ways, including hands-on experience, content knowledge and social capital in the form of meeting aeronautical engineers and being part of a context in which engineering was a shared identity, aspiration and pursuit. Through the sessions, the young women also became comfortable in predominantly male environments. As noted in Laylany's case, access to **gender-specific forms of engineering capital**, through encounters with inspirational women engineers, were also valuable.

Forms of engineering outreach were also specifically mentioned on the survey by those who had taken engineering routes. For instance:

> *"I really enjoyed science and maths at school, and wanted a career where I could use science and maths to make a difference to the world around me. I was involved in engineering outreach programmes, work experience and an Arkwright engineering scholarship, which included mentoring, during school. All of these opportunities allowed me to understand the different applications of engineering in different sectors. I tried my best to research different degrees and career options, and I found engineering" (White woman, IMD3, engineering degree).*

Victoria's case also highlights the powerful role that **institutional culture** can play in growing young people's engineering aspirations and making an engineering pathway both possible and desirable. She attributed her shift in aspirations towards engineering to attending a specialist engineering school, where there was a pervasive culture and expectation to pursue engineering – a phenomenon that she called "white noise", which encouraged her to align her choices with this institutional engineering identity ('it's what we do here').

Economic capital was also significant within both young women's trajectories. For instance, Laylany ended up taking a mechanical engineering diploma when the aeronautical engineering course that she originally applied for closed unexpectedly and she could not afford to travel to a college further away that offered the course. As someone from a lower income family, the apprenticeship offer helped make engineering a less risky aspiration, compared with degrees that involve high fees and a longer period of study without pay. Victoria, who pursued an engineering degree route, was able to access economic capital via an industrial sponsor. However, the constraints that came with this money closed off pathways she might otherwise have enjoyed, and contributed to her leaving engineering.

Both case studies illustrate how repeated access to, and mobilisation of, various forms of engineering-related capital over time helps support young people's engineering identity development and progression within engineering.

Case Study 1: Laylany is a White British young woman from a working-class family. When we first met her at age 10, she described herself as "techy" and "a DT [Design Technology] sort of person", adding "I enjoy science as well". She enjoyed the "practical bits" of lessons and loved tinkering in her spare time. Laylany also liked spending "a lot of time" on the computer at home "trying to figure out stuff".

Aged 21, she reflected on her mum's support for her early engineering experiences: "I used to take apart my toys and instead of getting mad at me, she would encourage me to learn how it worked and put it all back together". Laylany and her mum also had "science-y chats" on their daily walks to and from school. She also saw other family members as having relevant engineering expertise, such as "my uncle… he built his ice-cream machine… from scratch" and "my granddad used to be a painter and decorator, so I was used to getting my hands dirty".

At 13, Laylany joined Air Cadets, attending twice-weekly sessions that often included engineering activities and meeting engineers. As a result, by age 17/18, aeroplanes had become a "fascination" for her and she now aspired to work in aeronautical engineering, describing this as something "I've always wanted to do". Laylany's identity as an engineer, as a "hands on person wanting to make stuff", also developed around this time.

After her GCSEs, Laylany applied for aeronautical engineering but ended up taking a vocational diploma in mechanical engineering at a local college when her preferred course closed unexpectedly and she could not afford to travel to a more distant college. During the diploma, she experienced persistent sexism from her male peers ("things like 'oh, go back to the kitchen'… horrible stereotypical women comments like 'oh, you don't belong in an engineering world'. As much as I didn't have a problem being surrounded by all the boys, their sarky comments would always make me… want to punch them"). A female tutor helped address the sexist behaviour and supported Laylany. The college also set up talks for female students with "two female speakers who had been in engineering for a long time", which Laylany strongly appreciated.

After a successful work experience placement at a local engineering company, Laylany took up an apprenticeship and then full-time employment at the same firm. She experienced sexism at work from male colleagues ("various sexual remarks and their girly comments: 'Why are you here?'") but she assertively challenged these, leading to a change in her colleagues' behaviour ("since I've been there, they've completely changed their attitude… They wouldn't dare to do that now – they'd get a blast for it from me").

