wellcome

Young people's views on science education

Science Education Tracker 2019

Wave 2

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Department for Education

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Foreword

Young people are rarely asked their views on education, and Wellcome's Science Education Tracker reflects the growing global recognition that their voices do matter. This report presents the results of our second survey of young people across England exploring their attitudes, experiences and aspirations in science and related disciplines.

Wellcome first commissioned a survey of young people in 2016, covering ages 14–18. This new survey, conducted in 2019, follows up on that research, introduces new questions and now includes views from students throughout secondary school (ages 11–18). We received responses from 6,400 young people and the sample is nationally representative by gender, ethnicity, region and socioeconomic status, allowing us to identify and explore some interesting demographic trends.

Schools and teachers are clearly crucial to young people's enjoyment and experiences of STEM learning, and they deserve thanks for their untiring efforts to inspire and educate young people. More than half the students surveyed explicitly say that they value the ability of a teacher to explain things well and a third say that having a good teacher motivates them to learn science. This highlights how essential it is to value and support teachers' continuing professional development throughout their careers, so they can build the skills that keep students engaged. And research shows that such professional development also helps with improving teacher retention, which benefits students because experienced teachers are likely to be able to engage with them better.

Practical work emerges as the top motivator for studying science, and students who are traditionally less engaged in science are more likely to want to do more. The decline in practical work from 2016 to 2019, combined with the lack of STEM work placements, is thus a cause for concern and may be contributing to the increase in students who do not view science as relevant to their own lives.

Gender gaps continue to be a major issue – both in the type of sciences young women do and don't choose to study and pursue as careers, and in their self-perception of their ability in science. The pattern set at school continues into adulthood: the Wellcome Global Monitor (wellcome.ac.uk/monitor), a survey of adults in 140 countries, found that men have more confidence in their scientific knowledge than women across the globe. If women are to take their rightful place in a STEM-rich society and economy, it is vital that we address these gender gaps urgently.

Experiences outside school play an influential role in the trajectories of young people's lives. While poverty does not necessarily dampen enthusiasm for STEM, it is strongly linked to having fewer choices and opportunities both in and out of school, impeding progression in these fields. Families and their connections also matter a lot in shaping young people's aspirations and experiences in STEM. From advising on GCSE choices and careers to brokering informal learning experiences outside school and work placements, parents make a big difference. To make STEM access and opportunities equitable for all young people, we must work more holistically, taking account of all the factors that support and prevent young people's engagement with STEM.

The benefits of better and more equitable STEM education extend way beyond improving young people's own experiences and job prospects: it will help to build a more STEM-literate society and a more highly skilled, innovative economy. And greater equity for students today can contribute to a more diverse and inclusive STEM sector tomorrow.

I hope that young people's voices, as represented in the Science Education Tracker, will not only guide Wellcome's education and learning activities but also inform others who wish to help young people achieve their potential. They have spoken; it's now up to us to listen and respond.

Dr Anita Krishnamurthi
Head of Education & Learning
Wellcome

Executive summary

Introduction

This report presents findings from the 2019 Science Education Tracker (SET 2019) survey, the second wave of a survey series that began in 2016 (SET 2016). The survey series is commissioned by Wellcome, with additional support from the Department for Education (DfE), UK Research and Innovation (UKRI), the Royal Society and the Department for Business, Energy & Industrial Strategy (BEIS).

The SET survey series provides evidence on a range of key indicators for science engagement, education and career aspirations among young people in England, allowing changes to be tracked over time.

The SET 2019 survey was based on a nationally representative sample of 6,409 young people in school years 7 to 13 (aged 11–18) attending state-funded schools in England. SET 2019 was broader in scope than SET 2016, which was based on a smaller sample of young people in years 10 to 13 only. In addition, the SET 2019 questionnaire was redeveloped to reflect updated policy priorities, although core measures could still be tracked.

SET 2019 fieldwork was conducted online between 13 July and 2 September 2019.

Key findings

This high-level summary of the 2019 findings includes variation between different groups of students and the key trends between SET 2016 and SET 2019.

Overall 2019 findings

Most students do not see science as relevant to their everyday life.

- Two in five young people in years 7–13 (41%) considered an understanding of science as important to their everyday life. Although relevance to real life was one of the more motivating aspects of science lessons, still only 27% of young people selected this as a motivation to learn science. *(Section 2.5)*

Young people access science outside school in a variety of ways, with online and TV being the most common.

- Most students in years 7–13 (94%) had engaged with some form of science content outside of school in the past year and 48% had done so in the past month. Students typically accessed science content through reading about it online (86% had done this in the last year), TV or streaming (75%), and books, newspapers or magazines (66%). *(Section 2.3)*
- Excluding zoos and aquariums, 37% of year 7–13 students had visited a science-related attraction or activity such as a science museum or festival in the past year. When zoos and aquariums are included, the rate was 51%. A third (32%) had participated in an extra-curricular school science event such as a talk from a STEM-based employer or a science or maths challenge or competition. *(Sections 2.3, 2.4)*
- 40% of those who had not visited a science attraction in the last year had accessed science via digital or media sources, which suggests an important role for these channels in widening access to and engagement in science. (*Section 2.3)*

Only about half of students in years 7–8 felt that primary school had prepared them well for learning science at secondary school.

- Overall, 53% of students in years 7 and 8 felt that the science they learned in primary school helped them in year 7 science. Lower-ability students (based on key stage 2 teacher assessment scores), males, Asian and Black students, and students from lower-income backgrounds were most positive about the transition. *(Section 3.2)*

Experience of practical work is key to motivating students in science, especially among disadvantaged students and those least engaged.

- Practical work was considered the most motivating aspect of science lessons at school, especially for students in years 7–9. When selecting from a list, 55% of year 7–9s and 32% of year 10–13s chose practical work as a motivation to learn science. *(Sections 5.2, 7.5)*
- However, hands-on practical work became less common as students progressed through school. In year 7, 63% reported doing hands-on practicals at least once a fortnight, but this proportion fell steeply by school year, and only 33% reported similar frequency of practicals in year 11. *(Section 7.4)*
- 65% of students in years 7–9 and 57% in years 10–13 wanted to do more practical work than they currently do, and this attitude was most common among students traditionally less engaged in science, such as more disadvantaged students, students with the lowest interest in science, students with lower science quiz scores (used as a proxy for science knowledge) and students taking double rather than triple science. *(Section 7.6)*

Teaching style is also key to students' experience of science at school.

- A third (34%) of year 7–13 students said that having a good teacher was a motivation to learn science. When asked to select the most important characteristics of science teachers, students particularly valued teachers who explained things well (55%), made learning fun (41%, rising to 49% for year 7–9s), were enthusiastic or passionate (29%), and were supportive (29%). *(Sections 5.2, 5.5)*

There was a sharp fall in interest in school science over the first three years of secondary school, especially between years 8 and 9.

- The proportion who were very interested in science lessons declined from 26% in year 7 to 23% in year 8 and 14% in year 9. The proportion who said they were very or fairly interested declined more gently, from 83% in year 7 to 73% in year 8 to 68% in year 9. *(Section 4.3)*
- Over the same period, students increasingly rejected science as a future pathway: the proportion who said that they did not plan to study science after GCSE increased from 26% in year 7 to 41% in year 9. *(Section 9.2)*
- A range of factors may underpin this drop in engagement. Between years 7 and 9 there was evidence of reduced experience of practical work (which was the most motivating aspect of science lessons), and an increase in the proportion of students who thought of science as difficult and involving a lot to learn. Furthermore, between years 7 and 9 there was also a drop in perceived science ability and an increase in anxiety about science. Wider evidence also points to an increasing number of schools starting GCSE teaching earlier in year 9, which may also help explain this marked drop in engagement over the early years of secondary school. *(Sections 4.3, 5.4)*

Students regard science as a difficult subject and, compared with other compulsory subjects, they are less likely to rate themselves as good at science and more likely to feel anxious about it.

- Perceptions of difficulty (41%) and volume of work (35%) were the strongest disincentives to learn science among students in years 7–13. *(Section 5.3)*
- When asked to compare maths, English and science, students were most likely to rate themselves as good at maths (66% in years 7–9, 57% in years 10–13) and English (65%, 58%). They had lower self-belief in science: 56% felt they were good at science in years 7–9, and in years 10–13 this proportion ranged from 37% in physics to 49% in biology. *(Section 4.4)*
- Based on the proportion of year 7–11s who felt anxious about tests or exams most times, students felt more anxious in science (38%) than maths (35%) or English (29%). *(Section 4.5)*

The pattern of engagement in computer science is different from that in science: interest levels are lower; the decline in interest sets in sooner; and there are wider gender and ethnicity gaps. However, there are indications that computer science is regarded as more accessible than science.

- Three-quarters (75%) of year 7 students found computer science interesting (86% of male students vs 65% of females). Interest in computer science then fell steeply between years 7 and 8, and by year 9 had fallen even further for female students, resulting in a very large year 9 gender divide (65% of males were interested vs 32% of females). When asked to rank how much they enjoyed a range of subjects at school, across years 7–9, computer science was the most enjoyed subject among males and the least enjoyed among females. *(Sections 4.2, 6.3)*
- Regression modelling confirms that, even after adjusting for a range of other factors, female students and students from a white ethnic background were much less likely to say they were interested in computer science than males and students from an Asian background. The gender and ethnicity gaps were larger for interest in computer science than interest in science in general. *(Sections 6.3, 6.4, 6.5)*
- Students with a special educational need (SEN) were more likely than those without to show an interest in computer science. Furthermore, while 41% of year 7–13 students were put off science because of its perceived difficulty, only 27% said this about computer science, suggesting that computing is seen as more accessible than science. *(Sections 6.4, 11.6)*

Attitudes to science as a whole mask differences in enjoyment of the three core science subjects.

- When asked to rank how they enjoyed different subjects, students ranked science subjects below maths and English, and above computer science and languages. *(Section 4.2)*
- In years 7–9, when science is often studied as a combined subject, it is ranked roughly midway (4th out of 8 subjects). In years 10–13, when sciences are studied separately, biology was the most enjoyed science subject (3rd out of 10), while physics was least enjoyed (8th out of 10). Chemistry was ranked in the middle (6th out of 10). *(Section 4.2)*

Most year 10–13 students said their school offered triple science as part of the school curriculum. However, not all of these students were given the opportunity to study it. Barriers to studying triple science appear to have been more related to the school being selective in who studies it, rather than not offering it at all. Barriers to uptake of triple science were mainly personal factors such as confidence and lack of interest, although some were discouraged by not meeting grade thresholds or by their teacher.

- While most students in years 10–13 taking a non-triple science course were content with this, 20% of them would have liked to study it if the option had been available to them: 4% said their school didn't offer it on the curriculum, while 16% said the option was not available to them personally. *(Section 8.5)*
- Among those who didn't study triple science, only 10% said that their school had not offered it. Instead, most (68%) gave a personal reason such as lack of confidence or interest, or concerns about volume of work; 43% cited a school selection barrier such as failing to meet the required grade, not being in the right set or discouragement from a teacher. *(Section 8.5)*

Sciences were more likely than other compulsory subjects to be associated with a 'growth mindset', which holds the potential to encourage more young people to pursue science.

- Compared with maths and English, exam success in science was more likely to be seen as due to hard work. In science, 61% of year 7–13 students associated exam success with hard work and 19% with natural ability (20% thought both were equally important). This was a larger perceived role for hard work than in maths (54% hard work, 29% natural ability) or English (47% hard work, 29% natural ability). These results suggest that science may fit better than maths or English with the idea of a learning or 'growth' mindset, the belief that intelligence is not fixed or innate but rather can be developed through effort and hard work. *(Section 4.6)*
- This pattern of results for science subjects holds throughout all school years. By contrast, as

students got older, they increasingly linked success in maths and English to natural ability. *(Section 4.6)*

When making post-16 choices, students were more likely to opt for a non-STEM than a STEM pathway. STEM subjects were most likely to be studied as part of a mixed pathway.

- Of all year 11–13 students who had made post-16 subject choices, 81% chose non-STEM and 53% chose STEM subjects (36% chose a mixture). The most popular STEM subject choices in order were maths, biology, chemistry, physics and computer science. *(Section 9.4)*
- A little under half (44%) of year 11–13 students who had made post-16 choices chose non-STEM subjects only, while 16% chose STEM subjects only. Therefore, most students taking STEM subjects did so as part of a mixed STEM/non-STEM pathway. *(Section 9.4)*
- The preference for non-STEM subjects was also apparent in aspirations for higher education and careers. Of all year 10–13s considering higher education, 45% were considering a non-STEM subject and 31% a STEM subject. And when year 10–13 students with some idea of a future career were asked about future aspirations, they were twice as likely to aspire to a non-STEM than a STEM career (68% vs 34%) based on a coding of verbatim responses. *(Sections 10.4, 11.6)*

Interest in a STEM career declined between year 7 and years 12–13. Experience of STEM-based work experience was rare.

- 67% of year 7 and 66% of year 8 students were interested in a STEM career, though this gradually dropped thereafter to only 44% of students in years 12 and 13. Just over half (55%) of year 7–13s were interested in a STEM career. *(Section 11.4)*
- Motivations for pursuing a science career focused mainly on interest, pay and range of career options while barriers mainly focused on lack of interest and having alternative plans. *(Section 11.5)*
- 67% of year 10–13 students had completed work experience, though only 14% had completed a STEM-based placement. A quarter (27%) reported that they had wanted to secure STEM-related work experience but had been unable to do so. *(Section 11.3)*

Differences between demographic groups

There was only a small gender gap in interest in school science. However, post-16 choices as well as higher education and career aspirations were heavily gendered. Female students had lower self-belief and higher anxiety about science than male students and cited a wider range of barriers to learning science.

- Across all students in years 7–13, the gender gap in interest in science was very small (22% of males were interested, 18% of females). *(Section 4.3)*
- Among students in years 11–13 who had made post-16 choices, males were more likely to choose maths, physics and computer science, while females were more likely to choose biology (as well as many arts and social science subjects); chemistry was more balanced by gender. *(Section 9.4)*
- In higher education subject aspirations among year 10–13 students, computer science and engineering were more popular among males, while healthcare was more popular among females. STEM-related career aspirations similarly varied by gender. *(Sections 10.4, 11.6)*
- Females were much less likely than males to rate themselves as good at maths, physics, chemistry and computer science. By contrast, there was no gender gap for biology and history, and for English the gender gap was reversed. Even after controlling for GCSE science attainment (re-basing results on all who had achieved at least two strong passes), the gender gap for perceived ability in physics and chemistry persisted in years 12–13. *(Section 4.4)*
- In years 10–11, 53% of females felt anxious about science tests or exams most times compared with 28% of males. There were similar gender divides in years 7–9, for both science and maths. *(Section 4.5)*
- Female students mentioned more barriers to learning science than male students did, and were especially likely to say that they had been put off by factors related to difficulty (49% of females,

32% of males), quantity of work involved (43% of females, 27% of males) and achieving good grades (17% of females, 9% of males). Males were twice as likely as females to say that nothing had put them off learning science (22% vs 12%). *(Section 5.3)*

- Females expressed a wider range of reasons for being disinclined towards a STEM career; they were more likely than males to be discouraged by a lack of enjoyment (49% of females, 34% of males), a preference for other subjects (41% vs 32%), or a lack of confidence in their ability (34% vs 20%) or that they would get the required grades (21% vs 12%). *(Section 11.5)*

STEM engagement and aspirations are affected by economic disadvantage.

- Some demographic groups of students were less likely to participate in most forms of informal science learning: those eligible for free school meals; those living in the most deprived areas; those with no family science connections; those without a university-educated parent; and those with a low science quiz score. *(Sections 2.3, 2.4)*
- Students from more disadvantaged backgrounds (as measured by free school meals eligibility and area deprivation level) were no less interested in science and were as likely as more advantaged students to aspire to a STEM pathway in post-16 subject choices and in a career. Among those considering higher education, students from less advantaged backgrounds were also as likely as other students to consider a STEM pathway (although from year 10 they were less likely to aspire to university in general). *(Sections 4.3, 9.4, 10.4, 11.4)*
- However, students from less advantaged backgrounds appear to face more obstacles to reaching these aspirations. They had lower levels of self-belief in science than more advantaged students, were less likely to take up triple science, and were less likely to aspire to university. Students from less advantaged groups were also less likely to hold family science connections, to consult parents about GCSE choices or careers, and to take part in STEM work experience placements. However, it is very possible that such obstacles are not STEM-specific and also affect aspirations for non-STEM subjects and careers (this wasn't fully measured in the survey). *(Sections 2.2, 4.4, 8.2, 8.4, 10.2, 11.2, 11.3)*

Family and especially parents are very influential in shaping young people's education and career choices. However, family science connections are more concentrated among students from more advantaged backgrounds, which perpetuates inequalities in access to STEM.

- Parents were cited as the most influential sources when making GCSE choices and seeking guidance about careers. *(Sections 8.2, 11.2)*
- Using a specially constructed Family Science Connections Index, stronger family science connections were found among students from more advantaged backgrounds as measured by low area deprivation, a lack of free school meal entitlement and parental attendance at university. White students living in the most deprived areas were notably more likely to lack family science connections, while Black students (overall) were more likely than other ethnic groups to have family science connections. *(Section 2.2)*
- Stronger family science connections were linked to higher access to informal science learning, triple science, STEM work experience and a wider range of careers advice. Students with stronger family science connections were also more likely to consult parents about GCSE choices, to take up STEM subjects after GCSE and to aspire to STEM-based higher education and careers. More widely, students with stronger family science connections showed more interest in school science and were more likely to appreciate the link between science and their everyday life. *(Sections 2.3, 2.5, 4.3, 8.2, 8.4, 9.4, 10.4, 11.2, 11.3, 11.4)*

Differences between 2019 and 2016

Where comparisons between 2016 and 2019 were possible, the results provide a mixed picture, although on the whole there are more negative than positive changes over time.

- There were declines in the proportion of year 10–13s who felt that understanding science was relevant to their everyday life (from 48% to 40%) and to society in general (from 67% to 56%). *(Section 2.5)*
- A smaller proportion of students in 2019 said they were encouraged to study science because they

found it interesting or enjoyable (35%, down from 41% in 2016). *(Section 5.2)*

- The proportion of students in years 10–11 doing hands-on practical work has fallen since 2016 (from 44% to 37%), as has the proportion observing a teacher demonstration of a practical (from 47% to 38%). (*Section 7.3)*
- The decline in hands-on practical work between 2016 and 2019 was concentrated among students living in the most affluent areas. In 2016, year 10–11 students in the least deprived areas reported doing more practical work than those in the most deprived areas, but in 2019, both groups were equally likely to experience practical work. *(Section 7.3)*
- 13% of year 10–13 students in 2019 said their school did not offer triple science, down from 19% in 2016. Of the students not taking triple science, the proportion who didn't study it because they thought it would be too much work increased from 21% in 2016 to 32% in 2019. *(Section 8.5)*
- Between 2016 and 2019, the proportion of year 10–13s who said that they were either very or fairly interested in a STEM career increased from 43% in to 48%. *(Section 1)*

1. Introduction

1.1. Background and objectives

Wellcome is an independent global charitable foundation dedicated to improving health and wellbeing through the funding and support of biomedical research and innovation. More specifically, Wellcome has a long-standing interest in science education, as science literacy and proficiency is important for young people to engage with, utilise and contribute to scientific and health research.

The Science Education Tracker 2019 (SET 2019) was conducted by Kantar and is the second wave of a survey series that began in 2016 (SET 2016). The survey series was commissioned by Wellcome, with additional support from the Department for Education (DfE), UK Research and Innovation (UKRI), the Royal Society and the Department for Business, Energy & Industrial Strategy (BEIS). The survey has been branded the Pathways Survey in all correspondence with young people.

The survey provides evidence on key indicators for science engagement, education and career aspirations among young people in England. The survey also provides evidence to support specific areas of interest for Wellcome and their funding partners.

The SET 2016 survey[1], also conducted by Kantar, covered just over 4,000 students in school years 10 to 13 in state-funded schools across England. The SET 2019 survey was broader in scope and the key differences between SET 2016 and SET 2019 were as follows:

- The age range for the 2019 survey was expanded to cover all students in school years 7 to 13 (young people aged 11–18) in state-funded schools across England.
- The sample size was increased to accommodate this extended coverage. In SET 2019, the survey findings are based on a total achieved sample of 6,409 young people.
- Although the focus was still on science and STEM[2], the questionnaire coverage was broadened to also cover engagement and aspirations in relation to school subjects more broadly. This allowed comparisons to be drawn between STEM and non-STEM subjects and ensured that the survey remained relevant to all students, regardless of their interests and future aspirations.
- The SET 2019 survey built in explicit consent to allow the research team to follow up survey participants in the future.

As in SET 2016, all survey data were collected via an online survey platform.

1.2. Context

The SET survey series (SET 2016 and SET 2019) built on two previous studies conducted on behalf of Wellcome: the Wellcome Monitor Survey Waves 1 and 2 conducted in 2009 and 2012[3]. The first two waves of the Wellcome Monitor were large-scale face-to-face surveys of adults and young people aged 14+. Each of these studies included a sample of around 400 young people aged 14–18.

From 2015 (Wave 3), the Monitor survey focused on adults (18+) only and a bespoke Science Education Tracker survey was established to focus on understanding young people's experience of science at school and outside of school, and how this influences decision-making around science-based subjects and career choices.

The survey represented a departure from the Monitor survey series in several respects: the survey moved from face-to-face interviewing to online self-completion; the sampling frame changed; the SET survey was focused on England, while the Wellcome Monitor covered the whole of the UK; the sample size was substantially increased to allow more detailed analysis

[1] https://wellcome.ac.uk/what-we-do/our-work/young-peoples-views-science-education

[2] Science, Engineering, Technology and Mathematics.

[3] https://wellcome.ac.uk/what-we-do/our-work/public-views-medical-research

by school year cohorts and population subgroups; and the questionnaire was redeveloped.

1.3. SET 2019 methodology

Further information about the survey background and methodology can be found in the detailed Technical Report (www.wellcome.ac.uk/set2019). Key details are as follows:

- The sample was a random sample of young people in school years 7 to 13 (aged 11–18) attending state-funded education in England. It was drawn from a combination of the National Pupil Database (NPD) and the Individualised Learner Record (ILR)[4].
- All sampled individuals were sent a letter inviting them to take part in the online survey. The contact approach for young people varied depending on their age at the start of fieldwork:
  - Young people aged 16 or over were written to directly with no requirement for parental consent.
  - For young people aged 13 to 15, all correspondence was directed via parents; parents were asked to hand over the survey invitation letter to their child if they were happy for them to take part.
  - For children aged under 13, an additional level of consent was required[5]. Before the selected child could access the survey online, parents were asked to complete a short consent survey to confirm that they were happy for their child to take part.
- Respondents were asked questions about a range of topics including their experience of science education, their plans for the future and their attitudes towards science-related careers. The questions built on those asked in SET 2016, although many questions were redeveloped to allow for changes in policy priorities since 2016, and also to build new content suitable for the younger age group (school years 7 to 9) covered for the first time in SET 2019.
- All questions about school science and other subjects related to the September 2018–July 2019 school year which respondents had recently completed.
- Respondents could complete the survey on any online device, including PCs, laptops, tablets and mobile phones. All new questions were cognitively tested with young people prior to administration. In addition, once the survey was scripted, user-interface testing was conducted on a range of online devices.
- A field pilot of c.500 online completions was conducted before the main survey to test survey procedures.
- 6,409 respondents completed the survey between 13 July and 2 September 2019, representing an overall response rate of 49%[6].
- This response rate was achieved after sending an initial invitation and up to three reminders. Reminders were targeted at groups with the lowest response rates to maximise the representativeness of the sample. The achieved sample closely matched the population on a range of demographic variables (Table 1.1 below).

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[4] Refer to the glossary (section 1.6) for further details of these databases.

[5] To meet consent requirements under GDPR.

[6] Response rate is calculated as the number of completed interviews/number of cases issued. This corresponds to Response Rate 1, as calculated by the American Research Association for Public Opinion Research (AAPOR, 2016, Survey Outcome Rate Calculator 4.0).

Achieved sample

Table 1.1 below gives the total number of respondents across all year groups contained within a range of demographic groups.

See Appendix D for a more detailed profile of the sample and comparisons with population totals.

Table 1.1: Profile of the achieved sample

	(n)	(%)		(n)	(%)
Academic year			***Region***		
Year 7	775	12.1	North East	553	4.3
Year 8	814	12.7	North West	739	13.3
Year 9	725	11.3	Yorkshire & Humber	899	10.5
Year 10	1,044	16.3	East Midlands	278	8.6
Year 11	1,093	17.1	West Midlands	854	11.2
Year 12	1,016	15.9	East of England	1,034	11.5
Year 13	942	14.7	London	664	14.0
Gender			South East	716	16.1
Male	3,113	48.6	South West	672	10.4
Female	3,228	50.4			
Other/refused	68	1.0	***Income Deprivation Affecting Children Index (IDACI – quintiles)***		
Ethnicity					
White	4,738	73.9	Most deprived (1)	1,281	20.0
Mixed	331	5.2	(2)	1,137	17.7
Asian	804	12.5	(3)	1,058	16.5
Black	375	5.9	(4)	1,064	16.6
Other	90	1.4	Least deprived (5)	1,181	18.4
Don’t know/refused	71	1.1	Missing data*	688	10.7

****No data are available for students who did not consent to link their data to NPD records***

1.4. Interpretation of the data in this report

Linking survey responses to administrative data

All respondents were asked their permission for administrative data from the NPD to be linked to their survey answers: 90% gave permission for their data to be linked. These administrative data include (amongst other data):

- eligibility status for free school meals;
- IDACI quintiles[7];
- whether English is the young person's first language;
- special educational needs (SEN) status;
- academic results from key stage 2 and key stage 4[8].

The 10% of respondents who did not consent to data linkage were asked some additional questions about qualifications achieved to cover some of the items that would have been drawn from the NPD.

Science quiz

The survey included a science quiz intended to measure young people's scientific knowledge. This comprised ten true-or-false questions. Two versions of the quiz were produced. For young people in years 10 to 13, the quiz was identical to the version used in SET 2016, as well as other science surveys such as the Wellcome Monitor and Public Attitudes to Science surveys. A new ten-item quiz was developed for years 7 to 9 which was more suitable for younger children and based on the year 7 curriculum.

Respondents were classified into one of three groups based on their score from the knowledge quiz:

Years 7–9 quiz classification:

- Low (25% of respondents) – 0–5 correct answers;
- Medium (54% of respondents) – 6–8 correct answers;
- High (21% of respondents) – 9–10 correct answers.

[7] Income Deprivation Affecting Children Index (refer to the glossary, section 1.6, for a full definition).

[8] Key stage 4 data was only available for young people who had already completed these exams. This was primarily young people in years 12 and 13.

Years 10–13 quiz classification:

- Low (26% of respondents) – 0–5 correct answers;
- Medium (53% of respondents) – 6–8 correct answers;
- High (21% of respondents) – 9–10 correct answers.

Throughout this report, the knowledge quiz scores are used as a measure of scientific knowledge and as a proxy for attainment in science. For respondents in years 12 or 13 who had agreed to link NPD data to their survey answers, we were able to compare knowledge quiz scores with achieved key stage 4 science results. A moderate Pearson's correlation coefficient of 0.5 was observed between quiz scores and key stage 4 results. Further details about the scoring of the knowledge quiz can be found in Appendix C.

Gender

All analysis by gender is based on a comparison of male and female students. It was not possible to include students who identify in any other way, as the subsample of this group (n=68) was too small to allow detailed analysis.

Ethnicity

Where analysis by ethnicity has been conducted, we have in general compared findings across four subgroup categories: white, mixed, Asian and Black. There was also an 'other' ethnic group (defined as 'Arab or any other ethnic group'). However, the base size for this group (n=90 in total) was too small to allow any detailed analysis where the analysis is based on a subsample which is smaller than the total sample size. In a very small number of cases, again where the analysis is based on a subsample of the total, a broader comparison has been used (white vs BAME).

Social disadvantage

There are significant challenges to asking young people directly about parental income or parental socio-economic group. Two measures were used as a proxy for family income levels: Income Deprivation Affecting Children Index (IDACI) quintiles and free school meal entitlement, which is defined as having been entitled within the last six years[9]. These measures were linked to the data for all young people who agreed to data linkage.

[9] Free school meals are available to school-aged children from families who receive qualifying benefits.

Reporting conventions

All differences commented on in this report are statistically significant at the 95 per-cent level of confidence[10]. All percentages reported are weighted to account for differential non-response.

Where percentages do not sum to 100 percent or to net figures, this will be due to either (i) rounding or (ii) questions which allow multiple answers.

Respondents were able to refuse to answer any question by selecting 'Prefer not to say'. 'Don't know' and 'Prefer not to say' responses are included in the base for all questions reported except where otherwise specified.

1.5. Multivariate analysis and segmentation

Multivariate analysis was conducted to investigate the factors that influence attitudes towards primary school science (Chapter 3) and interest in computer science (Chapter 6).

In addition, we carried out a segmentation analysis to investigate any underlying patterns in the population of young people with respect to interest in science and computing in an attempt to profile the population of young people. The motivation for this analysis was to further understand how the observed variation in science and computing interest is associated with factors such as young people's self-perceived ability in these subjects, their science quiz score and features which have encouraged them to or discouraged them from learning science and/or computing. Segmentation profiles are provided in Appendix E.

Full details of the methodology and statistics for these analyses are provided in the SET 2019 Technical Report.