Laylany consistently saw engineering as "more manly… a bit more of a man's world" (age 21) but one that fits her own gender identity. From age 10, Laylany felt "different" from other girls, and described herself as "not girly". Interviewed at 13/14, she remained "less girly" than her friends, enjoyed playing sports like rugby, and had "never been interested" in "hair and beauty". Looking back, she reflected "I feel like definitely having a bit more of a male crowd definitely pushed me towards engineering a bit more".

By age 21 she had developed a strong engineering identity (e.g. "we make things… we get our hands dirty and oily, and we go to the pub on a Friday… along with people who work in construction and building, plumbing… dirty trades where you get your hands dirty a lot"). Reflecting on her position and journey, she said: "I like everything about it… I want to stay within the industry, for sure".

Case Study 2: Victoria is White British young woman from a lower-middle-class family. She took Design and Technology, Mathematics and Politics at A level, followed by an engineering foundation course. She started a degree in electrical engineering, but withdrew during the first year.

Aged 10, Victoria's favourite subject was art and she aspired to be a fashion designer. Aged 12/13, her favourite subjects were art, science, mathematics and music, and at 14 she aspired to work in banking because "my dad says that's where the money is". Her aspirations shifted again when she joined a specialist engineering school, where engineering was a focal route ("it's thrown at me all the time. It's like white noise. Engineering and technology, well, it's the future"). Like Laylany, Victoria joined Air Cadets during her teenage years, which she described as "like a little family". An Air Cadets overseas trip to a military base sparked her interest in becoming a helicopter pilot.

From a young age, Victoria's father encouraged her to pursue science. When we first met her, aged 10, she explained, "he really likes me doing maths and science". On his advice, Victoria took the high-status triple science GCSE qualification. He also paid for her to have a physics tutor when her progress stalled due to "a really rubbish" teacher.

Victoria, aged 15/16, described herself as both "still quite a girly girl. I like make-up, shopping" and as being "different" from most girls due to her participation in rugby and Air Cadets "that has a tomboy aspect to it". She described managing her identity and adeptly changing her appearance and behaviours between settings. Two years later, at military college, when she expressed a desire to pursue engineering, her mother questioned the extent to which this might interfere with her femininity: "My mum said, OK you can go off to the RAF, but don't become really butch with no personality and a monotone voice".

Victoria found mathematics "really boring", but took it and physics at A level as required subjects for accessing engineering ("a common-sense thing for me to do to get where I want to be"). She attended a military boarding school, aiming for an aeronautical engineering degree. However, she struggled with A level Mathematics and Physics, and was not allowed to complete the Physics course ("I feel like that was always a bit hopeless. I got a B at GCSE, but compared to A level… it's just not even comparable").

Like Laylany, Victoria faced sexism in engineering. At the military college there was a "three-to-one ratio" of boys to girls and she described everyday sexist banter ("the boys like to say that every girl goes through three boys while they're here. And it's just a joke"). She dropped Engineering A level after four weeks: "I was the only girl on the course… so it was very separated with all the boys saying: 'Oh, this is so funny. Let's fling glue at people, or whatever'… So then I thought: I don't want to take this course – get me out of it".

Victoria progressed to a foundation degree, which she enjoyed. She received valuable funding from a sponsor organisation to cover the costs of her main degree, but she struggled academically and felt "not clever enough" to continue. Having not taken physics restricted her degree options, diminishing her interest and motivation ("The foundation degree I really liked, when we were learning about things that in my head applied more to everyday life… And then, all of a sudden, I was doing things I had to do because the [sponsor organisation] said 'Right, you either do mechanical or electrical'. I almost feel my brain just glazed over and go 'Oh, this is so boring'"). At this point, Victoria found study extremely stressful and her grades began to suffer ("I can't do three years of this. If I carry on, I'll fail. I'll just be in more debt").

Aged 21, she was working in a bank, but feeling "undervalued", and was considering a career change by applying to the police force.

Factor 2: The importance of 'fit' between a young person's identity and engineering, particularly in relation to gender

As found across all STEM fields in the wider study, and specifically in relation to engineering, **students' choices were influenced by the extent of 'fit' that they perceived and experienced between their own identity and the field in question – that is, how far engineering pathways were felt to be 'for me', or not**. Conversely, young people who had the requisite qualifications to have pursued engineering but chose not to were more likely to describe engineering as "not for me" in both the survey and interviews.

This notion of 'fit' took various forms. For instance, engineering degree students commonly explained how engineering fitted with their passion for **making, creating and understanding 'how things work'**. As one student put it: "I always wanted to pursue engineering. I love making things, taking things apart to see how they work and learning about the systems we see in everyday life" (White man, IMD2, engineering degree). This is also illustrated by Laylany's case, in which her early identity as a "techy person" who likes to tinker resonates with the field of engineering, as does her family identification with making and working with their hands.

Statistical analysis of ASPIRES survey data from when the cohort were age 10/11 (Year 6: 9,319 students) and age 15/16 (Year 11: 13,421 students) shows that, compared with their peers, students who aspire to do engineering express consistently **distinctive attitudes** over time, being more likely to be motivated to earn a lot of money, make a difference in the world and create things.[14] Moreover, young women who aspire to engineering appear to be distinctive both in relation to other young women (being more likely to be very confident in their scientific academic competency) and in relation to male peers who aspire to engineering (with aspiring female engineers less likely to be motivated by a desire to help other people through their future careers).

This attitudinal profile continues to be evident at age 21/22, with a considerably higher percentage of young people on engineering routes (92%) agreeing that they want to create things through their work, compared with other STEM students (74%) and young people on non-engineering routes (66%). Overall, most young people (on any route) wanted to help others through their work and to earn a lot of money, but **helping people was less of a concern and making money more of a priority among those following engineering routes**.

Multilevel modelling showed that student-level factors – but most notably gender – are most strongly associated with engineering aspirations, a trend that remains consistent from primary through to late-secondary level,[15] although the influence of school-level factors on engineering aspirations increases with age through schooling. So, what shaped the distinctive, significant, enduring relationship between gender and engineering aspirations and participation? The main reason raised by many suitably qualified young women for not pursuing engineering was the **perceived lack of fit between femininity and the male dominant/masculine culture of engineering** across both education and industry. Typical survey responses included:

> *"Didn't feel like females get enough representation" (PNS ethnicity woman, IMD1);*
>
> *"Seemed like more a subject aimed at boys" (Middle Eastern woman, IMD2).*