1.6. Structure of report

The remainder of this report is structured as follows:

- Chapter 2 explores young people's experience of science outside of school, including family connections to science and informal science learning in the local community.
- Chapter 3 examines the experiences of young people in years 7 to 9 in relation to how well primary school science helped prepare them for learning science at secondary school.
- Chapter 4 explores students' level of interest, engagement, perceived ability and anxiety, their mindset regarding studying science, and how these factors differ for science in comparison with other school subjects.
- Chapter 5 examines the factors which encourage or discourage young people from learning science, including the impact of the teacher.
- Chapter 6 examines the factors which encourage or discourage young people from learning computer science at school.
- Chapter 7 considers young people's experience of practical science at school.
- Chapter 8 focuses on GCSE pathways at school, including what influences young people's choices, and barriers to accessing triple science.
- Chapter 9 looks at science learning beyond GCSE, focusing on STEM and non-STEM subject choices in years 12 and 13.
- Chapter 10 explores young people's aspirations for higher education and the factors affecting decisions to study STEM at university.
- Chapter 11 explores science-related career aspirations and the factors which encourage or discourage students from considering a career in a scientific field.
- Chapter 12 covers level of interest in different areas of biomedicine.

At the end of the report, the Reflections chapter discusses and draws conclusions on the emergent themes of the report.

The appendices cover the bibliography (Appendix A), additional charts based on external data (Appendix B), further information about the science knowledge quiz (Appendix C), a more detailed sample profile table (Appendix D) and segmentation profiles (Appendix E).

[10] When comparing proportions, a design effect of 1.06 was used for the 2019 study and a design effect of 1.09 was used for the 2016 study. These design effects were estimated at the overall level and were calculated as = $(1 + cov(W)^2)$ – where cov(W) is the coefficient of variation of the weights. When conducting modelling, robust standard errors accounting for both the weighting and stratification have been calculated.

1.7. Glossary

Across the report we use a number of acronyms, abbreviations and terms related to education, science and careers.

For clarity, a glossary of terms, abbreviations and acronyms is provided in Table 1.2.

Table 1.2: Glossary of terms, abbreviations and acronyms

BAME	Black and minority ethnic, used to refer to all ethnic groups other than white.
Combined science GCSE	This is the later version of double science (see below) which was introduced as part of the GCSE reforms in 2018.
Double science GCSE	GCSE science course worth two GCSEs covering biology, chemistry and physics. Sometimes referred to as Core and Additional science GCSE.
FSCI	Family science connection index – a measure of a respondent's science-related networks outside of school. See Chapter 2 for further details.
Free school meals (FSM)	Pupils' eligibility for free school meals – used as an indicator of disadvantage.
Growth mindset	See learning mindset (below).
HE	Higher education
IDACI	Income Deprivation Affecting Children Index – a measure of the proportion of children in an area living in low-income households. Respondents' addresses have been grouped into quintiles, from most deprived to least deprived.
ILR	Individualised Learner Record. A database of students enrolled in further education and work-based learning in England, maintained by the Education & Skills Funding Agency (an executive agency of the Department for Education).
Informal science learning	The learning of science in informal settings outside of school, such as museums, science festivals, extra-curricular activities such as STEM clubs and learning about science via media and books.
Key stage 2 (KS2)	Refers to the four years of education between school years 3 and 6. Children are usually aged between 7 and 11.
Key stage 3 (KS3)	Refers to a stage of education typically between school years 7 and 9 when children are usually aged between 11 and 14.
Key stage 4 (KS4)	Refers to the stage of education incorporating GCSE and similar exams, typically school years 10 and 11 when young people are usually aged between 14 and 16.
Learning mindset (or growth mindset)	This refers to the belief that someone's ability can develop over time, in contrast to a fixed mindset, or the belief that someone is born with a certain degree of ability that is unaltered by experience.
NPD	National Pupil Database. A database about pupils in schools and colleges in England, maintained by the Department for Education.
Physical sciences	Sciences concerning the study of non-living systems, consisting of physics and chemistry, as well as astronomy and the Earth sciences.
Science capital	Science capital is a measure of someone's relationship with science, how much they value it, and whether they feel it is connected with their life.
Single science	Sometimes referred to as core science. A GCSE science course worth a single GCSE, covering biology, chemistry and physics. This course was only applicable in GCSE science courses taken before 2018.
SEN	Special educational needs
STEM	Science, technology, engineering and mathematics
Triple science	GCSE science course worth three GCSEs. Before 2018, this involved studying Core, Additional and Further Additional Science GCSEs. Since 2018, this has referred to studying biology, chemistry and physics as separate GCSE subjects.

2. Science outside the classroom

This chapter considers the extent to which young people have opportunities to engage with science and other cultural experiences outside of a formal classroom setting, for example by visiting science museums, accessing science online and taking part in extra-curricular school-based science activities. The chapter also considers the role of family networks in science engagement and the perceived importance of science in everyday life.

Key findings

As in SET 2016, young people from less affluent backgrounds were less likely to have family science connections.

- A Family Science Connections Index (FSCI) was constructed to measure the strength of young people's family science networks. This index was based on the number of people they knew in science-related jobs, parental interest in science and whether they knew people they could talk to about science outside of school.
- Stronger family science connections were found among students from more advantaged backgrounds as measured by low area deprivation, a lack of free school meal entitlement and parental attendance at university.
- Younger students in years 7–9 were more likely than older students in years 10–13 to report family science connections, possibly as a result of a broader definition of 'science' held by this age group and also because they reported more parental interest in science than older students.

Excluding zoos and aquariums, 37% of year 7–13s had visited a science-related attraction or activity in the past year. When zoos and aquariums are included the participation rate rises to 51%.

- Including zoos/aquariums, attendance was higher among the following groups of students: years 7–9; female; not eligible for free school meals; those with more family science connections; with a university-educated parent; and with a high science quiz score (used as a proxy for science knowledge).
- There was a strong association between visiting science-based and arts-based attractions, and the profile of students visiting each of these was similar. Students from disadvantaged backgrounds were less likely to visit both types of attraction, although the disadvantage gap was wider for arts-based than science-based attractions, suggesting that access to science-based activities is more inclusive.

About half (48%) of students in years 7–13 had engaged with science-related content outside of school in the past month and 94% had done so in the past year.

- Students typically accessed science content outside of school through reading about it online (86% had done this in the last year), through TV or streaming (75%) and via books, newspapers or magazines (66%). A third (33%) had created their own computer game, blog, website or animation.

A third (32%) of year 7–13s had participated in an extra-curricular school science event in the past year.

- This included talks from STEM-based employers, science or maths challenges or competitions and other enrichment activities such as CREST awards, STEM-based EPQs and school employer visits.

Students were more likely to regard science as being important to wider society than to their everyday life. Compared with SET 2016, young people in 2019 viewed science as less important in both of these contexts.

- 54% of year 7–13s felt that an understanding of science was important to society in general, while only 41% thought this was important to their everyday life. A quarter (23%) disagreed that understanding science was important to their everyday life and 32% were ambivalent (neither agreeing nor disagreeing).

- Between 2016 and 2019, the proportion of year 10–13s who felt that understanding science was relevant to their everyday life and to society in general fell (from 48% to 40%, and from 67% to 56%, respectively).

2.1. Context

Engagement with science doesn't just happen within the classroom environment. There are also several ways in which young people can connect with science outside of school, and these connections can help build scientific literacy, make science feel more relevant and accessible, and help young people to better understand the diversity of science-related career opportunities.

Engaging with science informally outside of school has been found to have a positive association with student science performance and aspirations (Archer et al., 2015). However, findings from previous surveys, such as the 2015 Wellcome Monitor (Huskinson et al., 2016) and the Taking Part Survey (DCMS 2017, 2019), indicate that participation is lower among adults and families in the lowest bands of income, educational attainment and socio-economic status. The SET 2016 survey also found that young people from more disadvantaged backgrounds were less likely to have attended science attractions and to have engaged with science outside of school through other channels, and SET 2019 confirms that many of these unequal patterns still hold. Furthermore, Wellcome (2012) notes that most teenagers do not regard informal science learning as something they actively want to do in their free time, and that any informal learning they do participate in tends to be passive, for example via a TV programme or online.

In recent years, the concept of 'science capital' has been developed to better understand how individuals, including young people, engage with science in their everyday life. Ultimately, the concept is an attempt to provide insight into why some people participate in and engage with science while others do not. The science capital measure developed by Louise Archer and her team currently based at UCL Institute of Education[11] comprises several dimensions which together encapsulate the ways that young people can feel 'connected to' science in their lives. In this chapter we explore some of those dimensions, including participation in informal science learning (science attractions and science media); family science connections; talking about science outside of school; extra-curricular school activities; and whether young people feel that understanding science is relevant to their everyday life.

2.2. Family science connections

Parents and wider family networks can be highly influential in the formation of scientific interest and aspirations. The ASPIRES study (Archer et al., 2013) established a clear association between the level of 'science capital' in the family and children's future science aspirations (section 2.1). This includes family science skills, knowledge and qualifications; knowing people in science-related jobs; and opportunities to talk about science outside of school (Archer et al., 2016b). These types of connections can help young people to better engage with and understand science in the wider world, as well as the careers and pathways linked to this.

To help measure and explain variation in family connections to science, a Family Science Connection Index (FSCI) was developed for SET 2016 based on young people in years 10–13. The SET 2016 survey found that those with more science connections were also more likely to be interested in science at school and future science-related careers.

The FSCI was repeated in SET 2019, although expanded to cover all age groups from year 7 to year 13. The 2019 FSCI allows us to assess any change in the level of science connections over the last three years, to compare connections between year 7–9s and year 10–13s, and to see whether those with more connections are still more engaged in science both in their current studies and with a view to future careers.

As in SET 2016, the index was constructed by scoring and combining responses to the three questions displayed in Figure 2.1.

[11] https://www.ucl.ac.uk/ioe/departments-and-centres/departments/education-practice-and-society/science-capital-research

Figure 2.1: The Family Science Connection Index (FSCI): constituent questions and scores

1. **Apart from your doctor, do you know anyone with a medical or science-related job that you could talk to about health, medicine or other scientific issues outside of school?**

   Don't know (score 0); No (score 0); One or two people (score 1); Three or four people (score 2); At least five people (score 2)

2. **Would you say your parents are interested in science?**

   Don't know (score 0); Neither parent interested (score 0); Yes-mother (score 1); Yes-father (score 1); Yes-both (score 2)

3. **Does anyone in your family work as a scientist or in a job using science or medicine?**

   Don't know (score 0); No-one (score 0); Siblings, Other family member in household, Other family member outside household, not mother or father (score 1); Mother or Father (score 2)

Scores across the three questions were then summed to create a scale with a minimum value of 0 and a maximum value of 6.

Respondents were classified into one of three groups based on their score:

- Low FSCI score – no science connections – score of 0 (27% of respondents);
- Medium FSCI score – score of 1–3 (53% of respondents);
- High FSCI score – many science connections – score of 4–6 (20% of respondents).

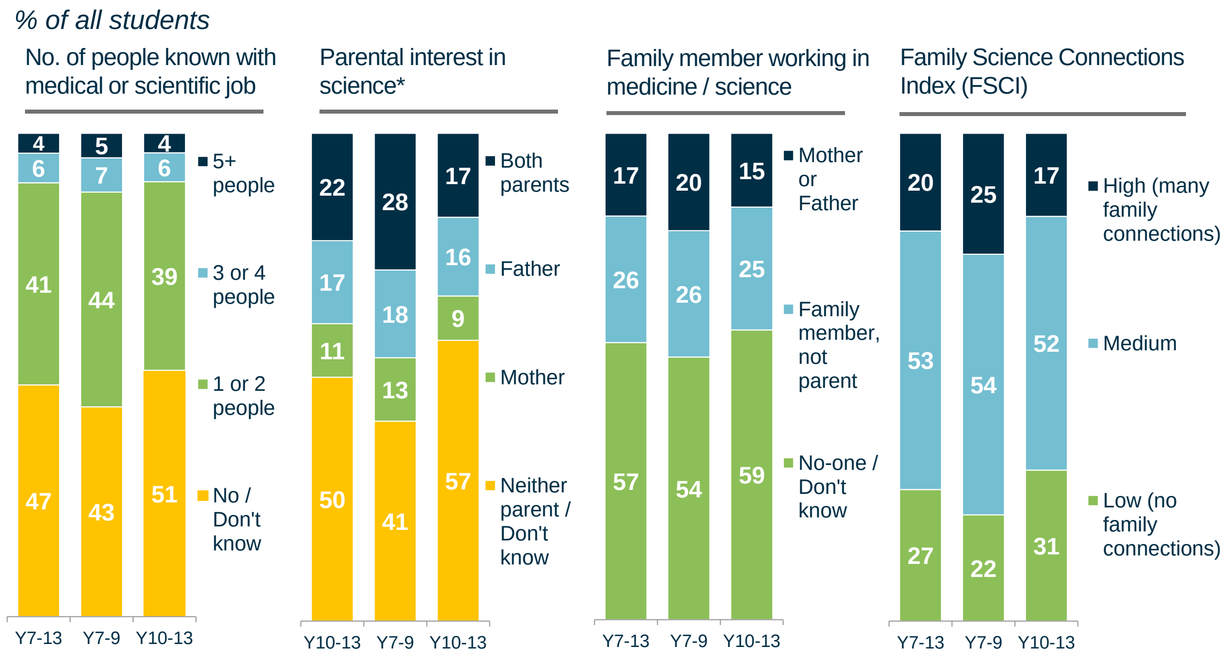
Therefore, the highest possible score was given to those who knew at least three people in a science-related job that they could talk to; who said that both parents were interested in science; and where either parent worked in a science-related field. The lowest possible score was given to those who knew no-one in a science-related job and where neither parent worked in science or were considered to have an interest in science.

Figure 2.2 shows the results for the three questions that produced the index and the overall FSCI. Results are presented for the full sample of year 7–13s and separately for year 7–9s and year 10–13s. This shows that nearly half of all young people (47%) did not know anyone with a relevant job that they could talk to about scientific interest outside of school; 50% did not consider that their parents were interested in science; and 57% said that they have no family members working in jobs using science or medicine. The proportion of young people who did not have any of these family science connections (i.e. were assigned the lowest FSCI score) was 27%.

It is also evident from Figure 2.2 that year 7–9s were more likely to say they had science connections compared with year 10–13s. There is no obvious reason for this difference. However, it's possible that the younger age group held a broader interpretation of what counts as 'science'. It is also possible that parents of year 7–9s are more involved in their child's education during these early years, for example helping with homework or talking about their school day, and therefore show more interest in school-based science.

Responses to these questions, and the breakdown of the overall FSCI, showed little change among year 10–13s between SET 2016 and SET 2019.

Figure 2.2: Constituents of Family Science Connections Index (2019)



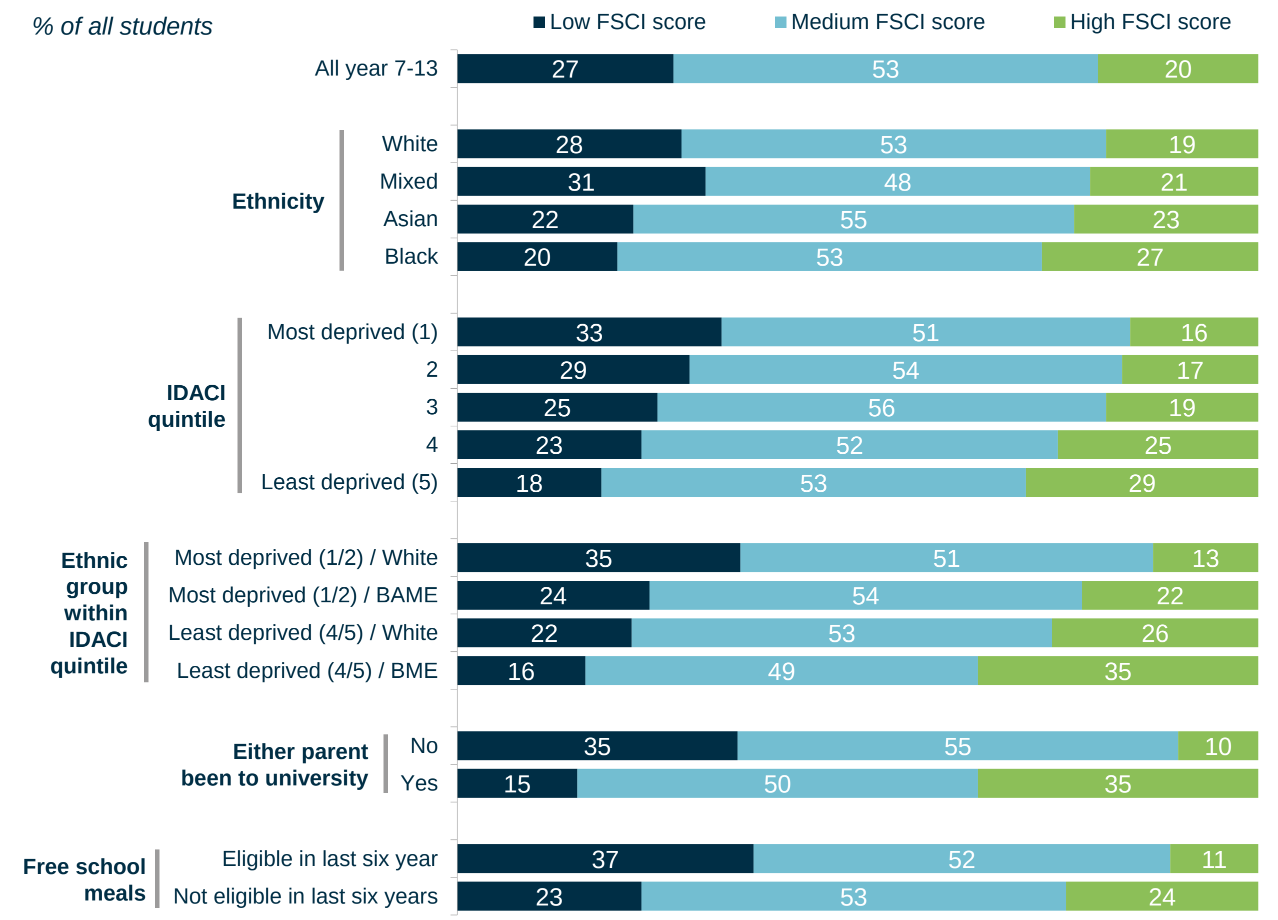
Apart from your doctor, do you know anyone with a medical or science-related job that you could talk to about health, medicine or other scientific issues outside of school? (SocNSci)
Do you think your parents are interested in science? (IntYPPar)
Does anyone in your family work as a scientist or in a job using science or medicine? (SciPar)
Family Science Connections Index (FSCI): combining responses to these three questions
Bases: All year 7–13s (6,409); all year 7–9s (2,314); all year 10–13s (4,095)
Note: 'Not applicable' responses have been excluded from the base for the 'Parental interest in science' results.

Consistent with SET 2016, family science connections were unevenly distributed across the sample of young people (Figure 2.3). A low FSCI score was most highly represented among young people from more disadvantaged families, that is, in the most deprived IDACI quintiles and eligible for free school meals. A high FSCI score, on the other hand, was more common among young people from families living in the least deprived quintiles; who were not entitled to free school meals; who had a parent with a university degree and those from a Black ethnic group.

When ethnic group differences were considered within deprivation quintile, this shows that both of these factors are important in terms of family science connections. White young people living in the two most deprived geographic quintiles were more likely than those living in the two least deprived quintiles to lack family science connections (22% vs 16%); and the same was true for BAME students in the most deprived vs least deprived quintiles (35% vs 24%)[12].

12 Due to low base sizes, Black and minority ethnic groups are combined for the analysis of ethnicity within IDACI quintiles.

Figure 2.3: FSCI band by demographic subgroups: all students in years 7–13 (2019)



Family Science Connections Index (FSCI): combining responses to: SocNSci; IntYPPar; SciPar

Bases: All students (6,409): white (4,738); mixed (331); Asian (804); Black (375); IDACI, quintile 1 (1,281); quintile 2 (1,137); quintile 3 (1,058); quintile 4 (1,064); quintile 5 (1,181); quintile 1/2 and white (1,504); quintile 1/2 and BAME (895); quintile 4/5 and white (1,969); quintile 4/5 and BAME (262); non-graduate parent (3,197); graduate parent (2,667); FSM eligible (1,368); FSM not eligible (4,330)

2.3. Informal science learning

Visits to attractions

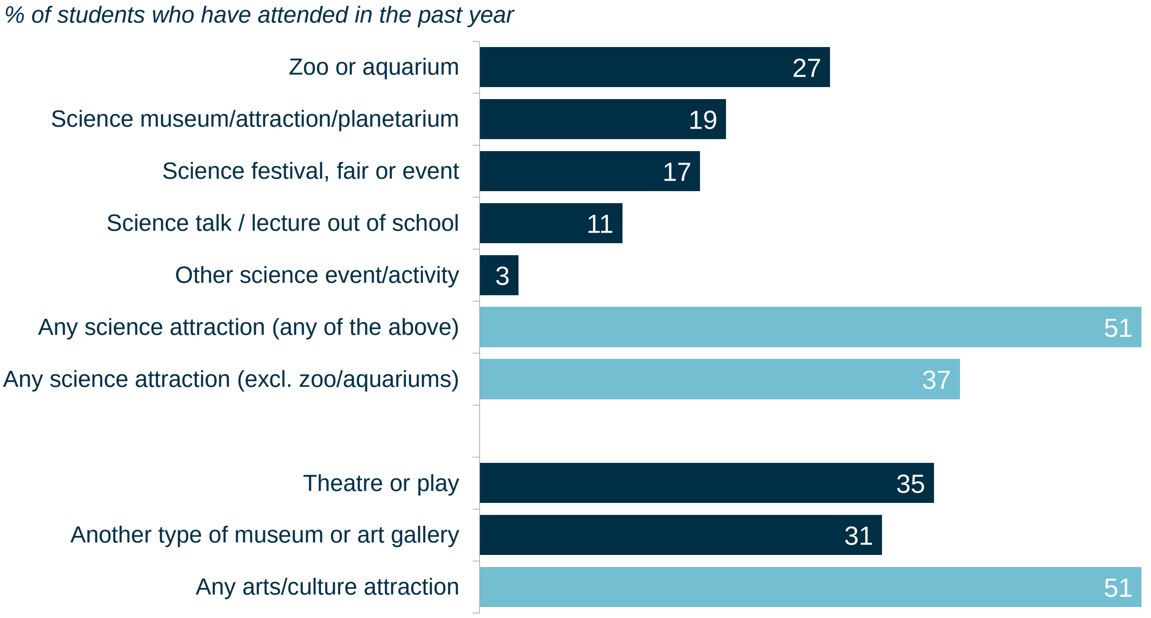
As in SET 2016, all young people were asked about their attendance in the last 12 months at several different science-related attractions. They were also asked about attendance at arts and cultural events to allow findings across the arts and science sectors to be compared. Attendance at these events could include trips with family or friends and/or with their school.

As shown in Figure 2.4, attendance at science attractions (including zoos and aquariums) in the last year across all young people in years 7–13 was 51%. If visits to zoos and aquariums are excluded[13], this reduces to 37%. Attendance at any arts or cultural attractions – a theatre or play or another type of museum or art gallery – was 51%.

The most commonly visited science-related attraction was a zoo or aquarium (27%), followed by a science museum, attraction or planetarium (19%) and a science festival, fair or event (17%).

[13] Zoos and aquariums are the most popular science-related attractions, though they can be perceived as less science-focused than other attractions in the list. Therefore, total figures are shown both including and excluding zoos and aquariums.

Figure 2.4: Visits to science and arts attractions in the last 12 months by all students in years 7–13 (2019)



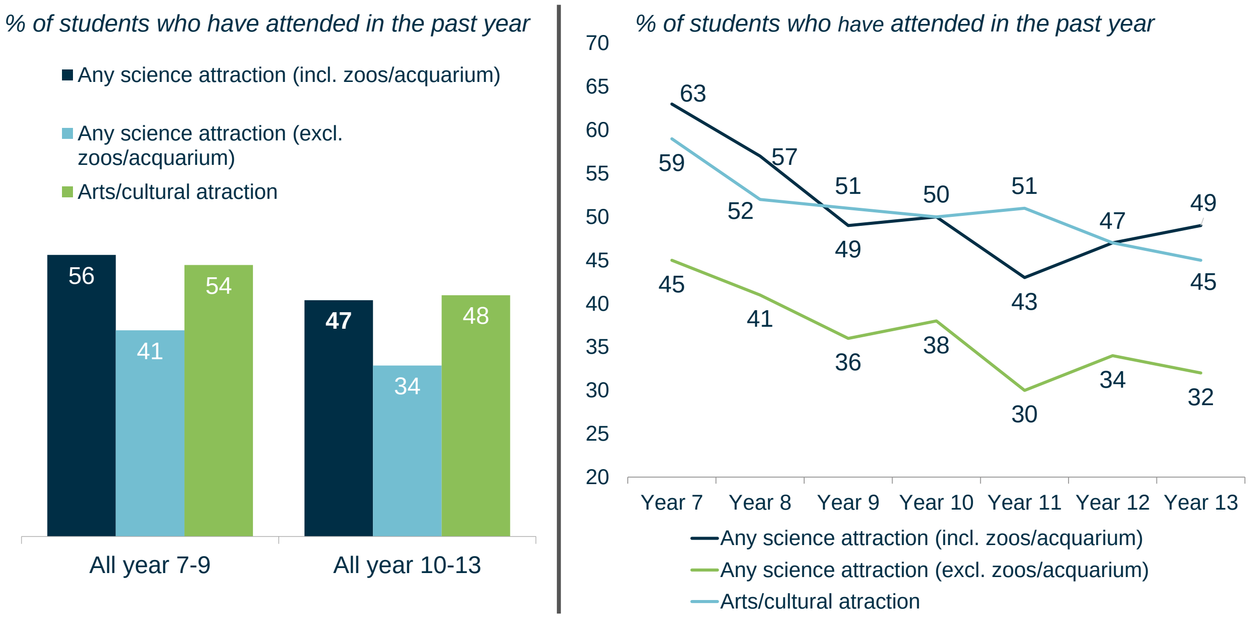
Which of these have you been to in the last 12 months? (SciVisit)
Base: All year 7–13s (6,409)

Attendance at science- and arts-related attractions was higher among year 7–9s than for year 10–13s, with those in year 7 particularly likely to have attended each type of attraction. Participation thereafter generally fell over time, although there was an upturn in visits to science attractions *including* zoos and aquariums among those in years 12 and 13 (Figure 2.5).

Year 7–9s were more likely than those in years 10–13 to have attended most of the individual science-related attractions displayed in Figure 2.4. The only exception to this was science talks or lectures out of school, which 14% of year 10–13s had attended compared with 8% of year 7–9s.

The proportions of year 10–13s attending both science and arts attractions was broadly in line with the levels observed in SET 2016.

Figure 2.5: Visits to science and arts attractions in last 12 months among all students in years 7–13 by year group (2019)



Which of these have you been to in the last 12 months? (SciVisit)

Bases: Years 7–9 (2,314); years 10–13 (4,095); year 7 (775); year 8 (814); year 9 (725); year 10 (1,044); year 11 (1,093); year 12 (1,016); year 13 (942)

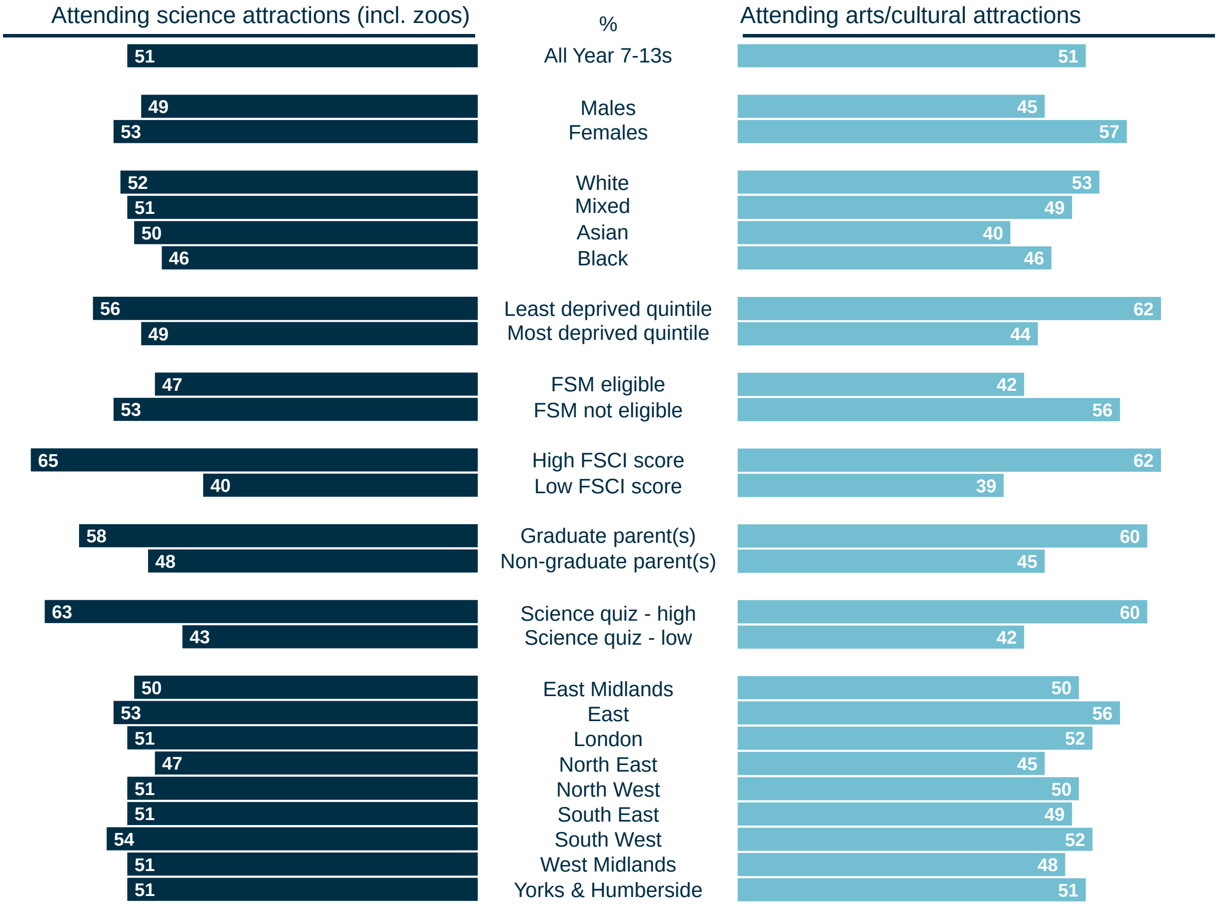
There were a number of differences between sub-groups in likelihood to have attended a science-related attraction in the last 12 months. Compared with all year 7–13s, young people more likely to have attended these attractions (including a zoo/aquarium) included the following:

- Female students
- Those living in the least deprived IDACI quintile
- Those not eligible for free school meals
- Those with the most family science connections
- Those whose parent(s) attended university
- Those with high science quiz scores (used as a proxy for science ability)

Most of these differences also hold for attendance at arts and cultural attractions. Indeed, there is a substantial degree of overlap between attendance at science and arts attractions: 60% of those who had attended an arts attraction in the last year had also attended a science attraction (including zoos and aquariums), compared with 42% of those who had *not* attended an arts attraction. This suggests that, for many young people and their families, science fits into a broader set of interests. This can be seen as a function of cultural capital, which refers to the forms of knowledge and skills that people acquire by being part of a particular social class (Bourdieu, 1984).

The reduced attendance rates at both types of attraction by young people from lower socio-economic groups could be related to a number of factors, including cultural capital as well as cost, with low-income families potentially having a lower ability to afford access to paid attractions. It is difficult to separate out these two explanations. However, it is noteworthy that white students are more likely to attend science activities than Black students despite having lower FSCI scores. It is also notable that the gap between attendance at arts and cultural attractions based on disadvantage (measured by IDACI and free school meal eligibility) was wider than the gap for attendance at science attractions.

Figure 2.6: Visits by years 7–13 in last 12 months to science attractions (incl. zoo/aquarium) and arts/cultural attractions by demographic subgroups (2019)



Which of these have you been to in the last 12 months? (SciVisit)

Bases: Years 7–13, (6,409); males (3,113); females (3,228); white (4,738); mixed (331); Asian (804); Black (375); least deprived quintile (1,181); most deprived quintile (1,281); FSM eligible (1,368); FSM not eligible (4,330); high FSCI score (1,307); low FSCI score (1,705); graduate parent(s) (2,667); non-graduate parent(s) (3,197); science quiz – high (1,416); science quiz – low (1,537); East Midlands (553); East of England (739); London (899); North East (278); North West (854); South East (1,034); South West (664); West Midlands (716); Yorkshire and the Humber (672)

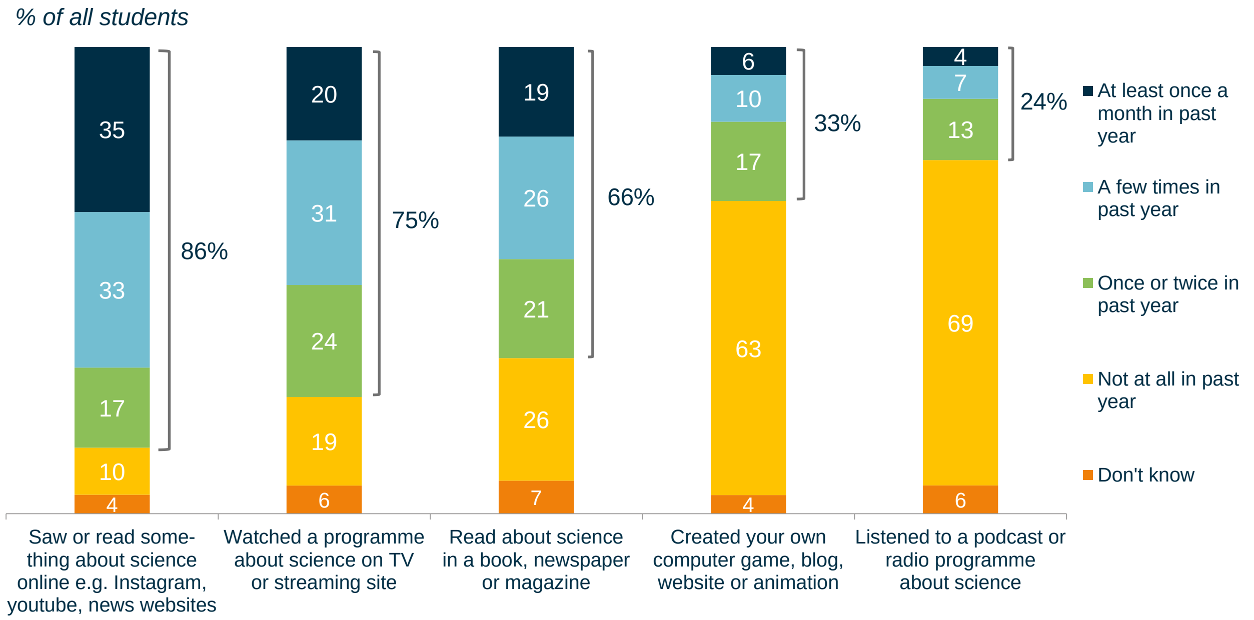
Engagement with science through other channels

Young people can also engage with science content outside of school through less structured channels than science museums, festivals and so on. The survey asked all young people how often they had taken part in a range of difference science- or technology-related activities outside of school in the last year (Figure 2.7). This question was updated from SET 2016 to better reflect the ways that young people now access content, and, as such, it is not possible to include a reliable comparison between the SET 2016 and 2019 results for this question.

Just over a third of young people (35%) had seen or read something about science online in the last month, while 94% had done so within the past year. Two in ten (20%) had watched a programme about science on TV or a streaming site in the last month and a similar proportion had read about science in a book, newspaper or magazine in the last month. Smaller proportions – 6% and 4% respectively – had created their own computer game, blog website or animation, or had listened to a podcast or radio programme about science in the last month.

The proportion of young people doing most of these activities did not differ greatly between year 7–9s and year 10–13s. The main differences were that year 10–13s were a little more likely to have seen or read something about science online in the last month (37% vs 33% of year 7–9s), and year 7–9s were more likely to have created their own computer game, blog, website or animation in the last month (8% vs 4% of year 10–13s)[14].

Figure 2.7: Engagement with science by years 7–13 through other channels: online, in the media and in other ways outside of school in last 12 months (2019)



How often, if at all, have you done each of the following in the past year outside of school? (SciMedia)
Base: All year 7–13s (6,409)

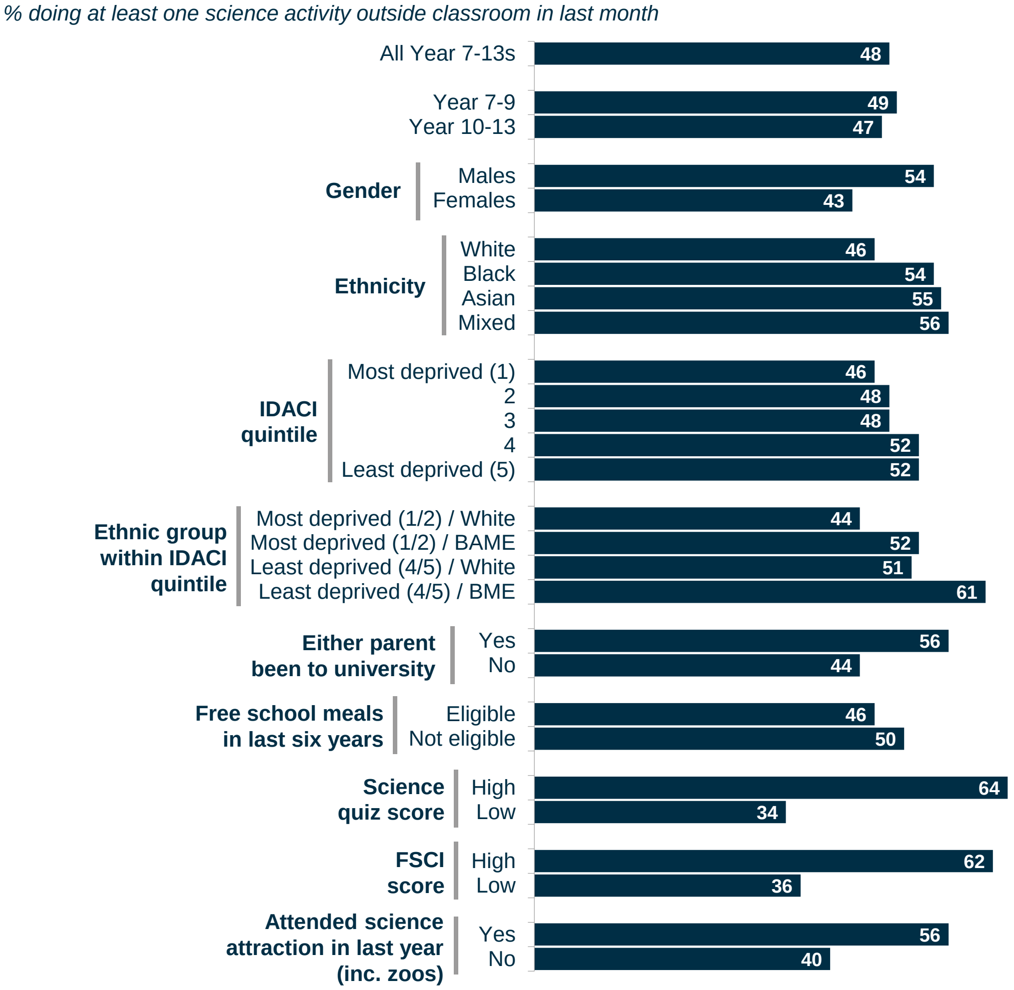
Many of the groups more likely to have visited a science attraction in the last 12 months (Figure 2.6) were also more likely to have accessed science via the media outside of school (Figure 2.8). This includes: those in the least deprived IDACI quintiles; those whose parents went to university; and those not eligible for free school meals. Young people who had higher quiz scores and who had more science connections were also more likely to have done at least one of these activities in the last month.

However, there were also some differences between visits to science activities and accessing science via the media for some subgroups. Males were less likely to have visited a science attraction than females but were more likely to have accessed science online, via the media or through other channels. There were also notable differences based on ethnicity: young people from white backgrounds were as likely as others to have attended a science attraction but were less likely than those from other ethnic groups to have accessed science in the last month in one of these other ways. This was particularly true for white people from the most deprived IDACI quintiles.

Responses to the two questions were correlated: those who had attended a science-related attraction in the last 12 months were more likely to have accessed science online, via the media or in other ways in the last month. However, 40% of those who had *not* visited a science attraction in the last year had accessed science in one of these other ways. This suggests an important role for the media and other channels in widening access to and engagement with science.

[14] While the question asked young people to only include activities done outside of school, it is possible that in some cases in-school activities were also included. The cognitive testing conducted in advance of the survey found that young people often struggled to separate in-school and out-of-school activities.

Figure 2.8: Engagement with science through other channels (media, online, computer activities): proportion of years 7–13 who had done at least one of these activities outside of school in the last month by demographic subgroups (2019)



How often, if at all, have you done each of the following in the past year outside of school? (SciMedia)

Bases: All years 7–13 (6,409); year 7–9s (2,314); year 10–13s (4,095); males (3,113); females (3,228); white (4,738); Black (375); Asian (804); mixed (331); IDACI 1 (1,281); IDACI 2 (1,137); IDACI 3 (1,058); IDACI 4 (1,064); IDACI 5 (1,181); most deprived/white (1,504); most deprived/BAME (895); least deprived/white (1,969); least deprived/BAME (262); graduate parent(s) (2,667); non-graduate parent(s) (3,197); FSM eligible (1,368); FSM not eligible (4,330); science quiz – high (1,416); science quiz – low (1,537); high FSCI score (1,307); low FSCI score (1,705); attended science attraction in last year (3,311); did not attend science attraction in last year (3,098)

2.4. Extra-curricular science outside of school

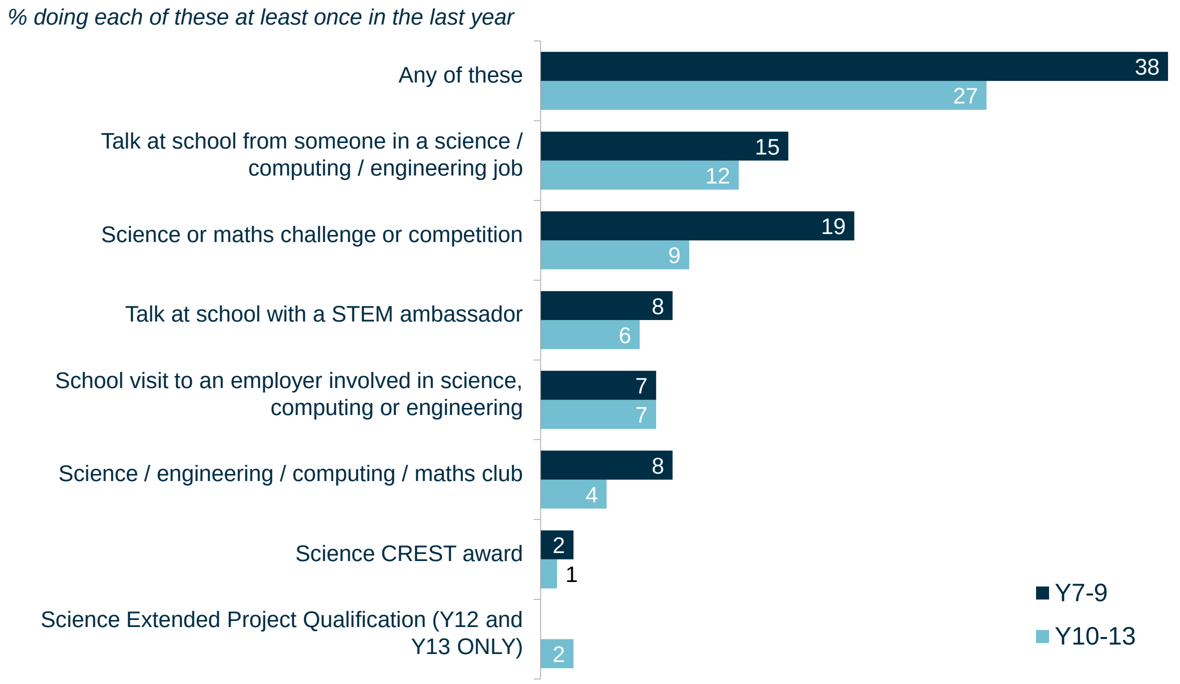
Young people were asked about a range of science-related activities facilitated by schools, but which are outside of the core curriculum (Figure 2.9). This included activities such as talks by someone in a science/engineering job, a STEM ambassador talk and a visit to a STEM employer.

As discussed in Chapter 11, encounters with STEM employers are an important way to broaden knowledge about science careers, and broadening access to STEM employers is a key component of the DfE’s current careers strategy (DfE, 2017).

Overall, 27% of year 10–13s and 38% of year 7–9s had done at least one of these activities in the past year. In SET 2016, 30% of year 10–13s had taken part in an extra-curricular science activity at school. However, several changes were made to the response options between the two surveys, so these results are not directly comparable.

The most common activities for both year 7–9s and year 10–13s were attending a talk at school by someone in a science, computing or engineering job (15% and 12% respectively), and a science or maths challenge or competition (19% and 9% respectively).

Figure 2.9: Whether students in years 7–13 have taken part in a range of extra-curricular activities at school related to science (2019)



In the past year, have you taken part in any of the following activities related to Science, Computer Science, Engineering or Maths? (STEMPrac)

Bases: Year 7–9s (2,314); year 10–13s (4,095)

Compared with the average (32% for the full sample of year 7–13s), participation in any of the above activities was higher among the following groups:

- Those with the most family science connections (46%)
- Those with high quiz scores (46%)
- Those from Asian backgrounds (41%)
- Those whose parents went to university (39%)
- Those in the least deprived IDACI quintile (37%)

2.5. Importance of science in everyday life

Beyond formal studies, science can play an important role in young peoples' lives. Helping young people to understand connections between science and their everyday life can improve their scientific literacy, enable them to interact with scientific developments and debates in wider society, and broaden their exposure to the wide range of science-related career opportunities available to them.

The perceived everyday importance of science has been measured in a number of surveys among adults in the UK in recent years. For example, the 2015 Wellcome Monitor found that 66% of adults said that their understanding of science was very or fairly useful to their everyday lives (Huskinson et al., 2016), while the Wellcome Global Monitor noted that 82% of UK adults considered the work of scientists to benefit people like them (Wellcome, 2018). The 2015 Wellcome Monitor found that people were also more likely to see science as being important in the everyday lives of 'people in general' than their own lives. These results suggest that while most adults acknowledge the importance of science in everyday life, a substantial minority are less convinced of its importance to them personally.

As in SET 2016, SET 2019 asked all young people to rate the importance of understanding science to each of the following:

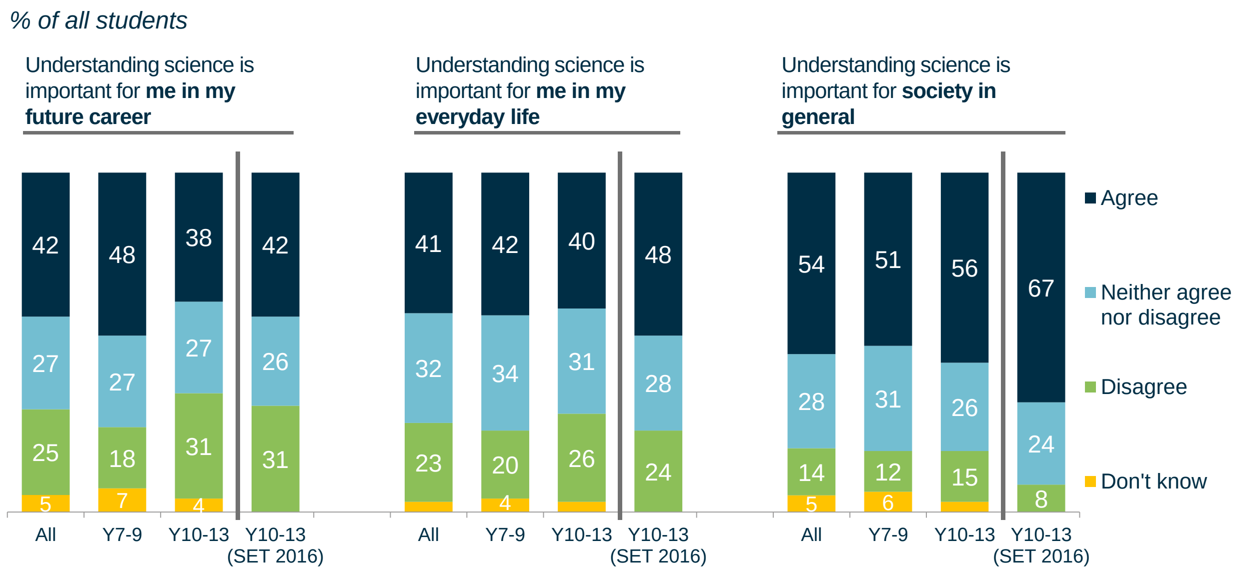
- Me in my future career
- Me in my everyday life
- Society in general

Overall, around four in ten agreed that understanding science is important for 'me in my future career' (42%) and 'me in my everyday life' (41%). Slightly over half (54%) agreed that understanding science is important for 'society in general' (Figure 2.10). Sizeable minorities disagreed with each of the first two statements: 25% disagreed that science is important for 'me in my future career' and 23% disagreed that it is important for 'me in my everyday life'. A slightly smaller proportion (14%) disagreed that science is important for 'society in general'.

Year 7–9s were more likely than year 10–13s to agree that science is important for 'me in my future career' (48% vs 38%), which reflects findings elsewhere in this report which show greater enthusiasm for science and science careers among the youngest age groups (e.g. sections 4.3, 11.4). By contrast, year 10–13s were a little more likely than year 7–9s to agree that understanding science is important for 'society in general' (56% vs 51%).

These statements were also included in SET 2016 and so it is possible to compare results for year 10–13s between the two surveys. As shown in Figure 2.10, the proportion agreeing with each of the statements has dropped between 2016 and 2019, most notably for 'understanding science is important for society in general', where agreement has dropped from 67% to 56% and the proportion disagreeing has increased from 8% to 15%. The reduced perceived importance of science for society in general does not appear to be driven by particular socio-demographic groups: the changes are consistent across year groups, genders, ethnic groups and measures of disadvantage

Figure 2.10: Perceived importance among years 7–13 of science for future career, in everyday life and for society in general (2019 and 2016)



How much do you agree or disagree with the following statements? (SciUse)

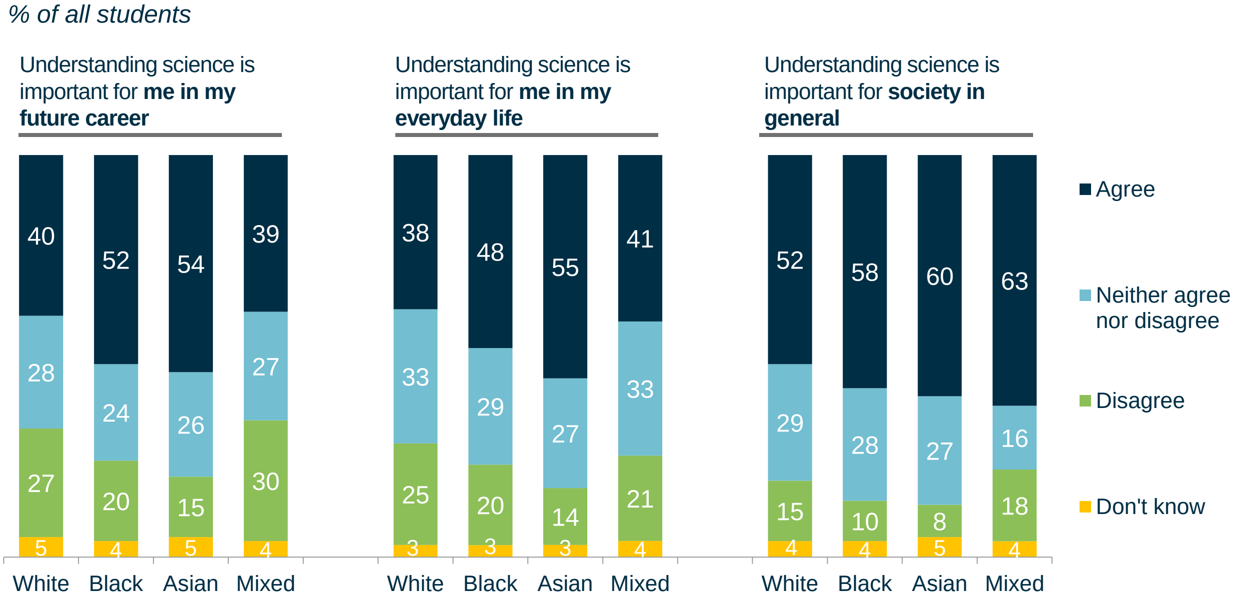
Bases: 2019 Sample A – all (3,150); years 7–9 (1,153); years 10–13 (1,997); 2016 Sample A – years 10–13 (2,044)

Young people with higher science quiz scores, with the most family science connections and whose parents went to university were much more likely than average to agree with each of the three statements.

Those in the most deprived IDACI quintile were less likely to agree that 'understanding science is important for me in everyday life' and that 'understanding science is important for society in general'. However, there were no notable differences by disadvantage regarding agreement that 'understanding science is important for me in my future career'.

There were also some notable differences between ethnic groups regarding agreement with the statements (Figure 2.11). Those from white backgrounds were less likely to see science as important than young people from Black and Asian backgrounds.

Figure 2.11: Perceived importance among years 7–13 of science for future career, in everyday life and for society in general (2019)



How much do you agree or disagree with the following statements? (SciUse)

Bases: All young people in Sample A – white (2,341); Black (195); Asian (383); mixed (140)

3. Primary–secondary science transition

This chapter covers the views of students in years 7 to 9 on how they found the transition between primary school and secondary school when learning science at school. These questions were asked for the first time in SET 2019 among students in early secondary school, and therefore no comparisons can be drawn with SET 2016.

Key findings

Only about half of younger students in years 7–8 felt that primary school prepared them well for year 7 science; lower-ability students were more positive than average.

- Overall, 53% of students in years 7 and 8 felt that the science they were taught in primary school helped them in year 7 science. Males, Asian and Black students, students from lower-income backgrounds and students with below-expected key stage 2 scores (based on teacher assessment) were most positive about the transition. However, despite this, most year 7–9 students enjoyed secondary school science more than primary school science.
- Seven in ten (69%) of students in years 7–9 said that they enjoyed secondary-level science more, and this was especially the case among students who had recently completed year 7 (76%).

There is no clear relationship between students' feelings about the primary–secondary transition and their enjoyment of secondary versus primary science.

- Students who were positive about the primary–secondary transition were as likely as those who were negative about this to say that they enjoyed secondary school science more (72% vs 75%).

3.1. Context

When transferring from primary to secondary school, students should ideally experience a seamless progression in terms of their knowledge, understanding and skills in science. However, wider evidence cites difficulties surrounding the transition between primary and secondary schools in England (Association for Science Education, 2016). Difficulties relate to a range of factors including repetition of science content at year 7, different teaching styles and classroom environment, poor liaison between primary and secondary schools, a failure to refer to pupils' previous learning experiences and attainment, and the desire by some secondary school teachers to adopt a 'clean slate' approach.

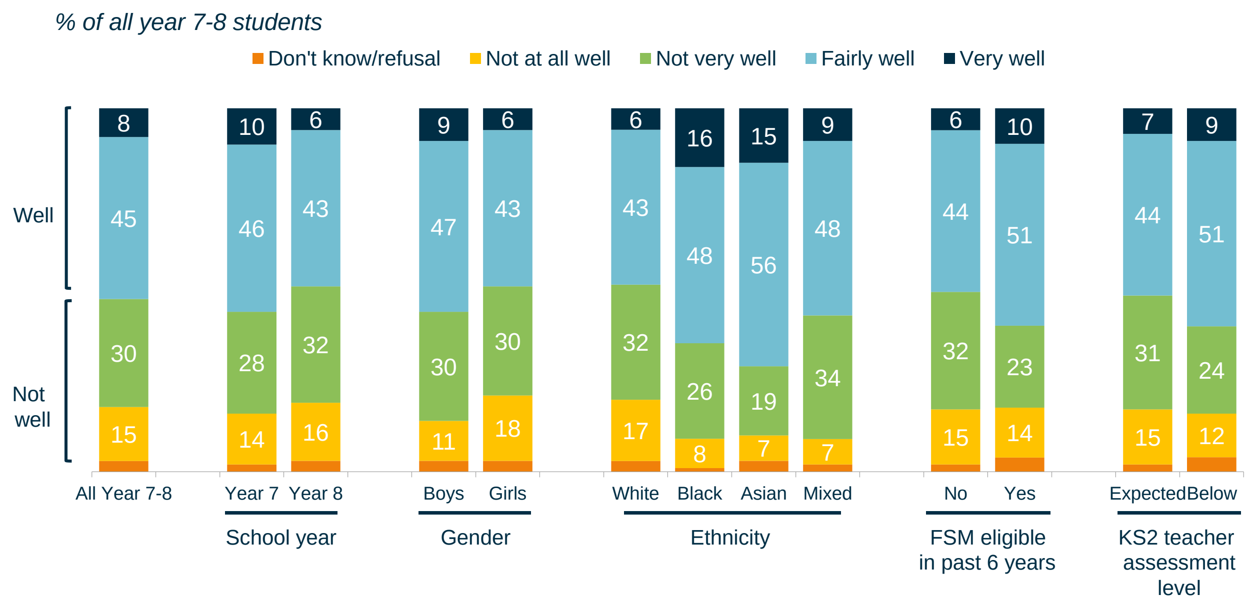
Students often start off in year 7 feeling very enthusiastic about science, though levels of interest decline over the early years of secondary school, as evidenced in this study (section 4.3, Chapter 4), and several other studies (see, for example, Archer et al., 2013; Greany et al., 2016). A smoother transition may therefore help to stem this erosion in engagement, allowing students to build on and consolidate their knowledge across the primary–secondary transition.

Against this backdrop, the SET 2019 survey explored how students in the lower years (years 7, 8 and 9) felt about their transition from primary to secondary school science.