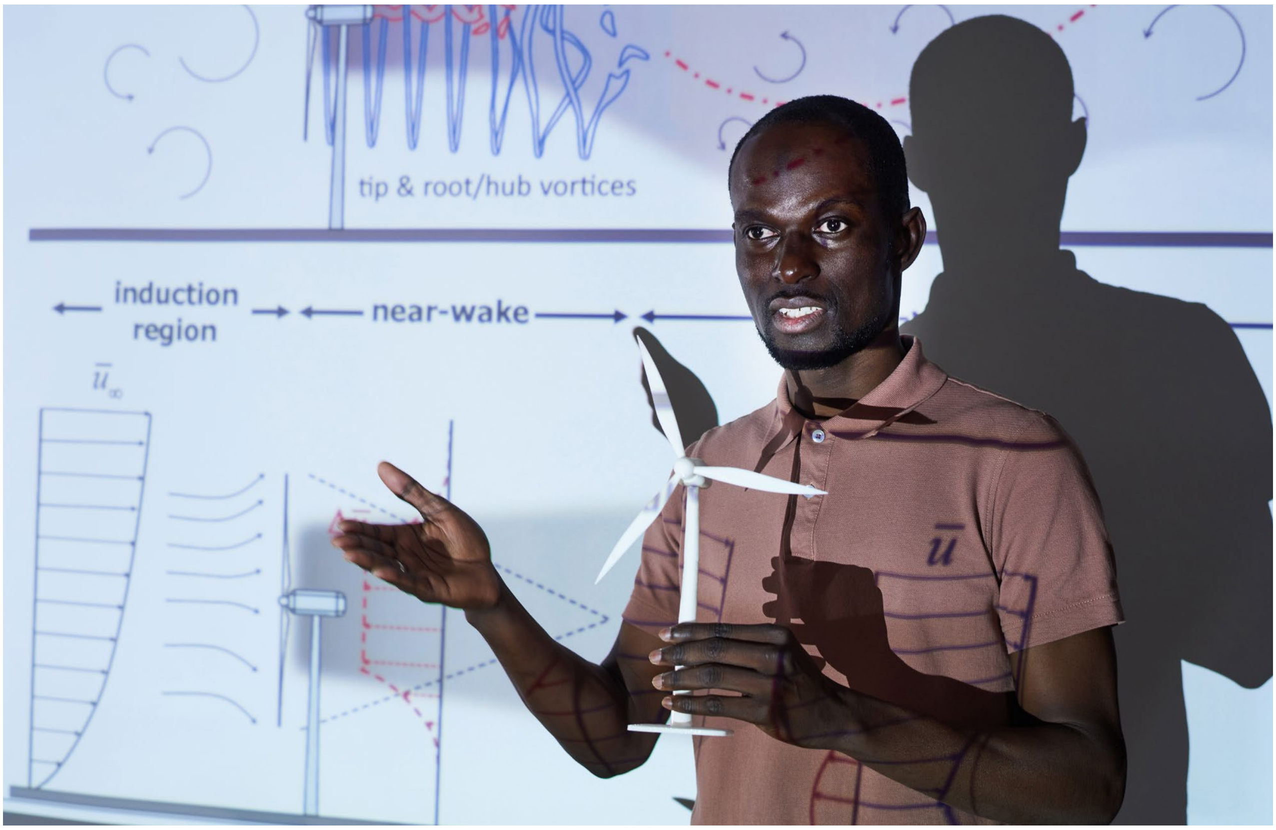
In contrast, young women who pursued engineering, like Laylany, were more likely to **identify as 'not girly' and/or 'balance' or moderate their femininity within engineering contexts**, like Victoria – as also noted in the wider literature on women who pursue trajectories in male-dominated STEM fields.[16] For instance, Laylany's friendships with men, her disinterest in 'girly' things, and participation in rugby and Air Cadets, help create a closer fit between her own gender identity and the masculine field of engineering.

Some young women also described being *discouraged by others from pursuing engineering due to its incompatibility with femininity*. For instance, one survey respondent explained that she was "told girls cannot be engineer" (Other ethnicity woman, IMD4) and another points out how engineering "was never really sold as a good option for girls" (White woman, IMD5). Within the interview sample, Hannah (who went on to take a physics degree at university) described her friends' negative reaction when she said she was considering engineering ("they said it was gross"). These negative views are also evident in Victoria's account of her mother's instruction: "don't become really butch with no personality and a monotone voice". However, one female engineering degree student on the survey sample explained how she had chosen her degree specifically to become a role model "to empower girls and women in the industry" (South Asian woman, IMD3).

Some young women within both the longitudinal interview and survey samples also shared how their **negative experiences within engineering settings** had put them off. These include Georgia's experience of being ignored at the engineering stand at a university open day, and the following survey participants' experiences of engineering spaces and extracurricular offers:

> *"It was quite a boys' culture every time I tried an engineering extracurricular scheme as a school child" (White woman, IMD1);*
>
> *"Felt outnumbered by the men within the subject" (White woman, IMD3).*

Finally, as exemplified by both case studies, **experiences of sexism on engineering courses** also threatened women's retention and progression. Fortunately, Laylany's tutor provided specific support to counter her male peers' sexism, although she had to continue to manage sexism alone within her workplace. Victoria's experiences of sexism on her engineering A Level led her to drop the subject, although she continued to have to navigate and manage ongoing experiences of sexism on subsequent engineering courses.



Factor 3: Feeling 'not clever enough'

As noted on the survey, around 12% of respondents said that the primary reason they had not taken engineering further was because they had not felt 'good enough' or 'clever enough' to pursue the subject (e.g. "Too hard, not clever enough" – Chinese woman, IMD4; "I felt I didn't have the academic aptitude" – White man, IMD1).