3.2. How well does primary school prepare young people for science at secondary level?

The SET 2019 findings broadly support the wider evidence noted in section 3.1 above, with only around half (53%) of all students in years 7–8 feeling that primary school science equipped them well for their first year at secondary school (Figure 3.1). Surveyed at the end of their first year, 56% of year 7 students thought this, although as students progressed into year 8 (reflecting back further) this dropped to 49%.

Figure 3.1: How well do year 7 and 8 students feel that primary school has prepared them for secondary school by school year, gender, ethnic group, free school meal eligibility and key stage 2 science attainment (2019)



Thinking back, how well do you feel that the science you learned in primary school helped you in Year 7 science? (Primdiff). Bases: All year 7–8s (1,589); year 7 (775); year 8 (814); males (819); females (755); white (1,183); Black (93); Asian (185); mixed (81); FSM eligible/no (330/1,110); KS2 expected/below (1,264/165)

The SET 2019 findings suggest that some students found the transition a more positive experience than others. Of particular note, those coming into secondary school with higher attainment levels (based on key stage 2 teacher assessment scores) were least positive about the transition, as were female students and white students.

Positive views about primary school science, as measured by the percentage saying that primary school science had prepared them 'very well' or 'fairly well', was highest in the following groups of students in years 7 and 8:

- Male students (56% vs 49% of female students)
- Students who had struggled more with science at primary school (61% of those who did not reach the expected level in science key stage 2 teacher assessment vs 51% who did)
- Students from lower-income backgrounds (60% of those eligible for free school meals vs 50% of those not eligible)
- Asian and Black students (71% of Asian students and 65% of Black students vs 49% of white students)

Furthermore:

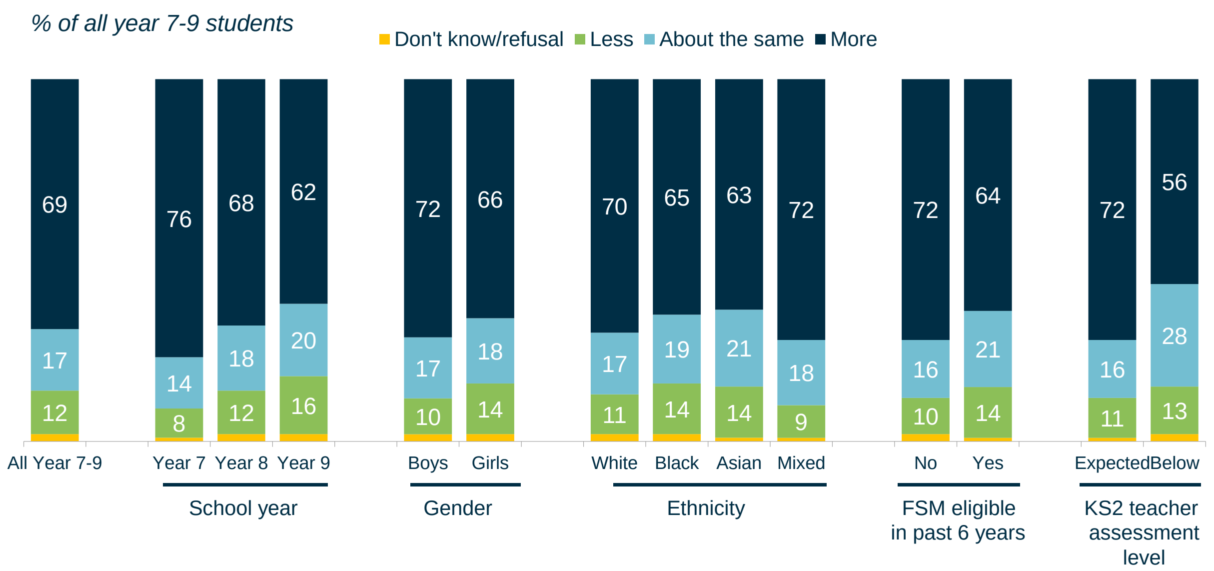
- Combining ethnicity and gender, Asian males were especially likely to be positive about the transition (78%) while white females were least positive (45%).
- Combining key stage 2 science attainment and gender, males with below-expected attainment were most positive (63%), while females who reached expected attainment levels were least positive (48%).

We conducted multivariate analysis (logistic regression) to investigate how different characteristics of young people and their schools are associated with whether or not respondents thought their primary school science had helped prepare them for year 7 science. The results largely confirm the picture above: somewhat higher feelings of preparation for year 7, males, young people from Asian backgrounds, and young people who achieved below the expected level in the key stage 2 teacher assessment. Further details of this analysis can be found in the SET 2019 Technical Report.

3.3. How much do students enjoy science at secondary school compared with primary school?

While many students were critical of the primary–secondary transition, on a more positive note, it was clear that most students in years 7–9 enjoyed science at secondary school more than they did at primary school: overall, 69% enjoyed secondary school science more (Figure 3.2). This preference waned throughout the first three years of secondary school, although this is likely to be linked to a more general decline in interest in science across these first three years of secondary school (section 4.3); as students lose interest in secondary-level science, this may cause them to reflect more positively on their primary school experience.

Figure 3.2: Whether students enjoy science at secondary school more or less than at primary school by school year, gender, ethnic group, free school meal eligibility and key stage 2 science attainment



Compared with science at primary school, do you enjoy science at secondary school …? (PrimEnJ)

Bases: All year 7–9s (2,314); year 7 (775); year 8 (814); year 9 (725); males (1,170); females (1,122); white (1,723); Black (134); Asian (269); mixed (117); FSM eligible/no (507/1,601); KS2 expected/below (1,819/253)

The extent to which students enjoyed secondary more than primary school science varied across the student population. The proportion of students in years 7–9 who enjoyed secondary school science more than primary school science was higher among the following groups:

- Male students (72% vs 66% of female students)
- White students (70% of white students vs 63% of Asian students)
- Students from higher-income backgrounds (72% of students not eligible for free school meals vs 64% eligible)
- Students who started secondary school with expected levels of attainment (72% vs 56% with a below-expected level at science key stage 2).

There was no relationship between students' attitudes towards the primary–secondary transition and how much more or less they enjoyed science at secondary school. Those who were positive about the primary–secondary transition were as likely as those who were negative about this (72% vs 75%) to say that they enjoyed secondary school science more.

4. Attitudes towards learning science compared with other subjects

This chapter explores students' interest in, engagement with, perceived ability in, anxiety about and mindset towards studying science. Comparable questions were asked about other school subjects. In this way, it is possible to gauge the extent to which attitudes towards learning science are specific to science rather than part of a more generic set of attitudes towards school subjects. Results are compared with 2016 where relevant.

Key findings

In terms of enjoyment, science was ranked below maths and English and above computer science and languages. In years 10–13, biology was the most enjoyed science subject, while physics was the least enjoyed.

- Science was ranked midway for students in years 7–9, though for years 10–13, when sciences are studied separately, biology was ranked 3rd and physics ranked 8th out of 10.

In years 7–9, computer science was the most popular subject for males and the least popular subject for females.

- On the other hand, science rankings were much less polarised by gender, ranked roughly midway for both genders in years 7–9. Among year 10–13s, rankings for biology and chemistry were similar for both genders, though males ranked physics higher than females (a ranking of 4 vs a ranking of 9 out of 10).

Interest in science lessons declined rapidly over the first three years of secondary school, and the fall was steepest between year 8 and year 9.

- The proportion who were 'very interested' declined from 26% in year 7 to 23% in year 8 and to 14% in year 9. Based on the proportion who said 'very' or 'fairly' interested, there was a more moderate decline from 83% in year 7 to 73% in year 8 to 68% in year 9. Among years 10–13, the level of interest in science at school remained unchanged since 2016 (68% were 'very' or 'fairly' interested in both survey years).
- The decline in level of interest between years 7 and 9 was accompanied by reduced experience of practical work (Chapter 7), a drop in perceived science ability and an increase in levels of anxiety about science. As noted in section 5.4, there was an increase in the proportion of students during this time who thought of science as 'difficult' and involving 'a lot to learn'. Together, these findings help explain these changes in attitudes towards learning science in the first three years of secondary school.

Across years 7–13, interest in science at school was much stronger among certain groups of students.

- Interest levels were higher among students from BAME backgrounds; those with a high science quiz score; with strong family science networks; and students taking triple (rather than double) science at GCSE. The gender gap in level of interest was very small.
- There was no difference in interest in science by free school meal eligibility. However, BAME students eligible for free school meals were less likely to be very interested in science. By contrast, there was no difference by free school meal entitlement in levels of interest among white students.

Compared with maths and English, in all school years students were less likely to think of themselves as 'good' at science.

- In years 7–9 and 10–13, students were most likely to rate themselves as good at maths (66% and 57% respectively) and English (65%, 58%). In comparison, students had lower levels of self-belief in science: 56% felt they were good at science in years 7–9, and in years 10–13 this proportion ranged from 37% in physics to 49% in biology.

From year 10, females and males had the same level of interest in science. However, females were much less likely than males to think of themselves as 'good' at maths, physics, chemistry and computer science.

- By contrast, there was no gender gap for biology and history, and for English the gender gap was reversed. After controlling for attainment in years 12–13 (re-basing results on all who had achieved at least two strong GCSE science passes), the gender gap for perceived ability in physics and chemistry persisted.

Students felt more anxious about tests or exams in science than in English. Females were more anxious than males in all subjects, though the gender gap was wider for maths and science than English.

- In general, anxiety in all subjects increases with school year. Across years 7–10, students felt more anxious about tests in science compared with tests in English.
- 53% of year 10–11 female students felt anxious about science tests or exams 'most times' compared with 28% of year 10–11 male students, and there were similar gender divides in years 7–9 and for both science and maths.

Compared with maths and English, exam success in science was more likely to be associated with hard work than natural ability.

- For example, 61% of year 7–13 students associated exam success in science with hard work, 19% with natural ability and 20% thought both factors were equally important.

- This pattern of results for science subjects holds throughout all school years. By contrast, students in older years were increasingly likely to see maths and English as being more about natural ability.

4.1. Context

Engagement in science lessons can be linked to several factors. As explored in Chapter 5, students were motivated by levels of interest and enjoyment in the subject, the opportunity to do practical work, understanding how science is relevant to real life, and teachers who explain concepts well and make learning fun. However, a lack of confidence or perceived ability in the subject ('science can be difficult') and concern about the volume of work ('there is a lot to learn and remember') were the most common barriers to engagement.

The findings in this chapter show that engagement in science is very clearly related to perceived ability and anxiety: as interest in science declines over the first three years of secondary school, this is accompanied by falling levels of perceived ability and increasing levels of anxiety. This pattern of findings mirrors other studies (see, for example, Archer et al., 2013; Greany et al., 2016).

Confidence has been found to play a central role in shaping students' performance. For example, Hansen and Henderson (2019) in their analysis of the Next Steps survey noted that after controlling for a range of contextual factors, young people who had the greatest belief in their academic ability were 18 per cent more likely to achieve five 'good' GCSE passes compared with those who had the least confidence. The Trends in International Mathematics and Science Study (TIMSS) in England report a similar link between confidence and attainment and the findings suggested that confidence may have a stronger association with pupils' science outcomes than other factors such as engaging teaching or valuing the subject (Greany et al., 2016).

Moreover, findings from this study and elsewhere consistently point to a wide gender divide in self-perceived ability and anxiety (sections 4.4 and 4.5). Evidence from SET 2019 suggests that, among females, perceived ability and anxiety were more of a barrier to science engagement than lack of interest. In support of this, Cassidy et al. (2018) found that among female students predicted to perform well in maths and physics GCSEs, a lack of confidence in their ability was a key barrier to taking these subjects at A level.

Learning mindset, that is, the extent to which students feel that doing well in a subject is down to their efforts rather than an innate ability, can also affect how students approach their learning of a subject (Mueller and Dweck, 1998).

In this chapter we explore all of these attitudes in relation to science and, importantly, for the first time in SET 2019, we are able to compare how experiences of science compare with other school subjects. An investigation of the differences in patterns of interest, engagement, perceived ability, anxiety and mindset for science compared with other subjects helps uncover issues which are specific to learning science rather than learning in general.

4.2. Enjoyment of science

Enjoyment of science compared with other subjects

Young people were asked to rank school subjects based on which subjects they enjoyed the most/least. The format of the questions differed according to school stage:

Students in years 7–9 were asked about a range of subjects which were expected to be compulsory in these school years. As many young people study sciences as a combined subject at this stage, students were asked to rank 'science' as a single subject.

- Students in years 10–13 were asked about the same range of subjects, although the three science subjects (biology, chemistry, physics) were ranked separately. Students in these older years were asked to think back to subjects they had previously studied before narrowing their choices at GCSE.

A minority of students (2% in year 7; 3% in year 8; 7% in year 9; 17% in years 10–13) said they had never studied computer science. For these students, computer science was omitted from the list of subjects they were asked to rank.

Figure 4.1 shows the mean rankings per subject for the two school stages. In years 7–9, the highest possible rank would be a score of 1 and the lowest would be a score of 8, although in practice mean scores ranged from 3.62 to 5.64. In years 10–13, the highest possible rank would be a score of 1 and the lowest would be a score of 10, although mean scores ranged from 4.23 to 6.90. There were some common themes across the two school stages:

- Maths and English were ranked relatively high in both school stages, and above science subjects.
- Computer science was ranked towards the bottom in both school stages.
- Languages were ranked at the bottom in both school stages.

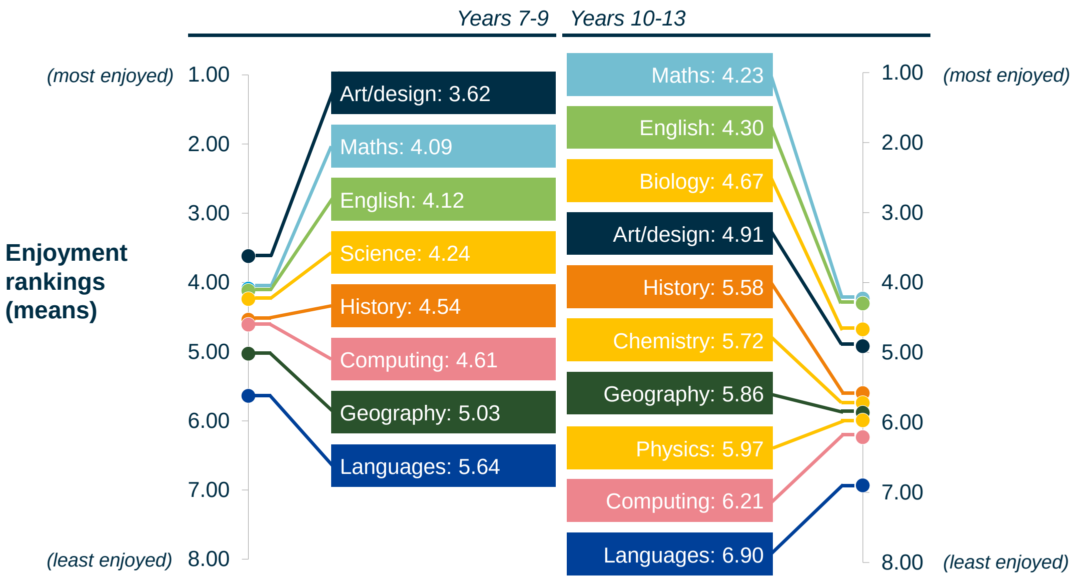
There were also some differences by school stage:

- Art/design was the most popular subject in years 7–9, though this was ranked lower, in fourth position, in years 10–13.

- In years 10–13, when sciences are studied separately, biology was clearly the most enjoyed science subject, and physics was the least enjoyed.

The relative ranking of enjoyment for year 10–13 students closely reflects recent analysis of the Next Steps survey which asked a similar subject ranking question among students aged 15–16 (DfE research brief, 2019b). The findings cannot be compared with SET 2016 due to differences in the range of subjects asked about.

Figure 4.1: Mean enjoyment rankings at years 7–9 (key stage 3) and years 10–13 (key stage 4) (2019)



At school, which of these subjects have you enjoyed the most, even if you no longer study them? Please rank all options with 1 being the subject you have enjoyed the most and 10 the subject you have enjoyed the least. If you no longer study these subjects, think back to when you were studying them (SchSubEnj, SchSubEnj2)

Bases: Half sample B: All year 7–9s (1,161); All year 10–13s (2,098)

In years 7–9, compared with non-eligible students (mean score of 4.60), students eligible for free school meals ranked science lower (mean score of 4.13).

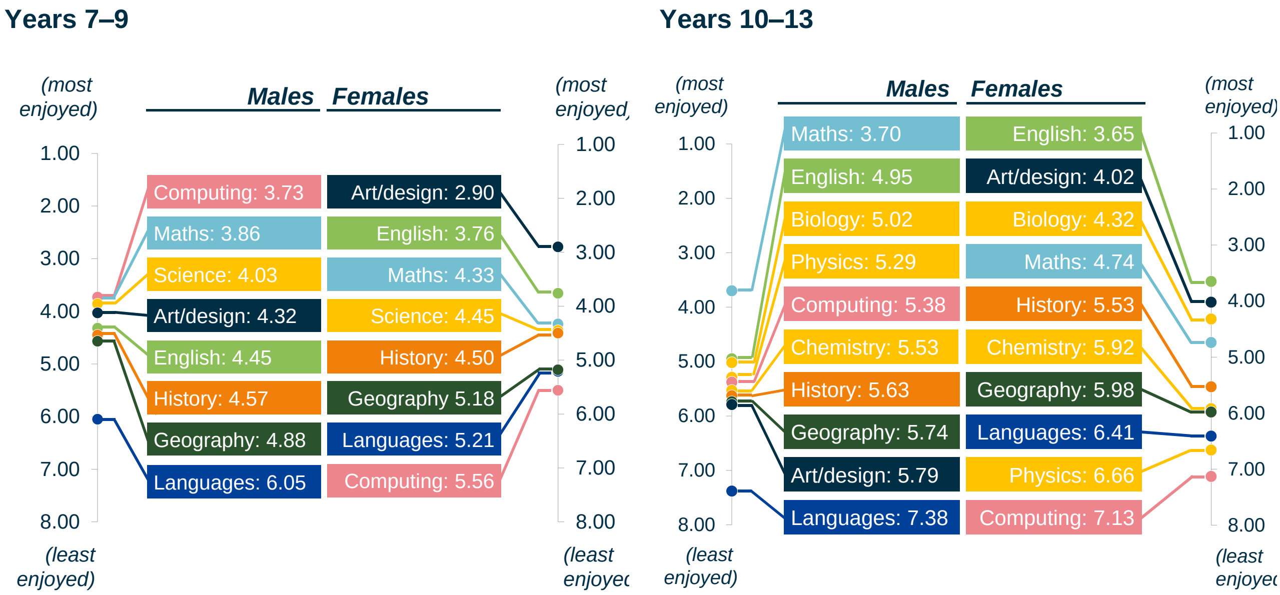
Enjoyment of science by gender

Figure 4.2 displays the mean rankings by gender for year 7–9 students and year 10–13 students. Some notable gender differences can be observed:

- Males ranked maths higher than females at both school stages.
- Males ranked computer science higher than females in years 7–9 and years 10–13, though the difference in years 7–9 was especially striking where males ranked it highest and females ranked it lowest.
- In years 7–9, males ranked science slightly higher than females (a mean rank of 4.03 vs 4.45).
- In years 10–13, the mean ranking for biology was higher for females (mean rank=4.32) than males (mean rank=5.02). However, males were much more likely than females to prefer physics (mean rank of 5.29 vs 6.66) and slightly more likely to prefer chemistry (mean rank of 5.53 vs 5.92).
- Females were more likely than males to rank art/design and English in a top position at both school stages.

As noted above, these gender differences match similar findings based on Next Steps survey data (DfE Research brief, 2019b).

Figure 4.2: Mean enjoyment rankings at years 7–9 (key stage 3) and years 10–13 (key stage 4) by gender (2019)



At school, which of these subjects have you enjoyed the most, even if you no longer study them? Please rank all options with 1 being the subject you have enjoyed the most and 10 the subject you have enjoyed the least. If you no longer study these subjects, think back to when you were studying them (SchSubEnj, SchSubEnj2)

Bases: Half sample B: All year 7–9 males/females (570/557); all year 10–13 males/females (949/1,063)

4.3. Interest in science

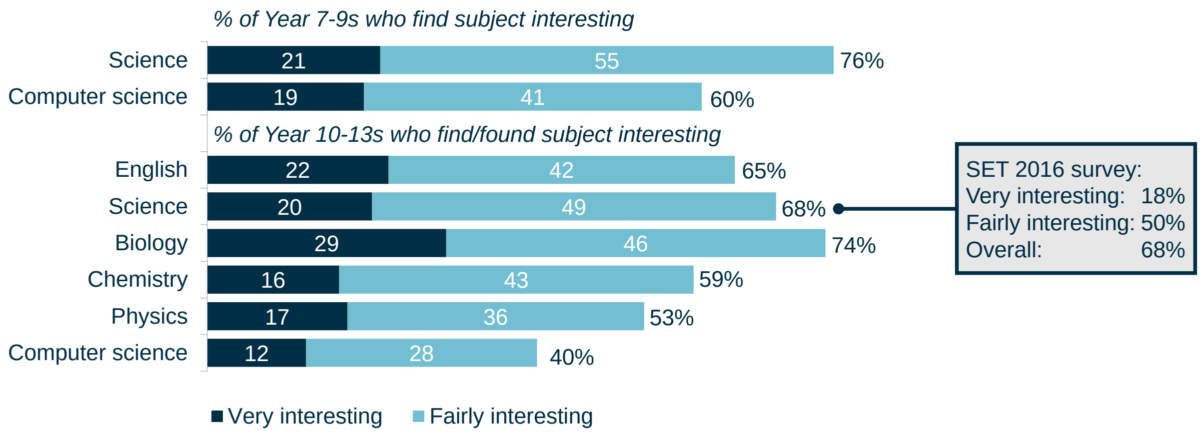
Interest in science compared with other subjects

In 2019, 76% of students in years 7–9 found science interesting, dropping to 68% of students in school years 10–13 (Figure 4.3). For students in school years 10–13, the level of interest in science remained unchanged since 2016. For a more detailed breakdown by school year, refer to section 4.3.

In years 10–13, the level of interest in English was similar to that in science (65% of students in years 10–13 were interested in English, and 68% were interested in science). Computer science was considered less interesting than science in both school stages: 60% of year 7–9s and 40% of year 10–13s found computer science interesting.

In years 10–13, all students were asked about interest levels in 'science' and half were also asked about their level of interest in each of the sciences individually. This shows that overall interest in 'science' masks differences by individual subject. Year 10–13 students were most interested in biology (74%) and least interested in physics (53%), which is consistent with the findings shown in Figure 4.1.

Figure 4.3: Interest in science vs other subjects at school by school stage (2019)



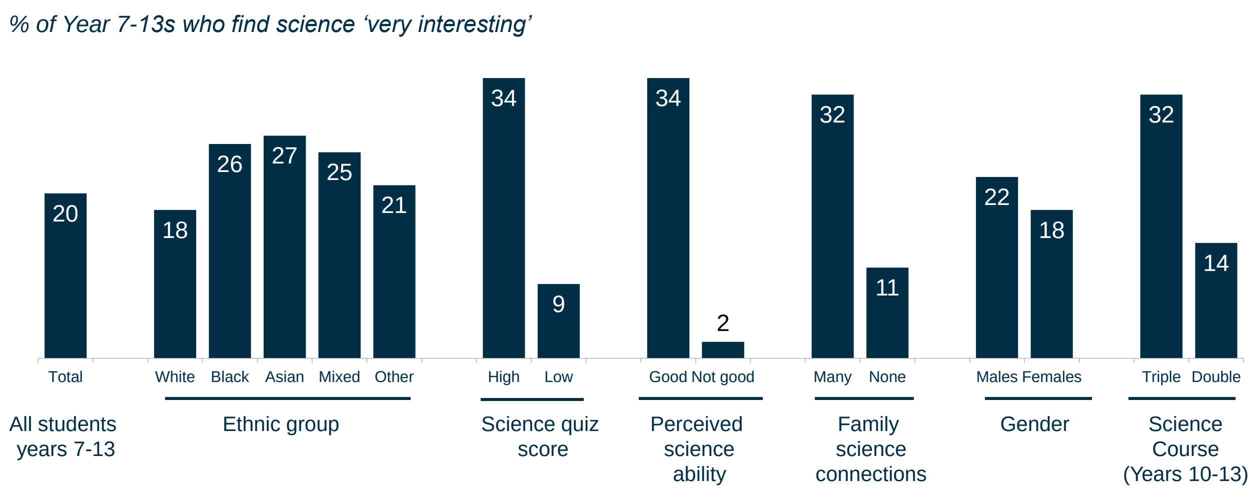
How interesting do you find the following lessons at school? (SciInt, Otherint_1 to Otherint_4, CSInt)

Bases: All students: Science: year 7–9s (2,314); year 10–13s (4,095); Half sample B: Biology/chemistry/physics/English: year 10–13s (2,098); all who have studied computer science: year 7–9s (1,108), year 10–13s (1,676); 2016: All year 10–13s (4,069)

How does interest in science vary across different groups of young people?

Figure 4.4 provides a more in-depth look at which groups find sciences most interesting (for a more detailed breakdown of levels of interest in computer science, see section 6.3). For this analysis, the results focus on those who find science 'very interesting'.

Figure 4.4: Percentage of students in years 7–13 'very interested' in science by ethnic group, science quiz score, perceived ability in science, family science connections (FSCI) and gender (2019)



How interesting do you find the science lessons at school? (SciInt)

Bases: All year 7–13s (6,409); white (4,738); Black (375); Asian (804); mixed (331); other (90); quiz score high/low (1,416/1,537); perceived science ability good/not good (3,403/1,009); family science connection many/none (1;307/1;705); males (3,113), females (3,228); years 10–13: triple science (1,529), double science (2,124)

At an overall level, interest in science was linked to ethnic background, science quiz score, perceived ability in science and family networks. There was no difference in level of interest by disadvantage (based on IDACI quintiles and free school meal eligibility). Although there was a gender gap, this was relatively modest. Across all school years 7–13, the following groups were most likely to find science 'very interesting':

- Students from Black, Asian and mixed ethnic groups
- Students who scored more highly in the science quiz
- Students who considered themselves 'good' at science
- Students with strong family networks in science
- Male students
- Students who had taken triple rather than double science (years 10–13 only)

The propensity for Asian and Black students to feel more engaged in science was also noted in the ASPIRES study, which showed that Asian students in years 6, 8 and 9 expressed the strongest science aspirations of any ethnic group, followed by Black and then white students (Archer et al., 2013).

Interestingly, although there was no difference in the proportion saying that they were very interested in science by free school meal eligibility overall, there was a difference among students from BAME groups. So, while white students eligible for free school meals were as likely as those not eligible to be very interested in science (eligible 17%, not eligible 19%), among some BAME groups, those eligible for free school meals were less likely to be very interested in science (Black students: eligible 18%, not eligible 32%; and students from mixed ethnic backgrounds: eligible 19%, not eligible 30%).

How does interest in science vary by school year?

Figure 4.5 displays how interest in science varies by school years, both overall and within different groups. The findings here are only shown for years 7–11 as this covers all years when science is still a compulsory subject (for findings related to years 12 and 13, see further down).

Overall levels of interest by school year

At an overall level, interest in science falls away quite rapidly between year 7 and year 9, with a marked drop between year 8 and year 9: the proportion who were 'very interested' in science declined from 26% of year 7 students to 23% of year 8 students and then to 14% of year 9 students. After year 9, once students have settled into GCSE courses, interest rises again to 18–19%, although it does not regain the peak level of interest observed in year 7.

Based on the proportion who said they were 'very' or 'fairly' interested, there was still a decline but the gradient was shallower: 83% were either very or fairly interested in school science in year 7, dropping to 73% in year 8 and then to 68% in year 9. Thereafter, this level stabilised at around 66–70% (66% in year 10, 68% in year 11, 69% in year 12 and 70% in year 13).

This decline in levels of interest in science lessons during the early years of secondary school reflects other well-documented evidence. For example, the most recent Trends in International Mathematics and Science Study (TIMSS) found that pupils in England felt much less engaged during science lessons in year 9 compared with in year 5 (Greany et al., 2016). Similarly, Archer et al. (2013) found that students enjoyed their science lessons increasingly less between year 6 and year 9, with the largest drop from year 8 to year 9. The authors speculated that an increasing focus on test preparation might be one of the factors associated with this decline.

Building on this hypothesis, there is also evidence that schools are increasingly starting the GCSE curriculum earlier in year 9 because of the increased content in the new 9–1 GCSE curriculum. NFER (2019) and TES (2019b) indicate that between half and two-thirds of schools may now be adopting this practice, while Cramman et el. (2019) suggest that this could be higher still (they report a figure of 88% of English state-funded schools starting GCSE teaching early). This practice would lead to the contraction of key stage 3 science from three years to two years.

Additionally, Chapter 7 (section 7.4) indicates that the volume of hands-on practical work, which we know from Chapter 5 (section 5.2) is considered to be the most motivating aspect of science lessons, decreases substantially between year 7 and year 9. Furthermore, section 5.4 also highlights an increase between year 7 and year 9 in the proportion of students who felt that science is 'difficult' or involves 'a lot to learn' and an increase in teacher-related issues putting students off science. All these factors combined could explain this marked loss of interest and motivation between year 8 and year 9 (see also section 5.4 for further discussion on this).

Levels of interest by school year among different groups

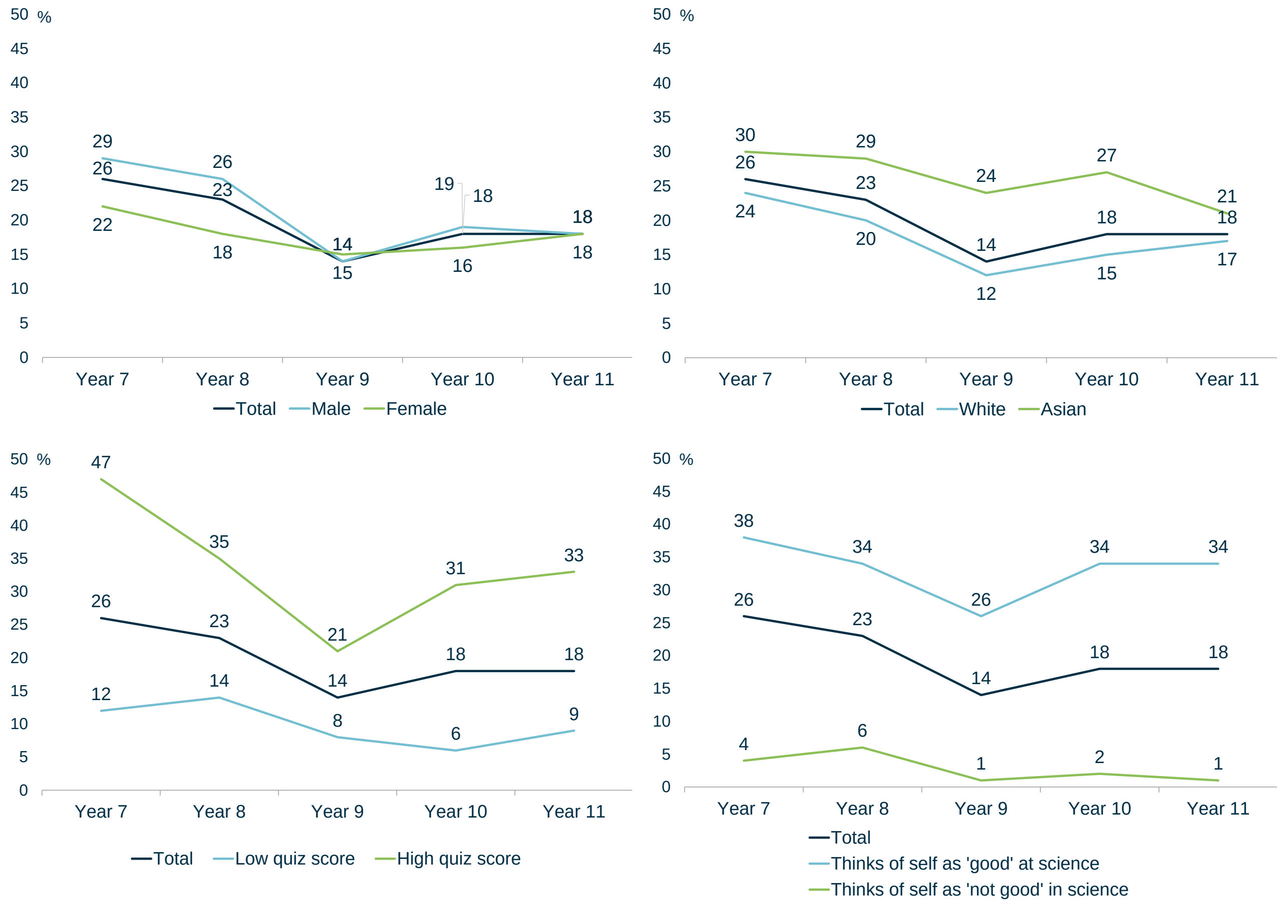
The more detailed findings in Figure 4.5 show that this year 9 dip is present across most groups, although the dip is more apparent among males than females, among white students compared with Asian students, among those who consider themselves 'good' at science, and among those with a high science quiz score. Of particular note, 47% of students with a high quiz score found science very interesting in year 7, while only 21% of those with a similar score in year 9 found science very interesting in year 9.

Figure 4.5 also shows gaps in interest between different groups over time. It reveals that there was a gender gap in interest levels in years 7–8, with males more interested than females, though this gap largely disappears from year 9 onwards. The higher level of interest in science shown by Asian students is apparent across all year groups, though especially in years 9–10. The ability gap (as measured by science quiz scores) was also apparent across all school years, though it was most marked in year 7 and year 11, when those with a high quiz score were three to four times as likely to be very interested in science compared with those with a low quiz score. In all school years, the gap in level of interest between those who had high versus low levels of perceived science ability is striking.

Taken together, these findings show that while there was considerable variation in the groups of students who find science interesting, there were noticeable dips in interest in year 9 which affect most students, including those who belong to groups which are typically more engaged.

Figure 4.5: Proportion of students in years 7–11 who find science 'very interesting' by gender, ethnic group (white vs Asian)*, science quiz score and perceived ability in science: within school year (2019)

% who find science 'very interesting'



How interesting do you find science lessons at school? By Science, we mean Biology, Chemistry and Physics (SciInt)

Bases: All years 7/8/9/10/11: All (775/814/725/1,044/1,093); male (412/407/351/488/527); female (357/398/367/550/552); white (586/597/540/738/799); Asian (92/93/84/135/149); low quiz score (207/189/155/287/236); high quiz score (142/188/183/183/255); good at science (502/464/354/482/534); not good at science (69/102/120/213/193)*

**Note low base size; subsample sizes are not large enough to show other ethnic groups within year groups*

In years 12 to 13, science is no longer a compulsory subject. The overall level of interest in these later years was 70% (22% very interested, 48% fairly interested), which was similar to the overall level of interest among students in years 10 and 11 and remains unchanged since SET 2016.

However, this level of interest varied considerably by subject choices in the sixth form. Among those in years 12 and 13 who had chosen to study at least one of the three sciences at sixth form level (biology, chemistry, physics), the level of interest was substantially higher. Overall, 93% of this group said that they found science interesting, with 53% saying that they were very interested and 40% fairly interested (no differences by gender). Nonetheless, it is notable that around half of students who had proactively chosen to study sciences in the sixth form did not say that they found science ‘very interesting’.

4.4. Perceived ability in science

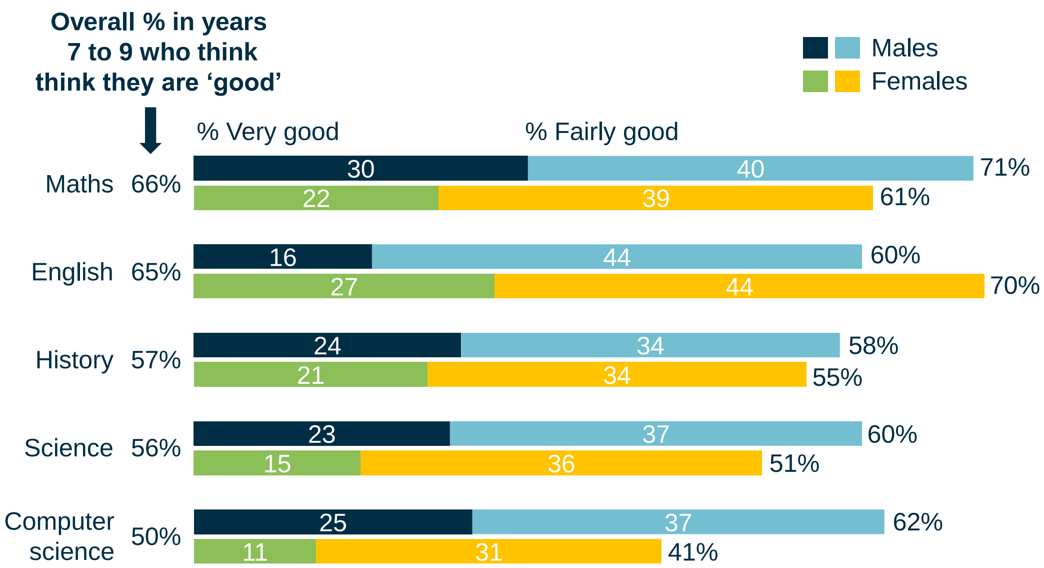
Perceived ability in science compared with other subjects

As noted in section 4.1, students’ perception of their own ability in science at school can play a central role in shaping their performance. Furthermore, self-belief in science is not always related to ability. Sheldrake (2016) found in a study of secondary school pupils in England that students who were underconfident in relation to their actual abilities expressed consistently less positive science attitudes than students who accurately evaluated their own ability, despite reporting the same science grades.

In SET 2019, for the first time, students were asked about their own level of ability in science and other subjects. Students in years 7–9 were asked about their self-perceptions in relation to science, while students in years 10–13 were asked about this in relation to the three sciences separately. Students in years 12–13 who were no longer studying sciences were asked to think back to when they were studying them at GCSE.

Figures 4.6 and 4.7 show the percentage of students in years 7–9 and 10–13 who thought of themselves as ‘very good’ or ‘good’ at each subject (for discussion on gender differences, see section 4.4). At an overall level, students in years 7–9 and years 10–13 had higher levels of perceived ability in maths (66% and 57% respectively) and English (65%, 58%). In comparison, students were relatively less likely to rate their abilities in science: 56% felt they were ‘good’ at science in years 7–9, and in years 10–13 the proportion thinking they were ‘good’ at a subject ranged from 37% in physics to 49% in biology. For students in years 7–9, where the subject was still compulsory, perceived ability in computer science was lowest (50%).

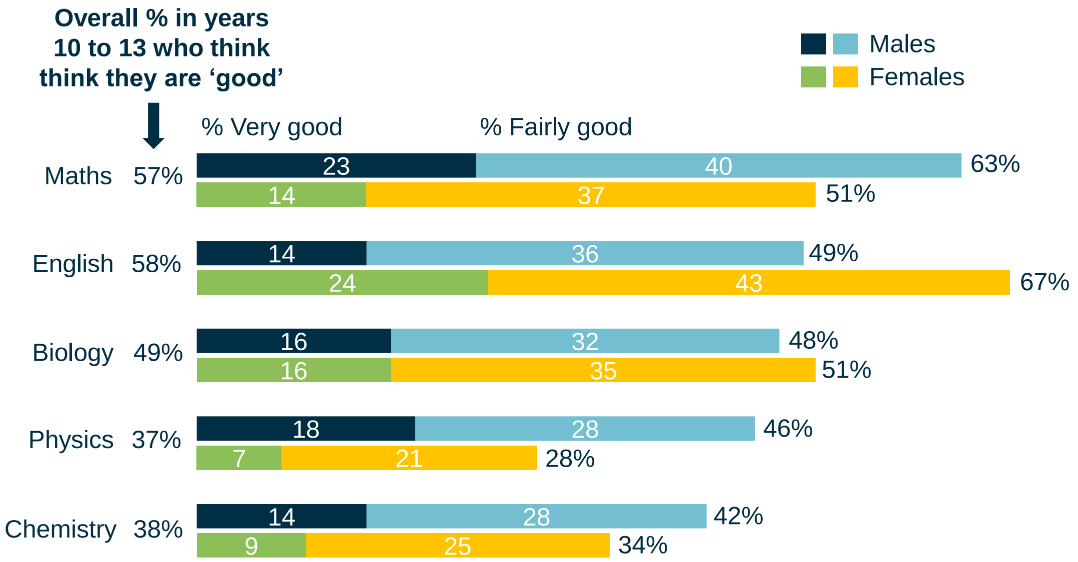
Figure 4.6: Proportion of year 7–9 students who feel that they are ‘good’ at different subjects by gender (2019)



How good would you say you are at…[subject]? (Good1-Good7, goodcomp)

Bases: All year 7–9s (2,314): Maths, English, history and science: males (1,170); females (1,122); all studying computer science: males (1,132); females (1,073)

Figure 4.7: Proportion of year 10–13 students who feel that they are 'good' at different subjects by gender (2019)



How good would you say you are at…[subject]? (Good1-Good7)

Bases: Maths and English: All year 10–13s (4,095): males (1,943), females 2,106); biology/chemistry/physics half sample B: All (2,098), males (983), females (1,092)

Perceived ability in science by gender

Figures 4.6 and 4.7 above also provide findings by gender, and they show that female students had considerably lower self-perceptions of their own ability than male students in most STEM subjects in years 7–9 (for maths, science and computer science) and years 10–13 (for chemistry, physics and maths). In contrast, the gender gap for English was reversed, with females more likely than males to think they were good at both school stages, while there was no gender difference for biology. This appears to indicate that the self-perception barrier among females is specific to STEM subjects (with the exception of biology) rather than school subjects in general.

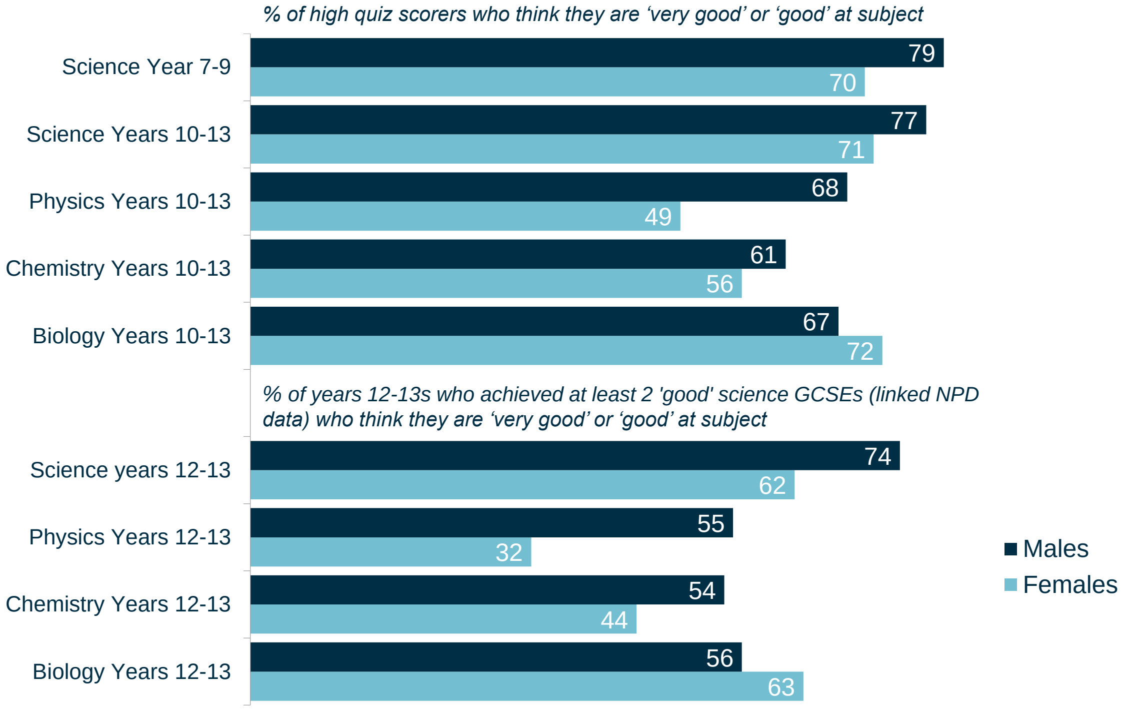
This wide gender imbalance in perceived ability in science reflects a considerable wider body of evidence reporting similar findings (see, for example, DfE Research brief, 2019b; Hansen and Henderson, 2019; OECD, 2015a). As noted in section 4.1, Cassidy et al. (2018) further indicate that, among females predicted to perform well in maths and physics GCSEs, a lack of confidence in their ability was a barrier to taking these subjects at A level.

To investigate the extent to which a lack of perceived ability among females in SET 2019 is based on an accurate evaluation of their abilities, the findings related to perceived ability were re-based on all who achieved the highest band in the science quiz, which is used here as a proxy for science ability (Figure 4.8). If lack of perceived ability is completely explained by lower ability in science, then we would expect no gender gap in levels of self-belief among those who perform well in science. The findings do indeed indicate that for many science subjects the gender gap narrows once ability is controlled for. However, it is interesting to observe that a gender gap in perceived science ability still persists both in years 7–9 (79% of males compared with 70% of females who performed well in the science quiz felt they are good at science) and in years 10–13 (where the equivalent male–female gap is 77–71%).

For the older age group, once ability is controlled for, the gender gap in perceived ability in chemistry and physics persists and remains especially wide in physics.

Although the quiz score measurement is not a perfect match for attainment, a similar pattern can be observed when looking at GCSE science results, which helps to corroborate these conclusions. For years 12–13, we performed the same analysis among students who had gained at least two 'good' science GCSEs, which is another method of controlling for high attainment; the same pattern of results can be observed (Figure 4.8).

Figure 4.8: Percentage of high science quiz scorers in years 7–13 who think that they are ‘very good’ or ‘good’ at science; percentage of students in years 12–13 who achieved at least two ‘good’ GCSEs who think that they are ‘very good’ or ‘good’ at science (2019)



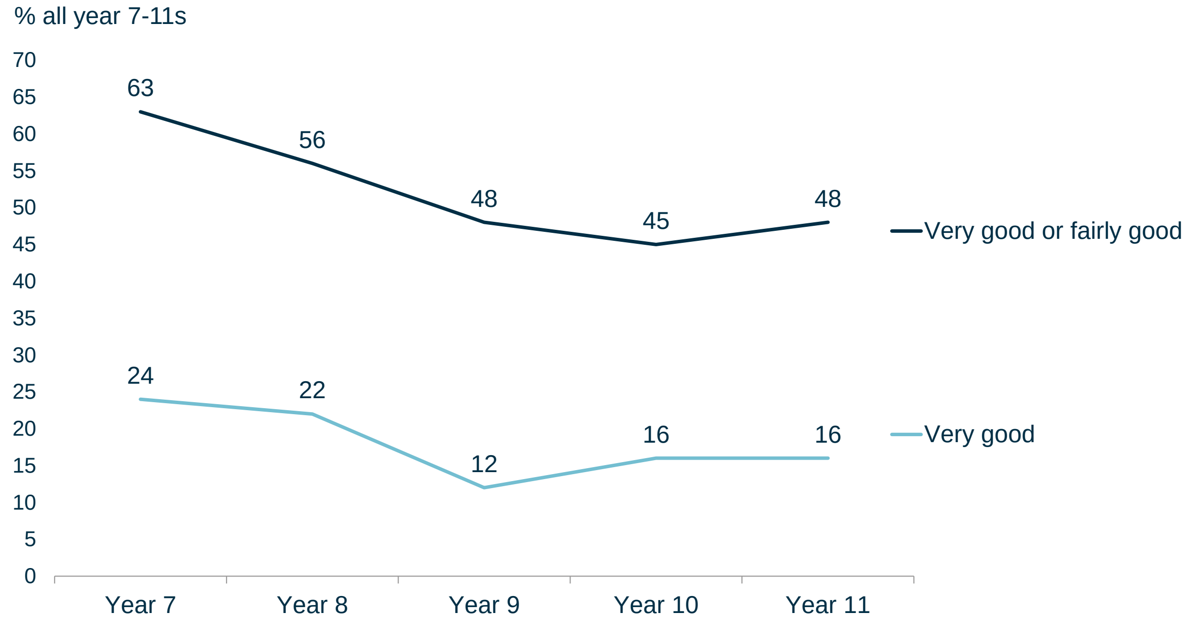
How good would you say you are at…[subject]? (Good1-Good7)

Bases: Male/female students with a high quiz score: years 7–9 science (281/228); years 10–13 science (535/358); years 10–13, physics/chemistry/ biology half sample B (278/178); male/female year 12–13s students with at least 2 good science GCSEs: Science (553/623), physics/chemistry/biology half sample B (270/333)

Perceived ability in science by school year

Focusing on the proportion who consider themselves to be ‘very good’ in science, perceived ability in science declines over the first three years of secondary school (years 7, 8, 9) before regaining some ground in years 10 and 11 (Figure 4.9). This mirrors the pattern of engagement in learning science over this period (section 4.3; Figure 4.5).

Figure 4.9: Percentage of students in years 7–11 who feel that they are ‘very good’ or ‘fairly good’ at science by school year (2019)



How good would you say you are at science? (Good3)

Bases: All year 7–11s: year 7 (775); year 8 (814); year 9 (725); year 10 (1,044); year 11 (1,093)

In years 12 to 13, re-basing the survey data only on those studying a science subject, the overall rate of perceived ability was much higher at 90% (56% thinking of themselves as ‘very good’ and 35% as ‘good’). Male students studying science in years 12 to 13 were somewhat more likely than female year 12–13 students to think of themselves as ‘very good’ (61% vs 50%).

Students in years 12 and 13 were also asked about their perceived level of ability in biology, chemistry and physics. Based only on those who were studying these subjects, perceived ability was about the same for all three subjects: 47% of those studying biology in sixth form considered themselves to be ‘very good’ at biology, while the equivalent perceived ability figures among A-level chemistry and physics students were 50% and 53% respectively.

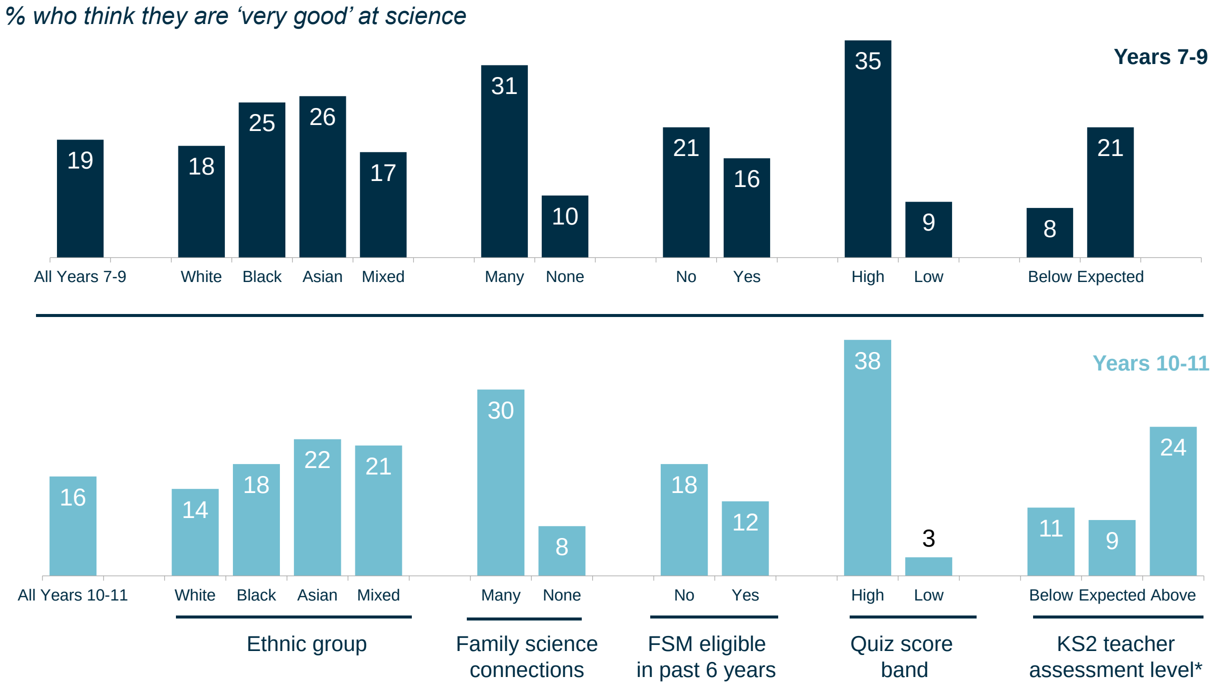
Which groups of students had the highest and lowest levels of perceived ability in science?

Aside from gender differences, perceived ability in science also varied by demographic subgroup; Figure 4.10 shows the percentage of people in different groups who considered themselves to be ‘very good’ at science. Across both school stages where science is still compulsory (years 7–9 and years 10–11), the following groups reported a lower self-belief in science:

- White students (compared with Asian students)
- Students with few family science connections (compared with those who had many)
- Students entitled to free school meals (compared with those who were not entitled)
- Students with lower attainment (compared with those with higher attainment), as measured by both the science quiz score and the teacher-assessed attainment at key stage 2

These findings match similar findings based on the Next Steps survey analysis (Hansen and Henderson, 2019).

Figure 4.10: Percentage of students in years 7–9 and 10–11 who feel that they are 'very good' at science by ethnic group, free school meal eligibility, family science connections, science quiz score and key stage 2 science attainment* (2019)



How good would you say you are at science? (Good3)

Bases: All year 7–9s and year 10–11s (2,314/2,137); white (1,723/1,537); Black (134/133); Asian (269/284); mixed (117/126); FSCI many (588/419); FSCI none (488/611); FSM eligible (507/485); not FSM eligible (1,601/1,447); quiz score high (513/438); quiz score low (551/523); KS2 assessment below expected (253/145); KS2 assessment expected (1,819/872); KS2 assessment above (NA/813)

**Linked NPD data – due to changes in key stage 2 assessment between cohorts, the format for results is different for years 7–9 and years 10–11*

4.5. Anxiety in science

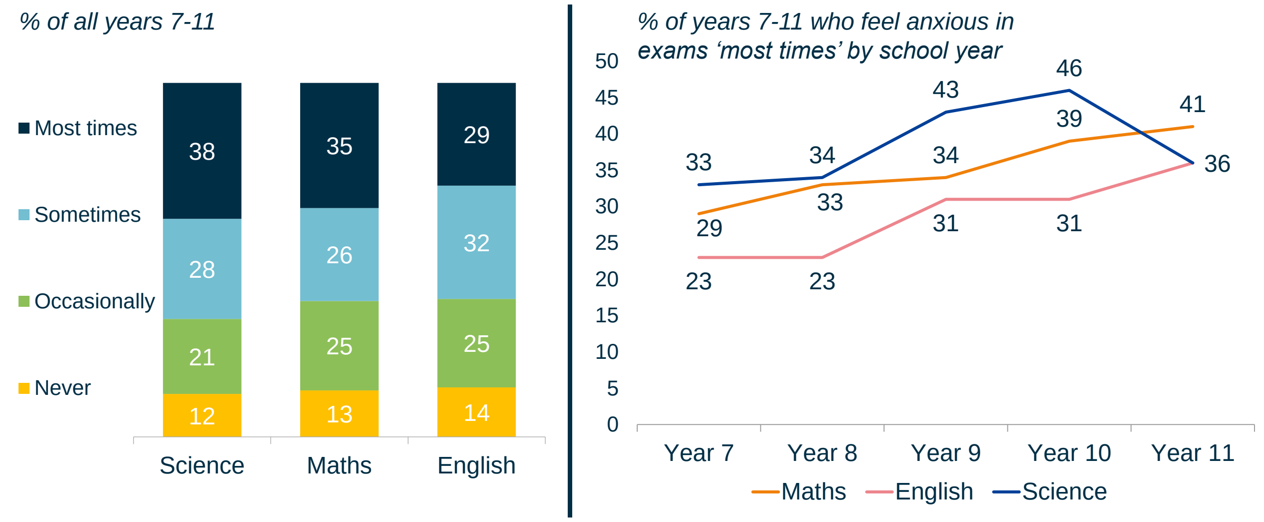
Anxiety in science compared with other subjects

Anxiety in tests and exams is another contextual factor which may affect performance and motivation in science and other subjects. Ofqual (2019) suggests that while anxiety about tests and exams is normal and can even be helpful, for some students these worries go beyond being a helpful focus and can pose a threat to both their academic achievement and their wellbeing. Ofqual research among 14–16-year-olds found that 16% of students reported themselves to be highly 'test anxious'; the proportion was higher among female students (23%) than male students (10%) (Putwain and Daly, 2014). Results from the 2015 PISA survey based on 15-year-olds also found that UK students were considerably more anxious than those in most other countries: 72% of UK students reported feeling 'very anxious even if I am well prepared for a test' compared with an OECD average of 55%; and the gap between females and males was 19 percentage points (OECD, 2017). The PISA 2018 survey found that 63% agreed that when they fail, they worry about what others think of them (against an OECD average of 56%), and the gender gap was similarly wide (OECD, 2019d).

In SET 2019, there was an interest in comparing the differences in test anxiety for science with that of other subjects to examine the extent to which patterns of anxiety in science are subject-specific or generic. Figure 4.11 shows the proportion of students in years 7–11 who said that they felt anxious when sitting a test or exam in each of three subjects: science, maths and English. At this overall level, focusing on the proportion who said they felt nervous or worried 'most times', students felt more anxious about tests or exams in science (38%) compared with both maths (35%) and English (29%).

Figure 4.11 also shows that an increase in test anxiety by school year is observed in all three subjects, which is to be expected as this reflects the transition from internal class tests to GCSE exams. However, the results also clearly show that students felt more anxious about tests or exams in science than in English in all school years, aside from in year 11, when there was no difference. In year 11, the pattern changes and students were more anxious about maths than other subjects. Students felt least anxious about English exams in all school years up to year 10.