As discussed above, analyses of survey data over time also revealed how, between age 10 and 16, the young women who aspired to engineering tended to express exceptionally high math and science self-concepts. The longitudinal case studies suggested that A level was a particularly important time, during which young people's sense of themselves as either 'clever enough' or 'not clever enough' to pursue high-status STEM subjects such as engineering influenced their degree choices (e.g. see the ASPIRES reports on mathematics and chemistry). This is illustrated by the case of Victoria, who described herself as "not clever enough" for A level Physics and engineering, reflecting gendered ideas of 'natural ability' that are associated with more men than women identifying as 'good' at physical sciences and mathematics.

Factor 4: Perceptions of engineering jobs

Over a quarter (27%) of engineering degree students attributed their course choice to positive views of engineering jobs, and just 4% of those who chose otherwise indicated that this was due to negative perceptions of engineering jobs. These positive perceptions spanned a range of dimensions, including the attraction of well-paid, secure jobs that offer challenge and the capacity to 'make a difference', as exemplified by the following students' reasons:

> *"I want to make a difference in the world where I can, and I thought this would be the best tool to do that with my skillset and hunger for challenges" (White man, IMD2);*

> *"As it can make a real difference in peoples' lives" (South Asian woman, IMD5);*

> *"It has well-paid jobs" (White man, IMD3);*

> *"Money, opportunities to make a difference to the world" (White man, IMD5);*

> *"I found it to be interesting, and it could provide me with a well-paid and secure job in the future" (White man, IMD5).*

There was some suggestion among the survey responses that some of those who did not pursue engineering either did not identify with engineering (e.g. "Didn't want to become an engineer" – White man, IMD3) and/or were less clear on what engineering is, or could lead to, although such comments were not prevalent and tended to be voiced more often by women (e.g. "I didn't know enough about what engineering is" – White woman, IMD4; "No clue what engineering was!" – White woman, IMD3). In comparison, as exemplified by Laylany and Victoria, those with more extensive engineering capital tended to develop an understanding of both what engineering is, and what types of career it could lead to.

7. What do engineering undergraduates say about their degree experiences?

Generally, engineering degree students reported fairly positive views of their degree experiences, although there remains a notable minority who expressed less positive views. There were some differences in views between engineering degree students and those taking apprenticeships.

Levels of satisfaction

60% of engineering undergraduates (but just 31% of engineering apprentices) agreed that the A levels they had taken had prepared them well for their engineering course. This figure is higher than for those (53%) studying for any STEM or high-status medicine degree who felt that A levels had prepared them well.

Most engineering degree students (60%) and engineering apprentices (66%) agreed that, if they could do it again, they would choose the same course. This is similar to the respective figure (63%) for other STEM and non-STEM degree students. However, just 47% of women who followed engineering trajectories said they would do the same again, compared with 65% of men.

Around two thirds of young people undertaking engineering degrees (65%) or apprenticeships (66%) felt comfortable and that they belonged on their courses. This was slightly less than the 70% of those studying STEM degrees (compared with 62% of those studying non-STEM degrees).

Just under one third (30%) of engineering undergraduates felt that their course was good value for money, which was roughly comparable to 28% of STEM and high-status medicine students overall, but was considerably less than the 66% of engineering apprentices who felt that their course had been value for money.

Concerns about completion

The proportion of students who expressed worries about completing their degrees was roughly comparable in engineering (24%) with the average (27%) across all STEM and high-status medicine degrees.

Across all degree subject areas, concerns about completion most often related to academic issues (identified by 43% of STEM students and 35% non-STEM students who expressed concerns), and were most frequently expressed by women, minoritised students, and students from low IMD backgrounds. 29% of both STEM and non-STEM students worried about financial issues. Problems related to, or exacerbated by, the COVID pandemic constituted the third most commonly mentioned concern (18% of STEM and 19% non-STEM students), although the latter were particularly frequently raised by those on engineering degrees.

As a general pattern, those from underrepresented groups – women, racially-minoritised students, and students from low IMD backgrounds – were the most likely to express concerns.