Figure 4.11: How often students in years 7–11 feel anxious when sitting a test or exam in different subjects and the proportion who feel anxious in these subjects 'most times' by school year (2019)



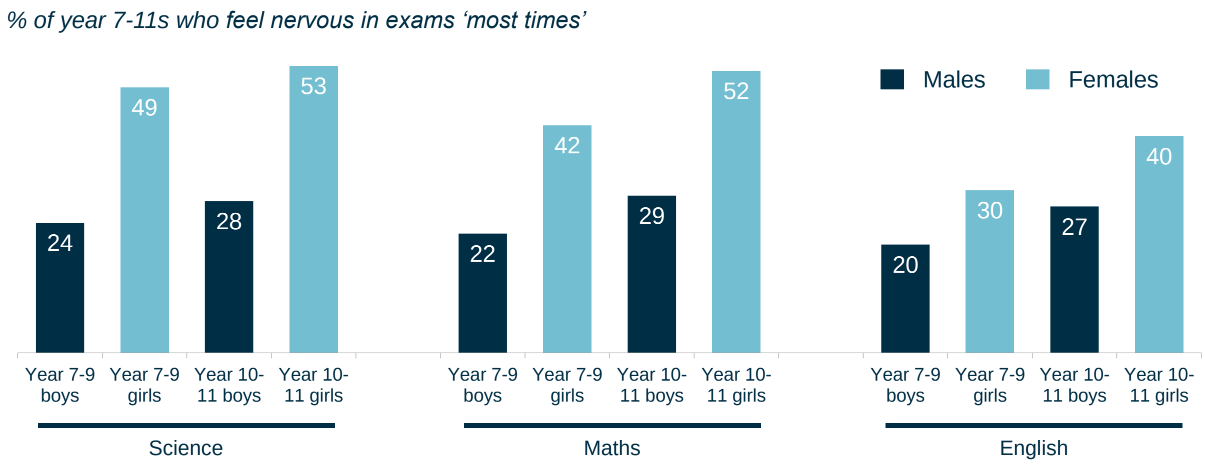
Thinking now about when you sit a test or an exam at school. How often have you felt nervous or worried when you are doing each of the following? (Examanx_1, Examanx_2, Examanx_3)

Bases: All year 7–11s, half sample B (2,258): year 7 (403); year 8 (412); year 9 (346); year 10 (536); year 11 (561)

Anxiety in science and other subjects by gender and other demographics

Reflecting the findings reported above (OECD, 2017; Putwain and Daly, 2014), there were very clear gender differences in levels of anxiety, with female students feeling considerably more anxious than male students when sitting tests and exams (Figure 4.12). Moreover, this gender divide was particularly pronounced in relation to science and maths tests and exams; it is notable that females were twice as likely as males to feel anxious in science exams at both school stages. While there was still a gender divide in relation to English exams, this was much narrower.

Figure 4.12: Percentage of young people in years 7–11 who feel anxious 'most times' when sitting a test or exam in different subjects by gender (2019)



Thinking now about when you sit a test or an exam at school. How often have you felt nervous or worried when you are doing each of the following? (Examanx_1, Examanx_2, Examanx_3)

Bases: Half sample B: All year 7–9 boys/girls (582/566); all year 10–11 boys/girls (514/572)

Focusing on levels of anxiety in relation to science exams, it can also be observed that anxiety in tests and exams was higher among some students than others. The proportion in years 7–11 who said they felt anxious 'most times' was higher among the following groups:

- Students with a low science quiz score (43% vs 32% with a high quiz score)
- Students with low perceptions of their ability in science (57% who felt they were 'not good' vs 43% who felt they were 'okay' and 30% who felt that they were 'good' in science)

The latter finding suggests that anxiety is strongly related to a lack of perceived ability in the subject. However, it is interesting to note that once perceived ability was controlled for, there was a still a gender gap in relation to science test anxiety. Basing results only on those who thought they were 'very good' at science, female students were still twice as likely as male students (30% vs 15%) to feel anxious in science exams 'most times' even though they had a similarly high level of self-belief in their abilities. A similar pattern was found in relation to English, though the gender gap was not as wide. Among those who thought of themselves as 'very good' at maths, 24% of females vs 15% of males felt anxious most times in maths tests.

4.6. Learning mindset

Learning mindset for science compared with other subjects

Learning mindset, also referred to as 'growth mindset', refers to the nature–nurture idea that intelligence can be developed rather than it being 'set in stone'. Based on advice originating from an influential research paper by Mueller and Dweck (1998), many schools in England have adopted the practice of praising students for their *effort* rather than their *achievement*, which is considered to help improve students' motivation, performance and perseverance in a subject (Guardian, 2018). Results from the 2018 PISA study support this: the study found that 70% of UK students had a growth mindset[15] and that, on average across OECD countries, having a growth mindset was positively associated with students' motivation, self-efficacy and learning goals (OECD, 2019b).

In SET 2019, there was an interest in the extent to which students viewed doing well in science subjects as being more about effort or natural ability, and how these perceptions compared with those relating to other subjects. Students in all school years were asked to place a marker on an 11-point scale to show the extent to which they felt that how well someone does in exams

[15] Defined as disagreeing with the statement 'Your intelligence is something about you that you can't change very much.' The OECD average was 63%.

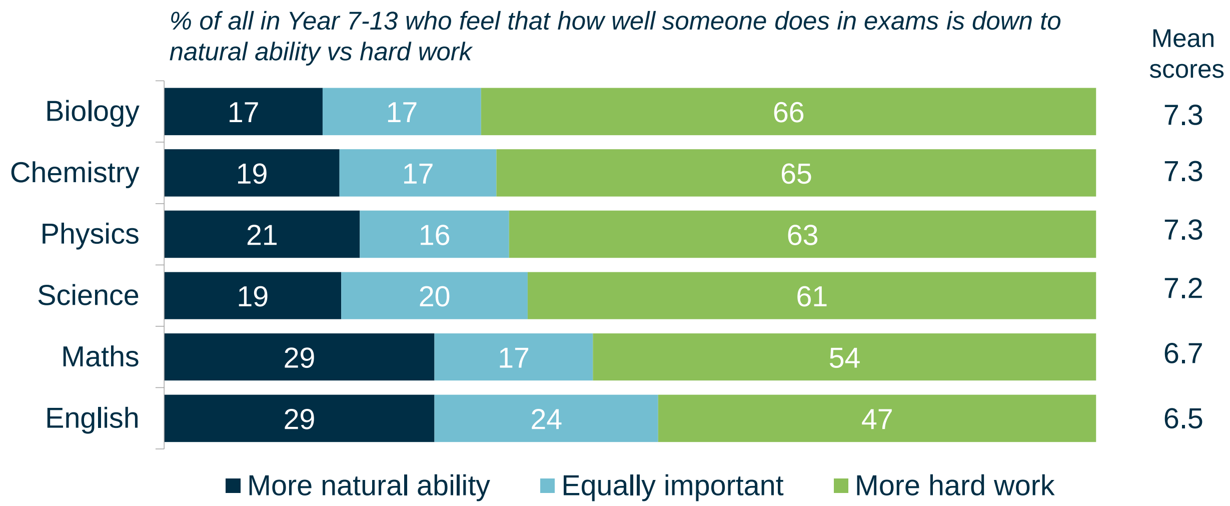
in a subject was more about 'hard work' or 'natural ability'.

As shown in Figure 4.13, although on balance exam success in all subjects was more likely to be attributed to hard work than natural ability, science subjects were relatively more likely than other subjects to be associated with hard work. The pattern of findings for science subjects was similar, whether the questions asked about 'science' generically or about the three science subjects individually[16]. For example, in science, 61% associated exam success with hard work and 19% with natural ability, and 20% thought both factors were equally important.

An equivalent question about science, maths and English was asked in 2016. The pattern of results for science and maths among students in years 10–13 was very similar. However, there is evidence that year 10–13 students in 2019 were less likely than in 2016 to associate success in English with natural ability (35% in 2019 vs 41% in 2016).

Figure 4.13: Extent to which young people in years 7–13 think exam success in different subjects is down to hard work vs natural ability (2019)

Natural ability					Equal	How hard you work				
1	2	3	4	5	6	7	8	9	10	11



*Some people say that how well someone does in exams is mostly down to their **natural ability**, while others say it is mostly down to **how hard they work**. Thinking about young people in general, tell us what you think for each of the following subjects (respondents were presented with sliding scales labelled 'How hard they work' on the left, 'Natural ability' on the right and 'Both equally important' in the middle (L2style_A, Lstyle_A)).*

Bases: All year 7–13s (6,409) science, half sample A (3,098); biology/chemistry/physics, half sample B (3,216)

As shown in Figure 4.14, the pattern of findings by school year differed by subject. Year 7 students were considerably more likely to rank exam success in English as more down to hard work (54%) than natural ability (17%). However, this gap progressively narrowed through the year groups such that students in year 11 who had recently sat their GCSEs were as likely to say that English is about hard work (41%) than it is about natural ability (38%). A very similar pattern was observed for maths, although a hard work–natural ability divide still remained in year 11.

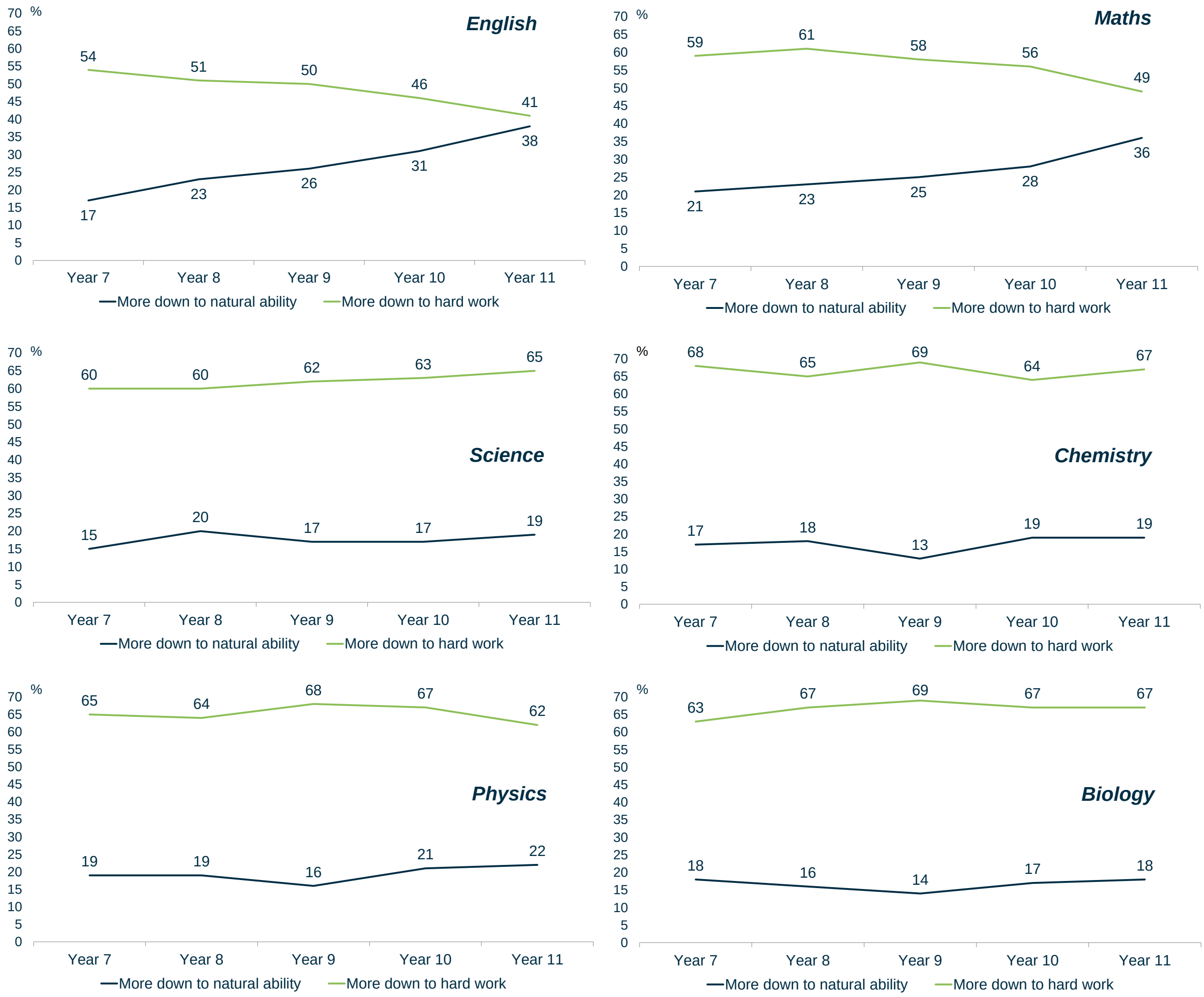
For science subjects, however, the findings were very different. For science in general, and for the three subjects individually, students consistently ranked sciences as being much more about hard work than natural ability, and there was relatively little variation by school year.

[16] Half the sample (module A) was asked about science and the other half (module B) was asked about each science individually.

This suggests that as students get older, they consistently regard sciences as subjects which they have to work hard at to achieve good results. In contrast, as GCSEs get closer, success in maths and English is increasingly seen by students as more about innate ability than hard work.

Figure 4.14: Extent to which young people in years 7–11 think exam success in different subjects is down to hard work vs natural ability by school year (2019)

% of those in each year group feeling it is more down to hard work or more down to natural ability

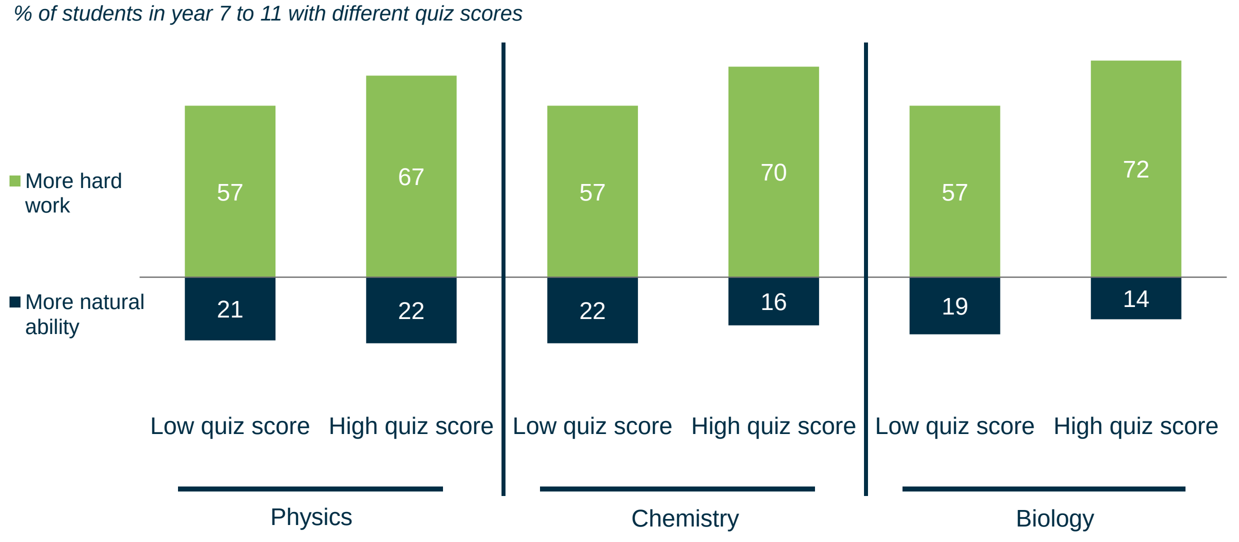


*Some people say that how well someone does in exams is mostly down to their **natural ability**, while others say it is mostly down to **how hard they work**. Thinking about young people in general, tell us what you think for each of the following subjects (respondents were presented with sliding scales labelled 'How hard they work' on the left, 'Natural ability' on the right and 'Both equally important' in the middle (L2style_A, Lstyle_A)).*

Bases: All year 7–11 students: Science, physics, biology, chemistry, half sample A: year 7 (352), year 8 (373), year 9 (360), year 10 (471), year 11 (503); English, maths full sample: year 7 (736), year 8 (760), year 9 (686), year 10 (974), year 11 (1,035)

Figure 4.15 shows that a tendency to view success in science subjects as more about hard work than natural ability was more evident among those who achieved a high science quiz score. Although the quiz score is only a rough proxy for ability, this does tentatively indicate that more able students were more likely than less able to students to see success in science subjects as being down to effort and hard work.

Figure 4.15: Extent to which young people in years 7–11 think exam success in science subjects is down to hard work vs natural ability by science quiz score (2019)



*Some people say that how well someone does in exams is mostly down to their **natural ability**, while others say it is mostly down to **how hard they work**. Thinking about young people in general, tell us what you think for each of the following subjects (respondents were presented with sliding scales labelled 'How hard they work' on the left, 'Natural ability' on the right and 'Both equally important' in the middle (L2style_A, Lstyle_A)).*

Bases: All year 7–11s: low quiz score (691), high quiz score (689)

There was no difference in learning mindset attitudes by gender for any subject, which is consistent with findings from PISA 2018 for UK students (OECD, 2019b).

Students eligible for free school meals were slightly less likely to have a growth mindset for chemistry and biology. Of those eligible for free school meals, 61% associated chemistry with hard work (compared with 66% of non-eligible students) and 61% associated biology with hard work (compared with 68% of non-eligible students); however, there was no disadvantage gap for physics or science in general.

For maths, a reverse pattern is observed: students eligible for free school meals were less likely to view maths as being mainly about natural ability (25% vs 31% of non-eligible students).

5. Factors affecting motivation to learn science at school

This chapter explores what motivates and demotivates students to learn science at school. It also considers the impact of teachers on the experience of learning science in schools. Where relevant, findings have been tracked from 2016.

Key findings

Doing practical science was the key incentive to learn science, especially for students in years 7–9.

- When selecting options from a list, 55% of year 7–9s and 32% of year 10–13s chose practical work as a motivating factor for learning science. Other motivating factors for all age groups included finding science interesting/enjoyable, having a good teacher, and relevance to real life (around a quarter to a third of all years 7–13s mentioning each of these).
- Younger students (years 7–9) were also more likely to mention that it is important to do well in science (26% vs 17% of students in years 10–13).
- Among all students in years 7–13, those with a low science quiz score (27%) and with no family science connections (26%) were much more likely than average (16%) to say that nothing had encouraged them to learn science at school.

Perceptions of difficulty and volume of work were the strongest disincentives to learn science.

- Around two-fifths of students in years 7–13 mentioned perceived difficulty and around a third mentioned the quantity of work. Further disincentives included lack of interest, teachers and science not fitting with future plans.
- Females mentioned more barriers than males and were especially likely to say that they had been put off by factors related to difficulty, achieving good grades and the quantity of work involved. Males were twice as likely as females to say that nothing had put them off learning science.

When learning science, students valued most the ability of a teacher to explain things well.

- When asked to select the most important characteristics of science teachers, 55% of students in years 7–13 mentioned this, while other important factors included making learning fun (41%; this was especially important for year 7–9s, at 49%), being enthusiastic/passionate (29%) and being supportive (29%).
- Female students were more likely to value the ability of the teacher to explain things well, to be supportive and to be organised. On the other hand, male students were more likely to value a knowledgeable teacher.

Compared with 2016, fewer students in 2019 said they were encouraged to study science because they found it interesting or enjoyable (35% in 2019 down from 41% in 2016).

5.1. Context

Inspiring young people to engage in science is important for several reasons. One of the major reasons is to inspire more young people to consider a science-based career. As well as providing young people with stimulating future career options, this will also help address the STEM skills gap, particularly in specific sectors such as engineering and technology. More generally, engaging young people in science is also important to improve the scientific literacy of young people to enable them to interact with scientific developments and debates in wider society. The youth climate change movement is one such example of how young people can relate what they learn in school to real world issues that impact them directly.

In Chapter 2, we discussed the ways in which young people develop an understanding of how science affects their everyday life through activities outside of school. In this chapter, we cover the role of the school, and also more specifically, the teacher, in engaging young people in science. This helps provide context to the findings reported in Chapter 4, which showed that engagement and interest in science falls away very rapidly over the first few years of secondary school. This chapter provides detail on the underlying reasons for this by highlighting the factors that most encourage young people and those that most discourage them.

SET 2019 also covered, for the first time, a more in-depth investigation of the impact of the teacher on learning science. This includes an estimate of the level of disruption experienced by students and teaching methods that engage them most. In the context of an overall shortfall of physics and maths teachers, there is concern that not enough students are able to access subject-specialist teachers (Sibieta, 2018)[17]. Research by the Sutton Trust suggests that there is a shortfall in the recruitment of specialist science teachers, particularly in physics, and that this is more acute in schools with the highest proportion of disadvantaged pupils (Kirby et al., 2017). This has the potential to reduce the opportunity to study some science subjects and to affect the quality of teaching, particularly for lower-income groups.

This chapter provides detail on the factors which both motivate young people to learn science and discourage them from doing so, and how these differ across population groups; it also sheds light on the role of teachers in helping to inspire young people in science lessons.

5.2. What encourages young people to learn science?

The main incentives to learn science at school centred on interest and enjoyment[18]. The single greatest incentive was enjoying practical work (42%), while 35% of students were motivated by finding science interesting or enjoyable (Figure 5.1).

Around a third (34%) said having a good teacher was a factor, which was considerably more than the proportion who felt encouraged by family or friends (13%).

The remaining core motivations centred on the utility of science: around one in four (27%) said that they were encouraged by the relevance of science to real life (27%), while 21% were motivated by the importance of doing well in science and 22% said it fitted with their study or career plans.

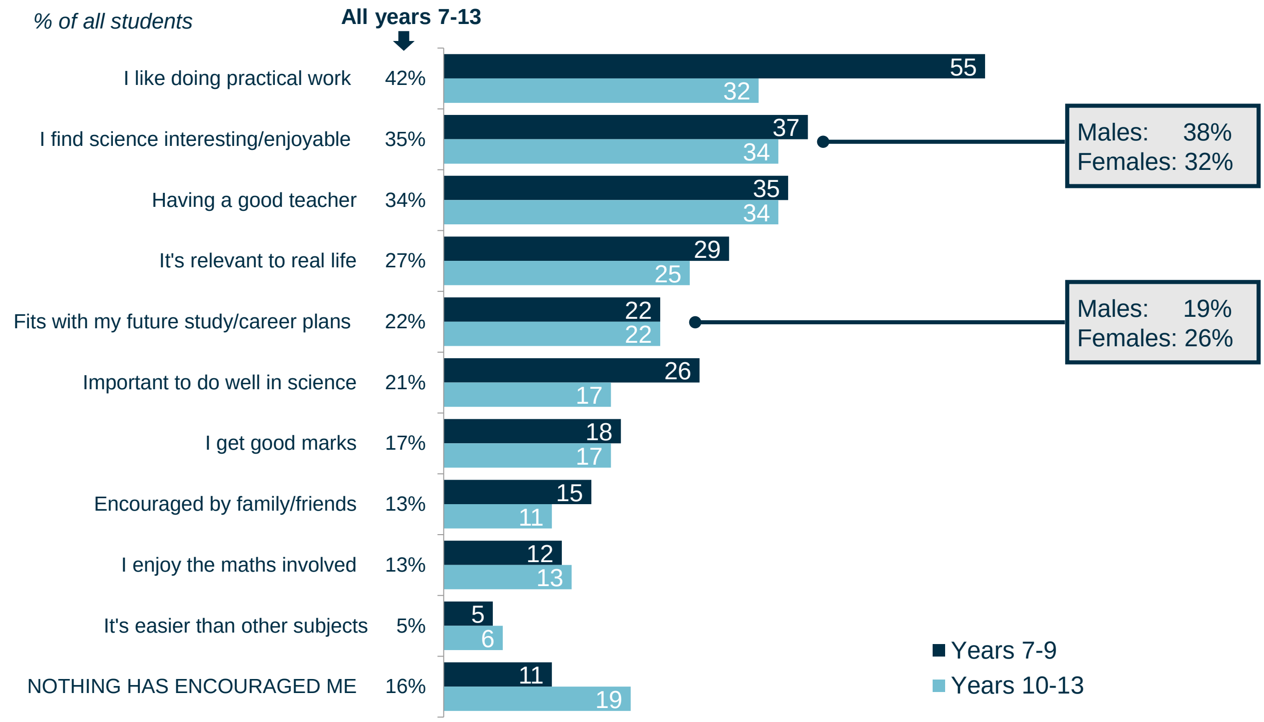
Perceived ease and ability were relatively less important, although 17% were encouraged by getting good marks. Overall, 16% reported no factors that had encouraged them to study science.

This question was broadly comparable with that asked in SET 2016, although SET 2019 offered students the choice of one additional incentive ('it is important to do well in science'), which may have partially displaced other options. The 2019 findings were, nevertheless, largely in line with the 2016 results, although there was one negative change: fewer students said they were encouraged to study science because they found it interesting or enjoyable (35% down from 41%).

[17] The Education Policy Institute noted in 2018 that just half of maths and physics teachers stay on in state schools beyond five years, which is worse than the overall retention rate of 60%.

[18] Respondents were presented with a list and could choose as many options as applied.

Figure 5.1: What has encouraged young people in years 7–13 to learn science by school stage and gender (2019)



What has encouraged you to learn science? Choose all that apply (SciEnc)

Bases: All year 7–13s 2019 (6,409): years 7–9 (2,314); years 10–13 (4,095); males (3,113); females (3,228)

The overall proportion of students saying 'nothing has encouraged me' was 16%, though this response was higher among older students in years 10–13 (19%), students with a low science quiz score (27%) and students with no family science connections (26%). There was little difference by gender alone, though the proportion feeling that nothing had encouraged them was higher among white males (19%).

As shown in Figure 5.1, students in years 7–9 were more likely to be motivated by a range of factors, though the difference was especially marked for enjoying practical science (55% of years 7–9 vs 32% of years 10–13) and feeling that it's important to do well in science (26% vs 17%).

Other specific incentives to study science were chosen more by the following subgroups:

By gender (Figure 5.1):

- Male students were more likely to find science interesting or enjoyable (38% vs 32% of females) while female students were more likely to be motivated by future career or study plans (26% vs 19% of males).

By ethnic background:

- Asian students were more likely to be motivated by a range of factors including future career or study plans (33% vs 20% of white students), encouragement by family and friends (22% vs 11%), finding it relevant to real life (35% vs 25%) and getting good marks (26% vs 16%).
- In particular, female students from an Asian background were more likely than average to choose fitting in with career plans (38%), science being relevant to real life (37%) and getting good marks (28%) as incentives.

By science ability – using science quiz scores as a proxy measure:

- Students with a high quiz score were more likely to mention most factors including finding science interesting or enjoyable (57% vs 18% of those with low scores), enjoying practicals (50% vs 34%) and getting good marks (31% vs 8%).

By family science connections:

- Students with many family science connections were more likely to have been motivated by encouragement from family and friends (26% vs 5% with no connections), fitting in with future plans (36% vs 12%), finding science interesting (51% vs 22%) and getting good marks (29% vs 10%).
- There was a similar pattern of differences between students who had at least one parent who had been to university and those who did not have a parent who had been to university, reinforcing the importance of family influence on science motivation.

By level of disadvantage (defined by IDACI area deprivation):

- Students in the least deprived quintile were more likely to be motivated to learn science on account of finding it interesting or enjoyable (41% vs 33% in the most deprived quintile), having a good teacher (42% vs 32%) and thinking that it was important to do well in science (27% vs 19%).

5.3. What discourages young people from learning science?

Perceived difficulties and concerns about the volume of work were the most demotivating aspects of science lessons for students (Figure 5.2[19]), which reflects the findings reported in Chapter 4, where it is shown that sciences were more likely than other school subjects to be associated with lower self-perceptions of ability (section 4.4) and hard work (section 4.6).

So, while finding sciences easy was not an incentive for many young people to learn science, perceived difficulty (41%) was the most important barrier, with almost as many put off by having a lot to remember (35%). A low perceived academic performance was, however, much less of a barrier, with only 13% put off by getting poor marks.

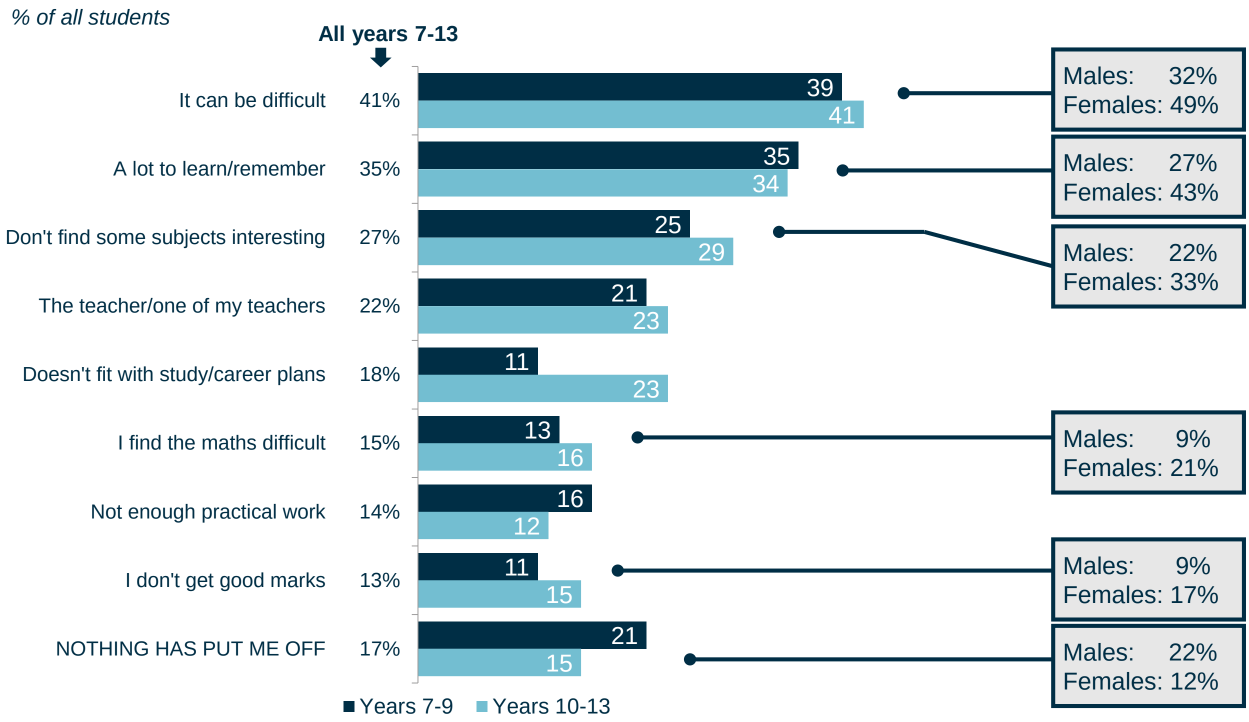
A lack of interest in some science subjects was off-putting for 27%, and 14% were discouraged from studying science because there was not enough practical work involved. Around two in ten (22%) said a teacher had put them off learning science.