In engineering, there was a notable gender gap, with 8% of women engineering degree students expressing concerns about completion, compared with 2% of men.

Students from across STEM and non-STEM degrees felt that the COVID pandemic and challenges of remote learning during this period had resulted in a range of negative impacts and had hindered their progress and/or potential completion.[17] However, STEM students drew attention to the particular problems that they had experienced as a result of missing out on the laboratory, practical and inquiry-based side of their courses, as well as lost placements (often a feature within many STEM degrees), which they felt negatively impacted both their learning and skills, and future prospects. Concerns about the impact of the pandemic on likely completion were particularly frequently voiced by engineering students. Typical responses included:

> *"Covid has made the last year or two very difficult and has ruined the university experience both academically and socially" (Other ethnicity woman, IMD4, engineering degree).*

Experiences of sexism on STEM degrees

Survey data from 798 students studying STEM and high-status medicine, and 1,959 students doing other degrees, revealed that **women on STEM degrees were significantly more likely to report experiencing sexism than those on non-STEM degrees.**[18] Overall, 15% of women (and 1.2% of men) taking STEM pathways had experiencing sexism in the past year in their educational setting.

Of those reporting such experiences, **women in physics and engineering were most likely to report experiencing sexism** (50% and 30%, respectively). Women in mathematics and biology were the least likely to report experiencing sexism (3% and 10%, respectively).

The source of these experiences of sexism was most frequently attributed to **male peers.**

The interviews revealed that **peer sexism usually involved everyday gendered microaggressions** and acts of disdain and disrespect, such as questioning women's academic legitimacy, and ignoring and patronising them. As per the wider literature, such experiences arguably reflect both the masculine culture of engineering and broader inequalities in how men and women interact.[19]

Plans for after graduation

The final-year ASPIRES survey sample included 224 people who were pursuing, or had recently completed, a post-18 engineering route. In line with other STEM fields, **most engineering graduates were planning to go into, or continue in, full-time work (71%)**.

Engineering students were more likely than those in other STEM degree areas to want to continue in their field after graduation. 82% of young people on engineering routes planned to stay in engineering, with a further 13% indicating that they might. Only 3% reported wanting to work in a different sector. This compared with 64% of computing students and 21% of chemistry students who planned to stay within their sectors.

Also of potential interest to those seeking to increase recruitment into engineering is that 28% of 21- and 22-year-olds on non-engineering routes agreed that they would like to learn more about engineering.

8. How can policy and practice support participation in engineering?

Engineering degrees are high-status qualifications with considerable *exchange value* – that is, they hold a value that can translate into a range of potential benefits, such as well-paid jobs and social prestige, both within and beyond the field of higher education. They can also support national economic prosperity, help tackle key societal issues, promote active citizenship, and encourage individual and collective mobility.

Engineering degrees are among the most popular of all STEM subjects at university level. However, women remain acutely underrepresented and there are issues with retention. ASPIRES documents the scale of this underrepresentation, the impact of engineering's male dominance and culture on young women, and the widespread sexism faced by women who pursue engineering trajectories. Our findings suggest that there are limits to what can be done by changing the views of individual students without addressing systemic practices in engineering education at all levels, from school to higher education and beyond. Our recommendations fall into five categories.

Support young people's engineering identities and capital over time and across contexts

To enable more young people to experience a 'wrap-around' of engineering-related social, cultural and economic capital over time that can support their engineering interest and identity development, funders and policymakers might usefully:

- Review the balance of support offered for short vs. longer-term interventions and consider shifting towards longer-term interventions with key communities. Provide more opportunities for young women in particular to engage in sustained tinkering and related activities from an early age;
- Explore the potential to create a better connected, more comprehensive and coherent engineering engagement 'ecosystem', in order to offer all young people clearer engineering 'pathways' over time and across spaces that can enable and support a range of potential engineering trajectories. This could include mapping provision geographically and demographically to ensure equitable distribution and provision, and to support the establishment of both local and national engagement pathways (to enable young people to better access and navigate provision);
- Review engineering-related careers education, work experience and outreach offers, to mitigate the inequities associated with self-referral models and strategically consider how to reach those who could most benefit. Partnership working with other community organisations may be helpful in this respect;

- Offer more fully funded, unconditional bursaries for engineering degrees, particularly to those from underrepresented backgrounds, and increase the visibility of apprenticeships.