A lack of relevance to future study or career plans was cited as a barrier for 18%, while 17% said there was nothing that had put them off learning sciences.

The list of barriers provided to respondents at this question changed considerably in 2019, which limits meaningful comparison with the findings from 2016. However, for those response options which remained the same, there appears to be little change over time.

[19] Respondents were presented with a list and could choose as many options as applied.

Figure 5.2: What has put off young people in years 7–13 from learning science by school stage and gender (2019)?



And what has put you off learning science? Choose all that apply (SciDis)
Bases: All year 7–13s 2019 (6,409): years 7–9 (2,314); years 10–13 (4,095); males (3,113); females (3,228)

The barriers to learning sciences at school varied considerably by subgroup, with differences largely providing a mirror of patterns shown in Figure 5.1. However, it is interesting to note that for disengagement factors there was less variability by year group (although year 10–13 students were more likely to be put off science as it doesn't fit with future plans) and many more differences by gender. In summary:

By gender (Figure 5.2):

- Males were more likely to say that nothing had put them off (22% vs 12% of females). On the other hand, female students were more likely to choose almost all barriers and were especially put off by factors related to difficulty and ability, including science being difficult, having a lot to learn, finding the maths difficult and not getting good marks. Females were also more likely to find some science subjects less interesting.
- Similar gender differences were seen within each school stage and within different ethnic backgrounds.

Science ability (using science quiz scores as a proxy measure):

- Students with high quiz scores were more likely to say nothing had discouraged them (24% vs 14% of those with low quiz scores).
- Students with high quiz scores were more likely to be put off by a teacher (26% vs 18% of those with low quiz scores). There was a similar differential on this measure between students with high and low family science connections (26% vs 19%) and between students from the least and most deprived IDACI quintiles (27% vs 18%). This could suggest that teacher-related issues have more of a negative influence on the more advantaged students.
- Students with low quiz scores were more likely than those with high quiz scores to be put off by not getting good marks (18% vs 8%).

5.4. Patterns of encouragement and discouragement by school years

Figure 4.5 in Chapter 4 shows that there is a clear pattern of decline in interest in school science by school year, with students most enthusiastic in year 7. Interest then declines through years 8 and 9 before regaining ground in years 10–11, but not to the same peak level as in year 7. In particular, there is a noticeable dip in interest between years 8 and 9, with year 9 representing the year group when students were least interested. It is suggested in section 4.3 that this might be related to the trend of students starting GCSE study in year 9 and a reduction in the volume of practical work.

To help investigate this further, it is useful to look at the pattern of encouragement and discouragement factors by school year, focusing on changes between year 7 and year 9. This demonstrates that being encouraged in science because of reasons to do with future pathways (fits with future career plans, important to do well in science) remains stable between year 7 and year 9.

However, the following encouragement factors were lower in year 9 compared with in year 7:

- Finding the subject interesting (31% in year 9 vs 42% in year 7)
- Having a good teacher (29% in year 9 vs 39% in year 7)
- Getting good marks (13% in year 9 vs 20% in year 7)
- Enjoying practical work (43% in year 9 vs 63% in year 7)

And the following discouragement factors were higher in year 9 compared with in year 7:

- A feeling that science can be difficult (44% in year 9 vs 35% in year 7)
- Concern about there being a lot to learn (41% in year 9 vs 32% in year 7)
- Issues related to a teacher (29% in year 9 vs 14% in year 7)

This suggests that the reason for the year 9 'dip' is not so much related to lack of aspirations – year 9 students were as likely as younger students to feel that it's important to do well and that it relates to future study/career choices. Year 9 students were instead more likely than younger students to be put off by a teacher, by their academic achievement and by the volume of work; they were less likely than younger students to be motivated by finding the subject interesting and having the opportunity to do practical work.

5.5. The impact of teachers

As noted in the previous section, teachers can have a strong influence on students' engagement with science, though teachers were more likely to be mentioned as a positive influence (34% of year 7–13s) than as a barrier to study (22% of year 7–13s). This section covers the impact of students reporting instability in science teaching and aspects relating to teacher characteristics).

Changes in teacher in the past school year (years 7–11)

Context of teacher movement (DfE and other data sources)

Teacher disruption can have a negative impact on the quality of teaching experienced by students. One concern is that students who experience more disruption are less likely to experience science taught by subject-specialist teachers, which has been found to be associated with effective science teaching (Kirby and Cullane, 2017; Royal Society of Chemistry, 2014). Wellcome research found that high teacher turnover can damage pupil attainment, particularly in subjects such as sciences where there is a shortage of teachers and it is harder to find a replacement; this can therefore result in lower recruitment standards, increased use of temporary teachers and increased class sizes (Allen and Simms, 2017).

In November 2018, based on all state secondary schools in England, there were around 40,600 science teachers, with most of these (c.32,800) teaching across all three sciences (DfE SWFC[20], 2018). These data indicate that the large majority of students in years 7–11 were taught by generalist teachers, while years 12 to 13 were taught more by single-subject science teachers.

SWFC data provided by Worth et al. (2018) indicate that in 2015 the rate of teachers leaving the profession was 11.8% and that 8.3% of teachers in state secondary schools moved to a different school. This suggests a total annual teacher churn rate in state secondary schools of around 20%.

Furthermore, Worth and Van den Brand (2019) highlight the particularly acute challenges in the recruitment and retention of teachers in shortage subjects, including physics, maths and chemistry, while Worth et al. (2018) found that maths and science teachers were most likely

[20] DfE School Workforce Census.

to move schools and had above average rates of leaving the profession.

Students may also experience temporary cover when a teacher is absent. According to 2018 SWFC data, around 1% of full-time posts in state-funded secondary schools were not permanently filled in 2018, and this was slightly higher for science posts (1.6%), which could result in temporary cover being required (DfE SWFC, 2018). Cover may also be experienced for longer-term absence through sickness or maternity leave. Worth and Van den Brand (2019) report that the number of in-year vacancies and temporarily filled posts doubled between 2010/2011 and 2017/2018.

A range of factors influence teacher retention, with working conditions among the most important (Allen and Simms, 2017). Recent research has concluded that low teacher wellbeing negatively affects teacher retention (Ofsted, 2019) and that over half of teachers had considered leaving their job in the last two years because of health and wellbeing issues (Education Support, 2019).

SET 2019 survey data on teacher changes

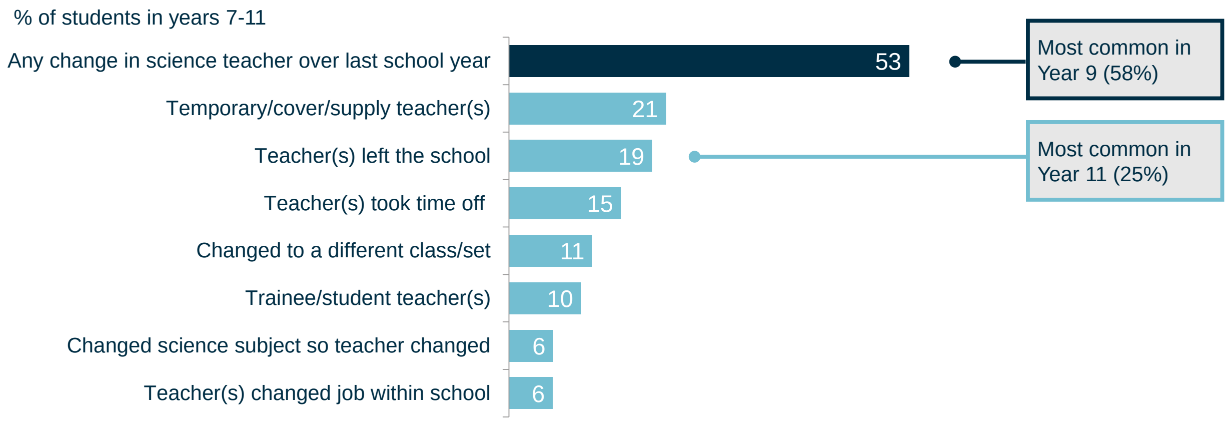
Given the context noted above, the SET 2019 survey included a new question to explore the potential level of disruption in science teaching experienced by students. Data collected at this question should be treated with some caution, as they rely on student perceptions of what constitutes 'a change in who taught you science'. For example, this could be interpreted by some to include short-term cover for illness, while other students might exclude this. Furthermore, teachers who do leave a school are most likely to do so at the end of an academic year, which would not result in an in-year teacher change. The results below should therefore be interpreted more generally as a measure of the disruption that students perceive rather than constituting an accurate reflection of patterns of teacher movement.

Around half (53%) of students in years 7–11 reported some change in who had taught them science in the past school year (Figure 5.3). It is worth noting that young people may have more than one science teacher (particularly in years 11 and 12, when sciences are usually taught separately) so they could have experienced a change in teacher for one science subject but consistency for other science subjects; this makes it difficult to directly compare student rates of change from the survey with official statistics.

Students who said that they had experienced a change in science teachers in the past school year were then asked why this was the case. Re-basing the survey data on all students in years 7–11, two in ten young people (21%) reported experiencing temporary cover, while 15% reported teachers taking time off (e.g. for maternity leave or illness), which could involve a longer absence and a need for cover.

Around two in ten young people (19%) reported that their teacher had left the school in the past school year and 6% said that the teacher had changed jobs within the school. Other reasons for changes included those linked to the student, such as changing class (11%).

Figure 5.3: Percentage of year 7–11 students who have experienced a change in science teacher in the last school year, and reasons for changes (2019)



Thinking about this past school year (September 2018 to July 2019), have there been any changes in who has taught you science? What are the main reasons there have been changes in who has taught you science this past school year? Choose all that apply (TeachSame/TeachWhy). (Note: TeachWhy was asked to those saying 'yes' at TeachSame but has been re-based on all respondents in this chart.)

Bases: All year 7–11s (4,451): year 9 (725); year 11 (1,093)

There were few differences in experience by different subgroup, and while teacher changes peaked in year 8 (55%) and year 9 (58%), they were reported by around half of all students in all other school years (49% to 52%). The rate of teachers leaving the school, as reported by students, increased by school year from 13% in year 7 to 25% in year 11.

There were some regional patterns of teacher changes. Young people in the North East were least likely (48%) to report a change in science teacher and those in the East of England were most likely to (58%). Young people in the North East were less likely than those elsewhere to report teachers leaving the school (12%), with higher proportions in London (23%), the East of England (22%) and the East Midlands (21%).

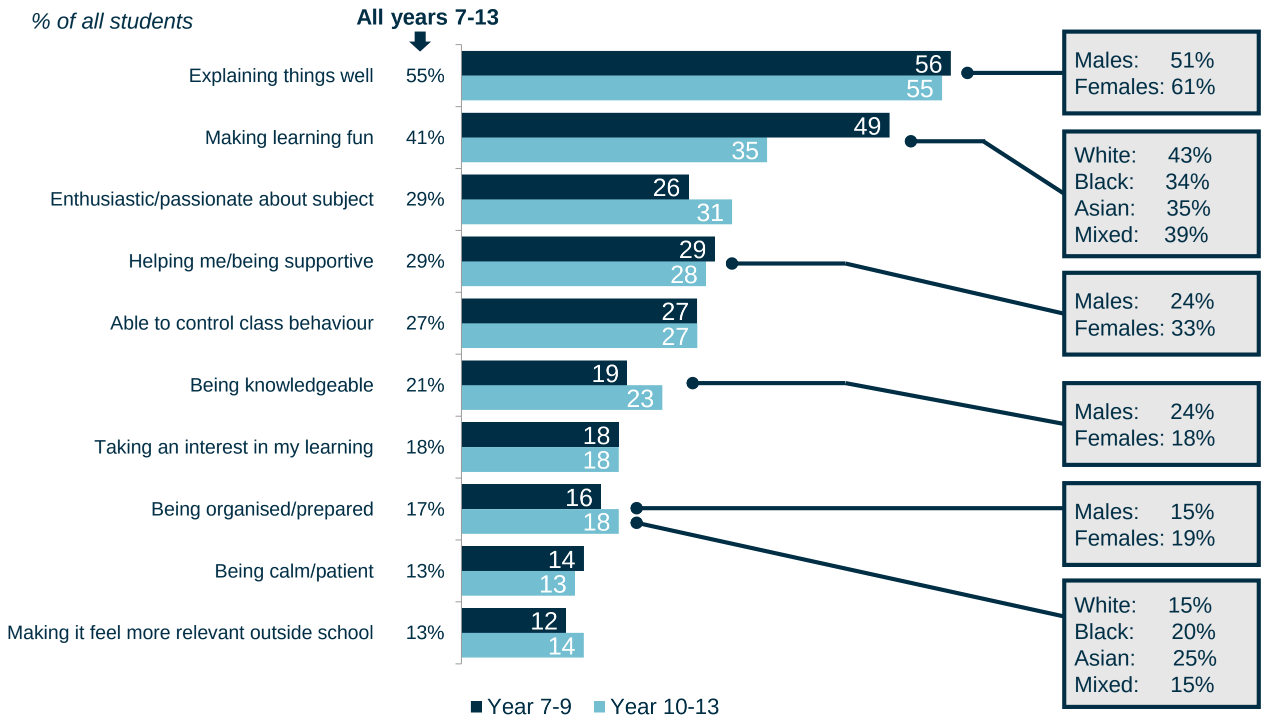
Characteristics of teachers that help students learn science

Students were asked to pick from a list the three most important characteristics of science teachers that helped them learn (Figure 5.4). The characteristic selected most often was the ability to explain things well (55%). The teacher's attitude was also important, with 41% thinking it important to make learning fun and 29% thinking that the teacher should be enthusiastic or passionate about the subject. It was relatively less important for the teacher to be knowledgeable (21%).

The way the teacher interacts with the individual student was also a factor, with 29% thinking it important that the teacher helps or supports them, 18% that they take an interest in their learning, and 13% that the teacher is calm and patient.

Just as important as enthusiasm and being supportive, 27% said that the ability to control the class was one of the three most important things that science teachers could do to help them learn.

Figure 5.4: The three most important things about science teachers that help students in years 7–13 learn by school stage, gender and ethnicity (2019)



Thinking just about science lessons, what are the three most important things about science teachers that help you learn? You can select up to three answers (TeachImp)

Bases: All year 7–13s 2019, half sample A (3,150): males (1,548); females (1,570); years 7–9 (1,153); years 10–13 (1,997); white (2,341); Black (195); Asian (383); mixed (140)

While explaining things well was the most important factor across the board, there was considerable variation in what else was considered important by subgroup.

Students in years 7–9 were especially likely to prioritise teachers making learning fun (49% in years 7–9 vs 35% in years 10–13), while those in later years were more likely to prioritise teacher enthusiasm (31% in years 10–13 vs 26% in years 7–9). The much higher proportion of younger students valuing making learning fun is likely to be linked to greater propensity for these year groups to be motivated in science by enjoying practical work (section 5.2).

Specific teacher characteristics were also chosen more often by other subgroups. In summary, teacher support was most valued by female students and those with lower ability (using the science quiz score as a proxy), while more able students (using quiz score) and those from more affluent backgrounds were more likely to cite teacher enthusiasm as a key requirement.

By gender (Figure 5.4):

- Female students were more likely to value the ability of the teacher to explain things well, to be supportive and to be organised. On the other hand, male students were more likely to value a knowledgeable teacher.

By ethnic background (Figure 5.4)

- White students were more likely to value making learning fun (43% vs 34% of Black and 35% of Asian students), while Asian students were more likely to prioritise teacher organisation (25% vs 15% white).

By science ability (using science quiz scores as a proxy measure):

- Students with a high quiz score were most likely to value a teacher being able to explain things well (62% vs 48% with a low score), being enthusiastic (37% vs 21%) and being knowledgeable (27% vs 16%).
- On the other hand, students with a low science quiz score were more motivated by a teacher who can help and support them (31% vs 20% with a high score).

Level of disadvantage (based on IDACI area deprivation and eligibility for free school meals):

- Students in the most deprived quintiles were less likely to value enthusiasm and passion (24% vs 34% in least deprived quintile), as were those eligible for free school meals (24% vs 32% not eligible).

6. Factors affecting motivation to learn computer science at school

This chapter explores motivations for and barriers to learning computer science at school and the level of uptake at GCSE. Differences by gender and other demographics are explored, and patterns of variation by demographics and other characteristics are compared for computer science vs science.

Key findings

Interest in learning computer science fell sharply between year 7 and year 8 and there was a widening gender gap in the early years of secondary school. White females were least interested in computing.

- Three-quarters (75%) of year 7 students found computer science interesting (86% of year 7 males vs 65% of year 7 females). Interest in computer science fell steeply between year 7 and year 8, and by year 9 had fallen most sharply for female students, resulting in a large year 9 gender divide in level of interest (65% males vs 32% females).
- Further analysis points to underlying reasons behind this sharp fall in interest between year 7 and year 9. By school year, students increasingly find the subject less creative, less interesting, more difficult and cite increasingly lower levels of perceived ability in the subject.
- Regression modelling confirms that even after adjusting for a range of other factors, females and young people from a white ethnic background were much less likely to say they were interested in computer science than males and young people from an Asian background. The gender and ethnicity gaps were larger for interest in computer science than interest in science in general.

Computer science was less popular than science but, relative to science, there was less variation in levels of interest by science ability and family science connections.

- 37% of year 7–13 students said that nothing had encouraged them to learn computer science, which is much higher than the proportion who said this about science (16%). Half (50%) of year 7–13s found computer science interesting compared with 72% who said this about science.
- Unlike science, for computer science there was no gap in level of interest between high and low science knowledge quiz scorers, while students with a special educational need (SEN) were more likely than those without to show an interest in computer science. In addition, the interest gap between those with many and those with no family science connections was much smaller for computer science compared with science. Furthermore, while 41% of year 7–13 students were put off science because ‘it can be difficult’, only 27% said this about computer science, suggesting that computer science is seen as more accessible than science.

Motivations to study computer science included creativity, interest and relevance to real life, while barriers focused on lack of interest, difficulty, repetition and a lack of fit with future aspirations.

- Around 20–25% of students in years 7–13 mentioned each of these motivating factors, while around 20–30% mentioned each of these barriers. Males were more likely than females to find computer science creative (30% vs 23%) and interesting (33% vs 17%) and were much less likely to cite each of these barriers.

Two in ten students (20%) in years 10–13 reported taking GCSE computer science at GCSE.

- In line with national statistics (DfE, 2018a), this was much higher among male (30%) than female (10%) students. Uptake was also higher among Asian students compared with white students.

6.1. Context

Change over time in relation to computer science is to be expected, given the changes made to the curriculum in September 2014, when the computer science GCSE was introduced to gradually replace the ICT GCSE, which focused on the use of technology and software rather than its creation. The new curriculum established computer science and computational thinking as a core subject alongside English, mathematics and the sciences for all children and young people in England from the age of 5.

The Roehampton 2018 annual computing education report (Kemp and Berry, 2019) states that in 2018, 61% of schools offered GCSE computer science, 79% of year 11 students were in schools offering this GCSE and that access been steadily increasing year on year. The Royal Society (2017) also reported differential access to computer science by school size: 52% of schools with at least 200 pupils offered computer science at GCSE, but this dropped to 11% of schools with 12–89 pupils. Kemp et al. (2018) also found that urban schools were more likely to offer computer science at GCSE than those with a rural catchment area, though this disparity may be at least partly explained by school size.

DfE data show that uptake of computer science at GCSE began to stabilise in 2017/2018 at 12% following an initially sharp growth in uptake after the changes to the curriculum in 2014, but it remained well below the peak levels previously seen for ICT (DfE, 2018a). Provisional GCSE results for 2018/2019 suggest that there has been little further increase in the uptake of computer science, while the ICT GCSE has now been almost phased out, reducing the total number of pupils taking GCSEs in this field (JCQ, 2019a). Since in 2018 only 20% of GCSE computer science students were female, while for ICT 37% were female, this change is likely to exacerbate the gender gap in this field (further details of uptake are given in section 6.10).

In terms of uptake of GCSE computer science, Kemp et al. (2018) report that, with increased availability, in 2017 computer science GCSE had become more inclusive in terms of socioeconomic status, better than for chemistry and physics, but that it still compared unfavourably with many other subjects. By ethnicity, it was most popular among students from a Chinese and Asian background, with Black students under-represented. Students with a special education need (SEN) were less likely to take computer science at GCSE than they had been to take ICT. Computer science students at GCSE level were often academically strong.

The Royal Society (2017) reports that in 2017, pupils aged from 5 to 14 typically had one hour per week of computing lessons, with some schools teaching computing within other subjects. However, it found that a majority of teachers were teaching an unfamiliar school subject without adequate support and that they may be the only teacher in their school with this task. It also reports a shortage of computer science teachers, with only 68% of the recruitment target met in England between 2012 and 2017.

In line with computer science GCSE students having a higher level of achievement, the Royal Society (2017) research found evidence that computer science GCSE was increasingly regarded by teachers and pupils as a 'difficult option', one that is only really suitable for the most able pupils and, in particular, pupils who are high achievers in mathematics; this has the potential consequence of making the subject appealing to a narrower set of pupils. This could explain, at least in part, the lack of wider uptake of this subject at GCSE. In 2018, the government set up a National Centre for Computing Education (NCCE) to provide training to help improve the teaching of computing and drive participation in computer science.

Against this contextual background, this chapter considers the range of barriers to and enablers for studying computer science, levels of interest and perceived ability, and the types of student most likely to be engaged by computer science in the early years of secondary school through to GCSE.

6.2. Access to computer science

While all young people should, by 2019, have had the opportunity to study computer science at school, this is a relatively recent addition to GCSE options, and in SET 2019, 11% of year 7–13s said that they had never studied it. Reflecting the change to the curriculum over time, this was lowest at 4% of year 7–9 students (2% in year 7); this figure was higher, at 13%, in year 10 and 17% in years 12 and 13. While changes to the questionnaire make direct comparison difficult, there is an indication that access to computer science increased between the 2016 and 2019 surveys. In SET 2016, 30% of students said that they did not take computer science at GCSE because their school did not offer it[21], while in SET 2019, 17% of year 10–13s said they had never studied it.

In SET 2019, having no access to computer science at school was reported more by female students than male students in years 10–11 (20% vs 14%) and years 12 to 13 (22% vs 12%) but there was no gender difference in years 7–9. The government's commitment

[21] This was asked as part of a question addressed to the 82% of year 10–13s who did not take computer science at GCSE about their reasons for not taking it. It was selected by 36% of these students.

to providing students with access to computer science in all schools should remove any gaps in access in future, and the SET 2019 findings suggest that this has largely been achieved for students in the youngest year groups (years 7–9).

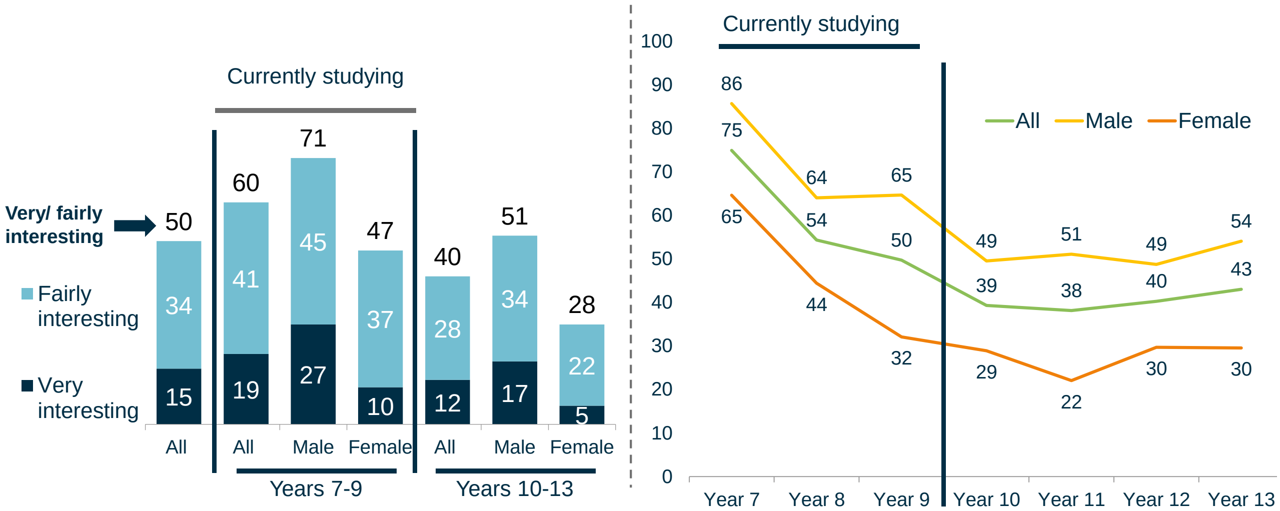
6.3. Interest in computer science

Among those young people who had ever studied computer science at school, 50% said they found it at least fairly interesting, and just 15% said it was very interesting (Figure 6.1). It is important to note that computer science is compulsory in years 7–9 and optional thereafter, so while year 7–9 students were reflecting on current or very recent experience of studying the subject, most students in years 10–13 were reflecting back to when they studied it in years 7–9.

Figure 6.1: Interest in computer science among students in years 7–13 by gender, school stage and year group (2019)

% of year 7–13s who have ever studied computer science who find/found it …

% of year 7–13s who have ever studied computer science who find/found it very or fairly interesting



How interesting do you find Computing/Computer Science lessons at school? If you no longer study this, think back to when you were studying it (CSInt)

Bases: Year 7–13s who have ever studied computer science 2019, half sample A: All/years 7–9/years 10–13 (2,784/1,108/1,676); all/male/female by year: year 7 (364/188/172); year 8 (388/194/191); year 9 (356/184/170); year 10 (444/209/233); year 11 (424/220/199); year 12 (414/210/196); year 13 (394/197/191)

Figure 6.1 also illustrates changes in level of interest by school year and shows a very clear gender divide both within years 7–9, when the subject is still compulsory, and later in years 10–13.

The level of interest was highest in year 7, particularly for male students, but the majority of female students in this year also found it at least fairly interesting. The overall level of interest then fell steeply between year 7 and year 8, and by year 9 interest had fallen most sharply for female students, producing a very large year 9 gender divide (65% males vs 32% females finding it at least fairly interesting).

In years 10–13, when most students were reflecting back on experience in previous years, around half of male students and three in ten female students reported finding it interesting (49% vs 29% in year 10, with a similar gender gap maintained in later years). There were also differences in the level of interest by other demographic subgroups, with the following groups more likely to find computer science either ‘very’ or ‘fairly’ interesting:

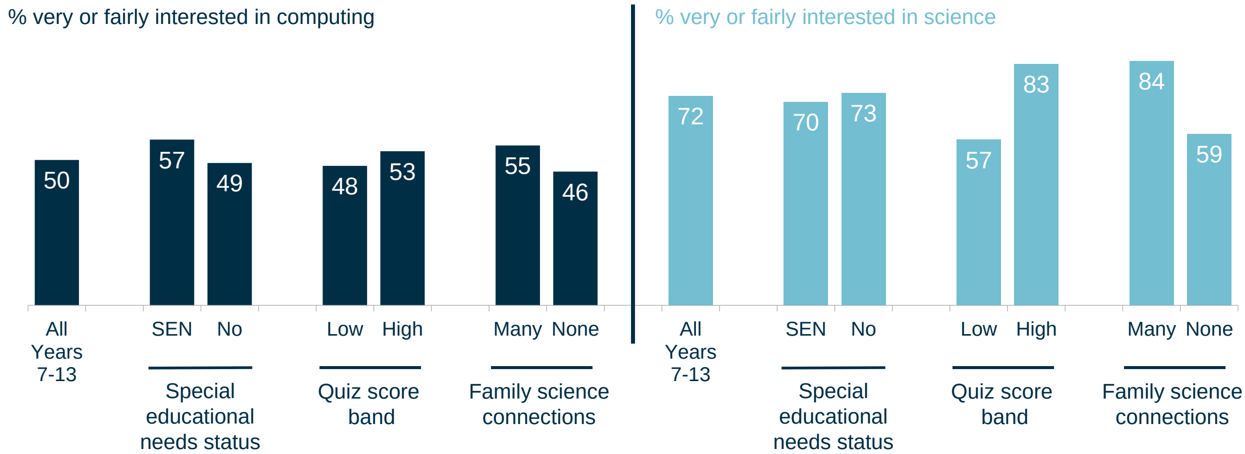
- Students from an Asian background (62% vs 47% of white students)
- Asian male students (75%), while white female students were least likely to be interested (35%)
- Students living in the most deprived IDACI quintile (55% vs 46% in the least deprived quintile)

Among those in years 10–13 who had taken or were taking computer science at GCSE, 65% said they found it interesting (29% very interesting and 35% fairly interesting): the overall level of interest was higher among male GCSE computer science students (69%) than female GCSE computer science students (51%).