Practitioners, teachers and educators might:

- Use pedagogical approaches and resources such as the Equity Compass and the (Primary) Science Capital Teaching Approach to increase understanding of the issues and scaffold critical professional reflection towards more gender-equitable pedagogy. In particular, they may use such approaches to identify and implement ways to actively support and augment young people's (but particularly young women's) engineering identities and capital;
- Family encouragement and discouragement are cited often by young people in relation to their decision to pursue, or not pursue, engineering. Providing more young people – particularly those from underrepresented backgrounds – with specific and sustained support from a trusted adult over time could help make engineering routes feel possible and desirable for more young people. Similarly, targeted support for students from underrepresented backgrounds could support their wellbeing and retention.

Challenge ideas of maths and engineering competence being based on 'natural talent'

To help more young people to feel that they are 'clever enough' to continue with engineering, and to pursue key gatekeeper subjects to engineering, such as A Level Mathematics and Physics, funders and policymakers may find it useful to:

- Review the extent to which ideas about mathematics and engineering as based on 'natural talent' are reinforced and perpetuated by existing educational practices (such as pedagogy, attainment-based grouping practices, Gifted and Talented programmes, tiered examination entry);
- In England, address practices such as grade severity in A level Chemistry and Physics,[20] which have the effect of positioning these routes into engineering as being only for the 'cleverest';
- Support professional development to enable educators to be aware of, and challenge, everyday practices that reinforce such ideas;
- Explore the potential for widening pathways into engineering and the extent to which these might help disrupt the reliance on particular, elite qualification routes into engineering (e.g. in England, through the recent introduction of T levels).

Practitioners and those who support initial and continuing professional learning might draw on existing resources and approaches to:

- Increase understanding of how such ideas sustain unequal patterns of engineering participation and damage many young people's relationships with the subject;
- Adapt practice to make it more effective and relatable, to enable more young people to feel good at engineering (and key related areas, such as mathematics and physics) by centring ideas of equity,[21] broadening ideas about who/

what counts and gets recognised as being good at engineering, and using assets-based pedagogical approaches;

- Clearly communicate to others how ideas of 'natural brilliance/ability'[22] and the 'maths/ engineering brain' are myths that hinder more inclusive engineering participation.

Challenge peer sexism on engineering degrees and outreach programmes

To enable more young people – but specifically women – to experience a better 'fit' between their identities and engineering, challenge sexist behaviours and cultures, and improve women's progression and retention, policymakers, funders and practitioners might usefully:

- Support and encourage practitioners to understand, recognise and address sexist language and behaviours among students and staff, particularly in areas such as engineering, computing and physics. It may be helpful to integrate this work with Athena SWAN departmental task groups;

- Support anti-sexism practice and initiatives by sharing and promoting resources such as the ASPIRES 'Step Up' anti-sexism ally resources, and by engaging with wider anti-sexism initiatives aimed at tackling the sources of sexism;

- Encourage practitioners to reflect and adapt their practice to be more inclusive, using tools such as the Equity Compass.[23] It is particularly helpful for educators and employers to call out sexism, rather than relying on young women to do this;

- Shift the emphasis of interventions towards stopping sexism within engineering education settings and workplaces, rather than trying to increase individual women's confidence and resilience. This reflects ASPIRES evidence showing that young women who aspire to engineering tend to already have exceptionally high math and science self-concepts.

Support more equitable retention and belonging and transition on engineering degrees

To support and enhance the experiences of the notable minority of engineering students who are less positive about their degree experiences, and to support increased retention in engineering (particularly among young women), higher education policymakers, senior managers, professional societies and organisations concerned with equity in engineering might usefully:

- Give greater policy consideration and prominence to issues of retention in engineering (giving them parity with existing commitments to improving access to engineering) – both generally and specifically in relation to the retention and progression of those from underrepresented demographics. It may be helpful to engage and coordinate with charities and initiatives that focus on supporting women, and underrepresented and first-generation students;

- Review how support might be directed strategically to ensure it reaches those who could most benefit – not only in terms of reaching students, but also ensuring that all staff are equipped to recognise the issues and address them through their own practice;

- Support practitioners to engage in critical professional reflection and professional development, with the goal of enhancing their understanding and action to improve retention and belonging among engineering students.

Facilitate greater access to key forms of social and cultural capital for young people from underrepresented communities, to support social mobility in engineering and beyond

To create a more effective 'wrap-around' of support to build young people's engineering-related capital over time, funders, policymakers, practitioners and those concerned with supporting more inclusive engineering participation might usefully:

- Ensure that interventions targeted at young people from underrepresented communities focus on providing key forms of engineering-related social and cultural capital that can support their engineering trajectories;

- Fund longer-term interventions that foreground the generation of mutual trust and supportive relationships between young people and key adults, along with targeted measures to reduce the costs and risks of higher-level engineering routes for young people from underrepresented communities;

- Promote and use tools and approaches such as the SCTA to generate ideas for how to best build supportive and equitable relationships with young people that redistribute valuable forms of engineering capital (e.g. knowledge, experiences, social contacts, qualification routes). Explications and the principles of 'caring' pedagogy[24] may also provide useful insights.

Overall, the ASPIRES research indicates a need for policy and practice, in STEM education generally and engineering education specifically, to look beyond a narrow focus on attainment and funnelling more young people through an engineering 'pipeline'. Broader attention is needed on interventions to make the culture of engineering education and workplaces more gender-inclusive; to support more, and more diverse, young people to develop strong engineering identities; and to make engineering-related capital available to all.

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3 The undergraduate data in this section are provided by the Higher Education Statistics Agency (HESA), available at: https://www.hesa.ac.uk/data-and-analysis/students. The HESA gender statistics allow only the responses: Male, Female, Other, and Unknown. In contrast, the ASPIRES data, discussed next, uses the options: Man, Woman, Non-binary, Other, and Prefer not to say. Only England domiciled students aged 18 to 24 at the time of data collection were included in the analysis. People with unknown ethnicities, genders, IMD and school type were included in totals and percentage calculations. Undergraduate counts are a sum of Full-Time Equivalent (FTE) counts for those in first year of study only on a first degree or other undergraduate degree. Attrition data shows FTE sums for individuals who left their course without an award before the end of first, second or third year of study. HESA data have been treated according to the HESA rounding and suppression methodology (https://www.hesa.ac.uk/about/regulation/data-protection/rounding-and-suppression-anonymise-statistics).

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10 Data was weighted to be representative, and analyses were performed using both weighted and unweighted data. Because weighting made no difference to the findings, the analyses referenced in this report use unweighted data. Additionally, in this report, 'significant' refers to statistically significant findings from a variety of analyses. Please refer to our referenced publications within this report or contact us for more details.

11 Degrees classified as engineering by HESA include: CAH10-01-01 Engineering (non-specific); CAH10-01-02 Mechanical engineering; CAH10-01-03 Production and manufacturing engineering; CAH10-01-04 Aeronautical and aerospace engineering; CAH10-01-07 Civil engineering; CAH10-01-08 Electrical and electronic engineering; CAH10-01-10 Others in engineering.

12 The wider sample was recruited on the basis that they lived in England, were born between 1st September 1998 and 31st August 1999, and were registered on the Open Electoral Roll. The total survey sample was not representative with regard to official government population estimates in England for 21-22-year-olds based on gender, ethnicity and Index of Multiple Deprivation (IMD) as it over-sampled populations of interest who tend to be underrepresented in STEM (namely women, minoritised communities and young people from lower IMD quintiles).

13 Strong critiques have also been made of the link between STEM and militarism within youth STEM engagement and outreach experiences and programmes, e.g. Daley, P. (2023). https://www.theguardian.com/commentisfree/2023/jul/29/children-must-be-protected-from-the-influence-of-companies-profiting-from-war

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