6.4. Interest in computer science vs interest in science

There was a different pattern of engagement for students studying computer science compared with those studying science (Figure 6.2). For science, year 7–13 students with high science knowledge quiz scores were much more interested in science than those with lower scores, and there was no difference by special education needs (SEN) status[22]. However, for computer science there is evidence that the pattern by ability and knowledge is different. In fact, students with a special educational need were *more* likely than those without to show an interest in computer science, and there was little difference by science knowledge quiz scores[23]. Additionally, while the gap between those with high and low science connections was very wide for science, this gap was smaller for computer science. This suggests that computer science is, relative to science, seen as a more accessible subject and is less affected by parental connections. However, although there is less variation in level of interest in computer science across many demographic categories, it should be noted that interest levels in computer science are still much lower than those for science.

Figure 6.2: Interest in science and computer science among young people in years 7–13 by knowledge and ability measure (2019)



How interesting do you find Computing/Computer Science lessons at school? If you no longer study this, think back to when you were studying it. (CSInt) How interesting do you find Science lessons at school? If you no longer study this, think back to when you were studying it (SciInt)

Bases: Year 7–13s who have ever studied computer science 2019, half sample A: All (2,784); SEN (285); no SEN (2,187); quiz high (650), low (668); FSCI many (601), none (690). Bases: Year 7–13s who have ever studied science 2019: All (6,409); SEN (676); no SEN (5,046); quiz high (1,416), low (1,537); FSCI many (1,307), none (1,705)

[22] SEN status was included within NPD data and was linked to the dataset for those who consented to data linkage.

[23] Acknowledging that the quiz was designed to approximate science ability rather than computing ability.

6.5. Multivariate analysis: Interest in computer science

We used logistic regression to investigate the factors that influence a young person's reported interest in computer science[24]. Further details of this analysis can be found in the SET 2019 Technical Report.

When looking at the characteristics of young people and their schools, the strongest predictors of interest in computer science were **gender**, **ethnicity** and **year group**. We found the following, even after adjusting for factors such as deprivation, family science connections and quiz score (as a proxy for general science ability):

- Males were much more likely than females to say they were interested in computer science.
- Young people from Asian backgrounds were more likely than pupils from white or other backgrounds to say they were interested in computer science.
- Young people in year 7 were more likely to say they were interested in computer science than any other year group.

Neither deprivation nor school-level characteristics appeared to be strongly associated with interest in computer science. Family science connections also generally did not appear to be strongly associated with interest in computer science. The exception was that young people who said they had a **parent who is interested in science** were somewhat more likely to say they were interested in computer science.

Comparison with interest in science

As noted above (section 6.4), the bivariate analysis noted a different pattern of engagement for students studying computer science compared with those studying science. We used the same set of characteristics of young people and their schools to model interest in science in general[25]. The two models were broadly similar, but we note some differences:

- While gender, ethnicity and school year were each significantly associated with interest in science, the differences were much more pronounced for interest in computer science.
- Quiz scores had a very strong association with interest in science (young people with a high quiz score were much more likely to say they were interested in science), whereas the association with reported interest in computer science was relatively weak. This is not surprising as the quiz was designed to approximate science ability rather than computing ability.
- Similarly, parental interest in science was more closely associated with a young person's interest in science than with their interest in computer science.

See Table 6.3 and Figure 6.4.

Table 6.3: Examples of young people with high/low predicted probabilities of interest in computer science*

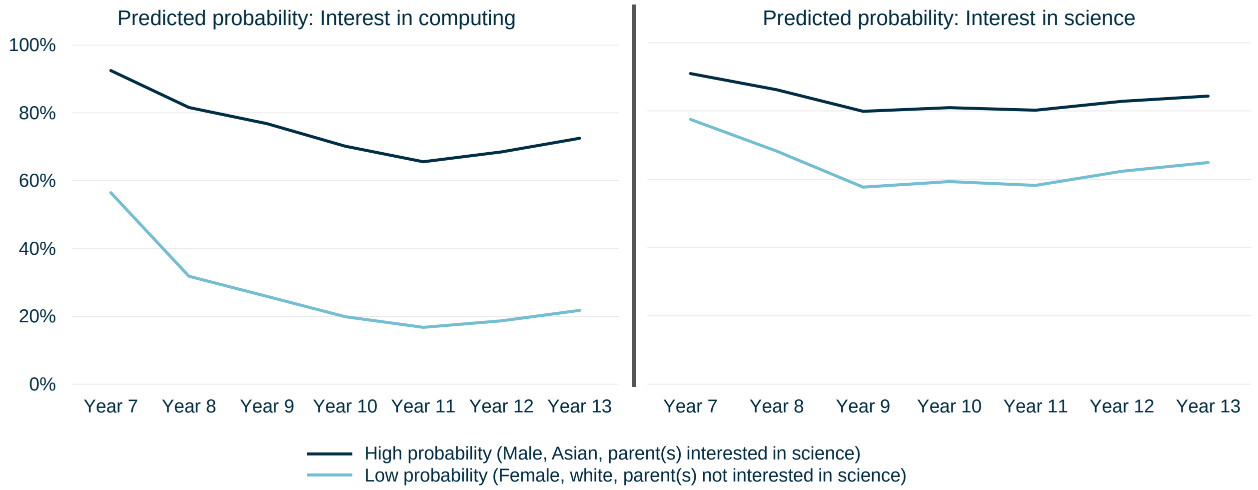
	High predicted probability of interest in computing	Low predicted probability of interest in computing
Sex	Male	Female
Ethnicity	Asian	White
Parent(s) interested in science	Yes	No
Predicted probability of interest in *computer science*	70%	20%
Predicted probability of interest in *science*	81%	59%

**Comparison of two young people with the same characteristics apart from gender, ethnicity and parental interest in science. For the purpose of this comparison, both examples correspond to a young person: in Year 10, with a 'medium' quiz score, not eligible for free school meals, living in the north of England in an area in the middle quintile of area-level deprivation (IDACI), attending a school with average academic performance (Progress8) and an average proportion of pupils eligible for free school meals.*

[24] How interesting do you find Computing/Computer Science lessons at school? If you no longer study this, think back to when you were studying it (CSInt).

[25] How interesting do you find science lessons at school? By Science, we mean Biology, Chemistry and Physics (SciInt).

Figure 6.4: Predicted probabilities of interest in computer science by year group*



**Comparison of young people with the same characteristics apart from gender, ethnicity, parental interest in science and school year. For the purpose of the comparison, both examples correspond to a young person: with a 'medium' quiz score, not eligible for free school meals, living in the north of England in an area in the middle quintile of area-level deprivation (IDACI), attending a school with average academic performance (Progress8) and an average proportion of pupils eligible for free school meals.*

Factors encouraging/discouraging young people in learning computer science

We then incorporated into the model young people's answers about the factors which have encouraged them to or discouraged them from learning computer science.

Young people who reported enjoying the maths involved in studying computer science were far more likely to also say they were interested in computer science. The strength of the association was of a similar magnitude to the gender gap for interest in computer science. In fact, a positive attitude regarding the maths involved in studying computer science was particularly important for females: a large gender gap in interest was observed for young people who said they found the maths difficult or who had a neutral impression. On the other hand, among young people who said they enjoyed the maths, the proportions of males and females saying they were interested in computer science were very similar.

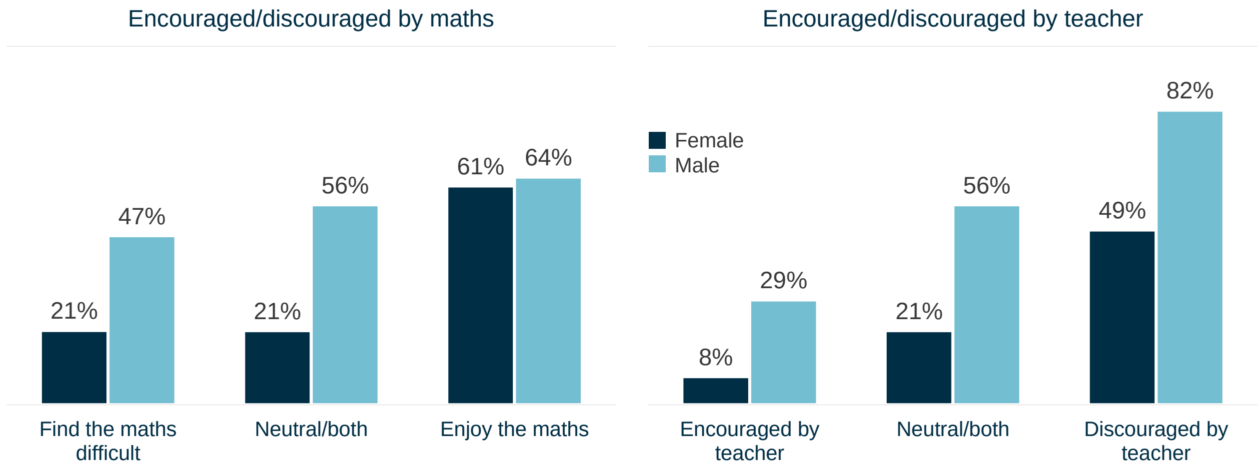
A pupil's opinion about their teacher was also found to have a substantial effect on interest in computer science. Young people who said they had been encouraged by a good teacher were much more likely to say they were interested in computer science, and young people who said they had been discouraged by a teacher were much less likely to say they were interested in computer science.

Several other attitudes were also positively associated with interest in computer science:

- Young people who said they were encouraged to learn computer science because they considered it important to do well in the subject.
- Young people who said they were encouraged because they found computer science easier than other subjects.
- Young people who said they were encouraged because they got good marks in the subject.
- Young people who said they had been encouraged by their family or friends.

In each case, young people who said they had been encouraged to learn computer science in this way were also more likely to say they were interested in computer science (Figure 6.5).

Figure 6.5: Predicted probabilities of interest in computer science*



**Comparison of young people with the same characteristics apart from gender and whether they reported being encouraged to/discouraged from learning computing by (i) the maths involved in the subject or (ii) a teacher. For maths, the 'neutral/both' category corresponds to (i) respondents who did not report being encouraged to learn computing because they enjoyed the maths or being discouraged because they found the maths difficult, and to (ii) a small number of respondents who reported being both encouraged and discouraged by the maths. Similarly, we used an equivalent categorisation for respondents who reported being encouraged and/or discouraged by a teacher.*

6.6. Perceived ability in computer science

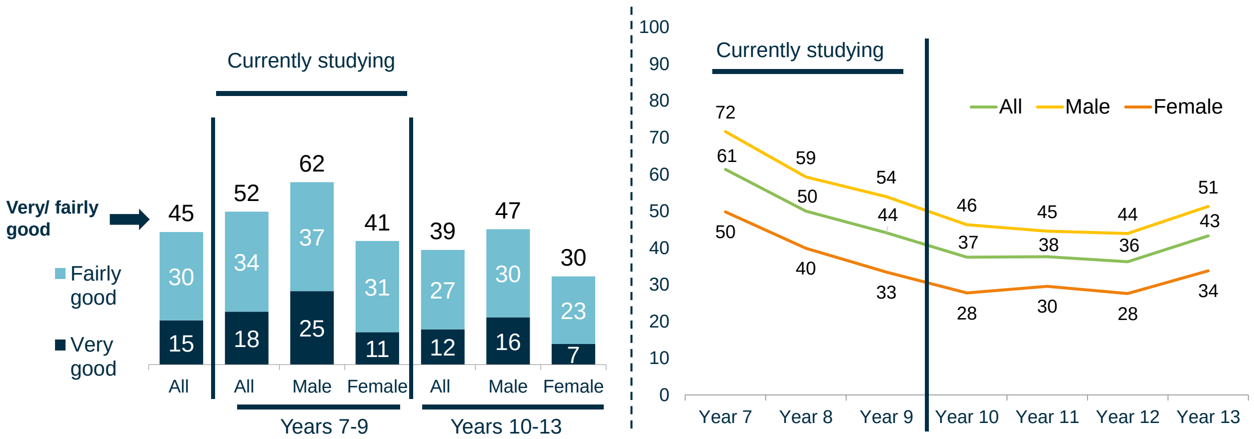
Perceived ability in computer science was at a similar level to interest and showed similar patterns of difference by gender and year group (Figure 6.6).

In total, 45% of those who had studied computer science thought they were at least fairly good at it, although just 15% thought they were very good at it.

Figure 6.6: Perceived ability in computer science among year 7–13s by gender, school stage and year group (2019)

% of year 7–13s who have ever studied computer science who think they are/were very or fairly good at it

% of year 7–13s who have ever studied computer science who think they are/were very or fairly good at it



And how good would you say you are/were at Computer Science/Computing? (GoodComp)

Bases: Year 7–13s who have ever studied computer science 2019: All/years 7–9/years 10–13 (5,619/2,226/3,393), All/male/female by year: year 7 (757/403/348); year 8 (792/396/387); year 9 (677/333/338); year 10 (911/434/471); year 11 (867/440/418); year 12 (837/417/407); year 13 (778/392/375)

Perceived ability in computer science followed a similar pattern to interest by school year and gender:

- Perceived ability was highest for male students in year 7, then dropped quite steeply between year 7 and year 10. Female students had lower levels of perceived ability than male students, and level of perceived ability followed a similar trajectory to that of male students, with the gender gap maintained throughout.
- In years 10–13, when most students were reflecting back on experience in previous years, the level of perceived ability largely stabilised.

Among those in years 10–13 who had taken or were taking computer science at GCSE, 63% thought they were at least fairly good at it (28% very good): 65% of male GCSE computer science students and 57% of female GCSE computer science students felt they were at least fairly good.

The findings by school year could be interpreted in two ways. It is possible that students become less interested in computer science and less confident in their own ability as they move through the school years. However, it is also possible that the introduction of compulsory computer science lessons at primary school in 2014 has meant that younger cohorts come into secondary school with more understanding, skills and confidence in computing and this might be creating the differences by school year (in other words, it is possible that this is a cohort effect rather than a school progression effect). More general access to and familiarity with digital media in the wider world may also be helping to boost confidence among younger cohorts.

Unlike interest in computer science, there was little difference by ethnic background in perceived computing ability, while students with an SEN were no less likely than those without to feel they were at least fairly good at computer science.

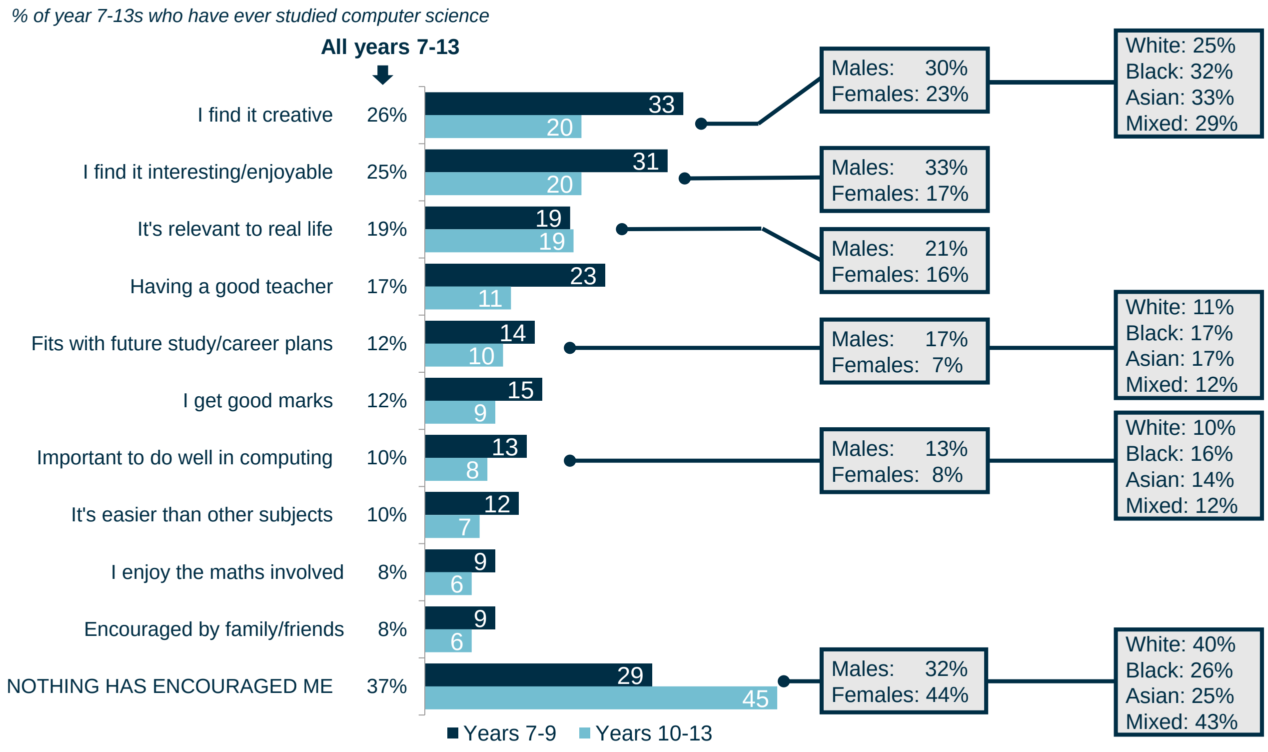
6.7. What encourages young people to learn computer science

The factors that have encouraged young people to learn computer science were ranked in a very similar order to those seen in Chapter 5 for science subjects, which suggests similar motivations across the two subjects (Figure 6.7). However, most of the response options were chosen by a lower proportion of students in relation to computer science than science. Overall, 37% of those who had ever studied computer science said that nothing had encouraged them, which is considerably higher than the equivalent proportion for science (16% – see Chapter 5).

Creativity (26%) and enjoyment or interest (25%) were the most common motivations for studying computer science. Relevance to real life (19%) was the motivation selected next most often, and 17% of students said that they were encouraged to learn computer science because they had a good teacher. Around one in ten were encouraged by it being a good fit with their study or career plans (12%), or because it was important to do well in computer science (10%).

Figure 6.7 also illustrates strong differentials by gender, school stage and ethnic background. The findings for younger students in years 7–9 are based on students who had been studying computer science in the past academic year, and these students were far more likely than older students (most of whom were reflecting on previous years of study) to mention a range of factors that encouraged them to learn computer science. Conversely, they were much less likely than older students to say that nothing had encouraged them (29% of year 7–9s vs 45% of year 10–13s).

Figure 6.7: What has encouraged young people in years 7–13 to learn computer science by school stage, gender and ethnicity (2019)



What has encouraged you to learn Computing/Computer Science? Choose all that apply (CompEnc)

Bases: Year 7–13s who have ever studied computer science 2019, half sample A (2,784): years 7–9 (1,108); years 10–13 (1,676); males (1,402); females (1,352); white (2,100); Black (159); Asian (327); mixed (119)

As indicated in Figure 6.7, specific incentives to study computer science varied by gender and ethnicity, as well as a range of other subgroups. This indicates that males and students from BAME groups were especially likely to be motivated in computer science, which reflects similar patterns noted for science.

By gender (Figure 6.7):

- Female students were much more likely to say that nothing had encouraged them (44% vs 32% of male students).
- Male students, on the other hand, were more likely to have been encouraged by a range of factors, including finding it creative, interesting or enjoyable, relevant to real life, fitting with future plans and finding it important.

By ethnic background (Figure 6.7):

- Black and Asian students were less likely than white students to say nothing had encouraged them and were instead more likely to have been motivated by the creativity of the subject and because it fits with future aspirations.

By science ability (using science quiz scores as a proxy measure):

- Those with a high quiz score were more motivated than those with a low quiz score by finding the subject interesting (31% vs 19%) and it being relevant to real life (25% vs 12%).

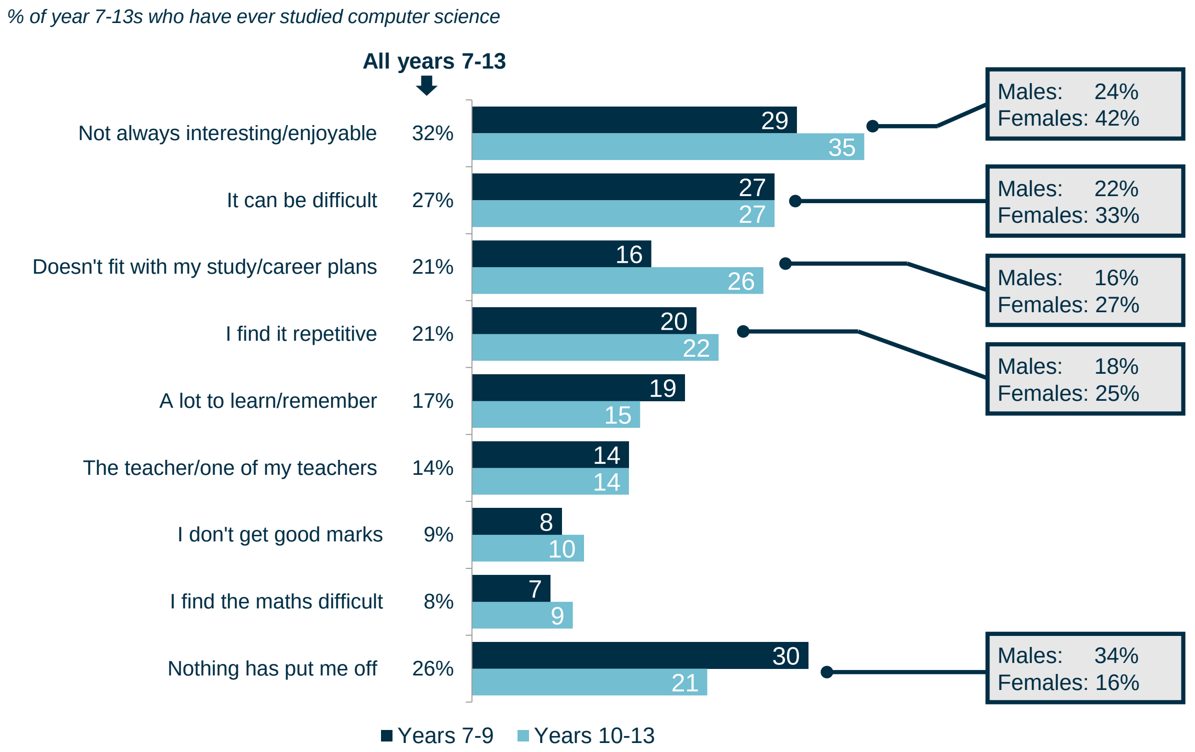
In years 10–13, only a minority continued studying computer science after year 9. Focusing, therefore, only on students in years 10–13 who had taken GCSE computer science, a much lower proportion said nothing had encouraged them (19%) than among all year 10–13s (45%). Within this cohort of students, there were, however, still some gender divides. Female GCSE computer science students were more likely to say that nothing had encouraged them (26% vs 17% of males), while male GCSE computer science students were generally more likely than females to choose each incentive, most notably finding it interesting or enjoyable (46% vs 31%) and it fitting with future career plans (31% vs 10%).

6.8. What discourages young people from learning computer science

The main barriers to learning computer science among students in years 7–13 who had ever studied it were lack of interest or enjoyment (32%), perceived difficulty (27%), not fitting with future career plans (21%) and finding it repetitive (21%) (Figure 6.8). The impact of a teacher or teachers was a disincentive for 14%.

The findings for students in years 7–9 are based on students who had been studying computer science in the past academic year, and these students were less likely than older students (most of whom were reflecting on previous years of study) to find computer science off-putting as a result of lack of interest and because it didn't fit with future plans. Those in years 7–9 were also less likely to say that nothing had put them off.

Figure 6.8: What has put off young people in years 7–13 from learning computer science by gender (2019)



And what has put you off learning Computer Science? Choose all that apply (CompDis)

Bases: Year 7–13s who have ever studied computer science 2019, half sample A (2,784): years 7–9 (1,108); years 10–13 (1,676); males (1,402); females (1,352)

Barriers to learning computer science varied by demographic subgroup as follows:

By gender (Figure 6.8):

- Female students were more likely than male students to be put off computer science as a result of lack of interest, difficulty of the subject, not fitting with study/career plans and finding it repetitive. They were also less likely to say that nothing had put them off.

By ability (using SEN and science quiz scores as proxy measures):

(These differences are interesting in the context of the Royal Society (2017) finding that computer science is often regarded as a subject for the more able (particularly mathematically able), given that there seem to be greater barriers for students with greater science knowledge.)

- Students with a high science quiz score were more likely than those with a low quiz score to find computer science off-putting due to a range of factors, including aspects relating to a teacher (20% vs 9%), a lack of fit with career plans (26% vs 16%),

a lack of interest (40% vs 25%) and finding it repetitive (26% vs 15%).
- Students with a special educational need (SEN) were less likely to say they were put off as a result of finding it uninteresting (20% vs 35% without an SEN).

Students in years 10–13 who had continued with computer science at GCSE were slightly more likely than all year 10–13s to say nothing had put them off (29% vs 21% of all year 10–13s), and the percentage saying this was higher for male GCSE computer science students than female ones (32% vs 16%). The gender differentials within this group were similar to those noted in Figure 6.7.

6.9. Patterns of encouragement and discouragement by school years

Figure 6.1 shows that there was a steep decline in overall level of interest in computer science from 75% in year 7 to 50% in year 9 and that this fall was much steeper for females (from 65% to 32%) than for males (from 86% to 65%). In an attempt to uncover the underlying reasons for this, figures 6.9 and 6.10 show how encouragement and discouragement factors vary by school year between years 7 and 9.

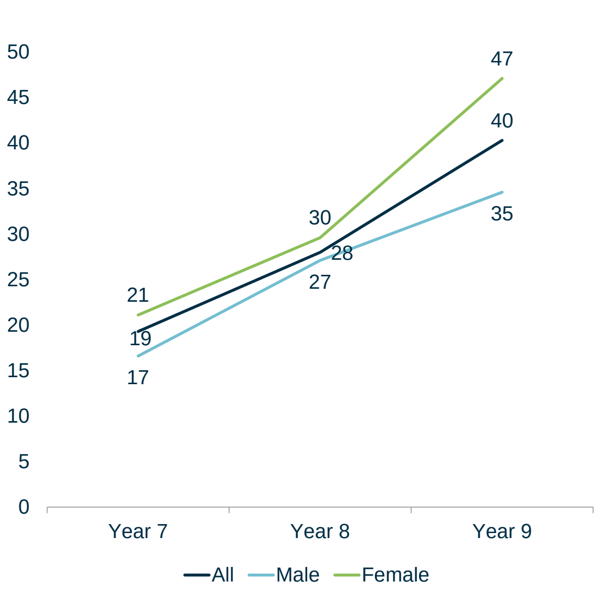
These figures show that:

- The proportion who felt that nothing had encouraged them rose steeply between year 7 and year 9, and the gender gap widened such that females were more likely than males to say this in year 9. Conversely, the proportion who said that nothing had discouraged them decreased between year 7 and year 8, although this flattened off between year 8 and year 9.
- The proportion who thought that the subject is creative dropped off quite considerably between year 7 and year 9. The gender gap on this measure was widest in year 7, though this had narrowed by year 9.
- The proportion who found the subject interesting also fell between years 7 and 9, which was mirrored by a rise between years 7 and 8 in the percentage who said that lack of interest was a barrier. On this measure, females and males follow parallel pathways.
- Between year 7 and year 9, there was a rise in the proportion who felt that the subject is difficult; this rise was much steeper for females than males, resulting in a widened gender gap at year 9.
- Between years 7 and 8, there was a rise in the proportion of males who were encouraged by feeling the subject fits with future pathways, but there was also a rise in the proportion saying they were discouraged because the subject *doesn't* fit with future pathways. This suggests that options start to polarise more in year 8, with male students being more open about developing this as a skill in year 7, but by year 8 they are beginning to decide whether this is or isn't for them in the longer term. There was a similar pattern of increase year on year for female students in relation to not fitting in with future pathways.

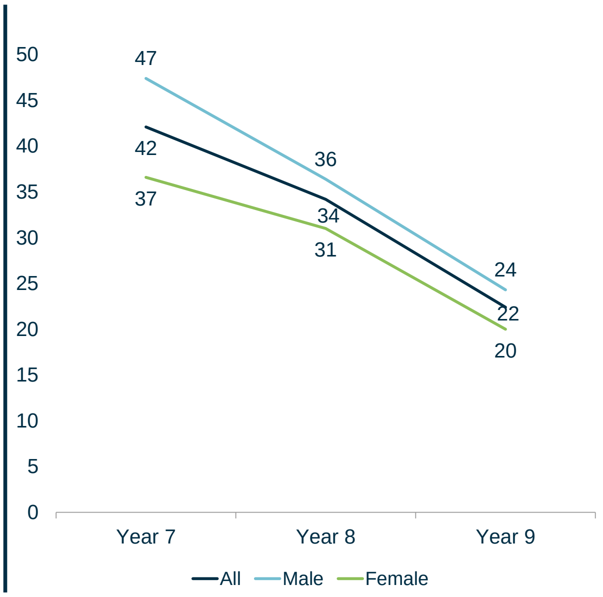
As discussed in section 6.6, it is not possible to say whether the differences by school year represent a cohort effect (with younger students more engaged due to greater familiarity) or a school progression effect, with interest in computer science declining with age or as the school curriculum changes.

Figure 6.9: What has encouraged young people in years 7–9 to learn computer science by gender and school year (2019)

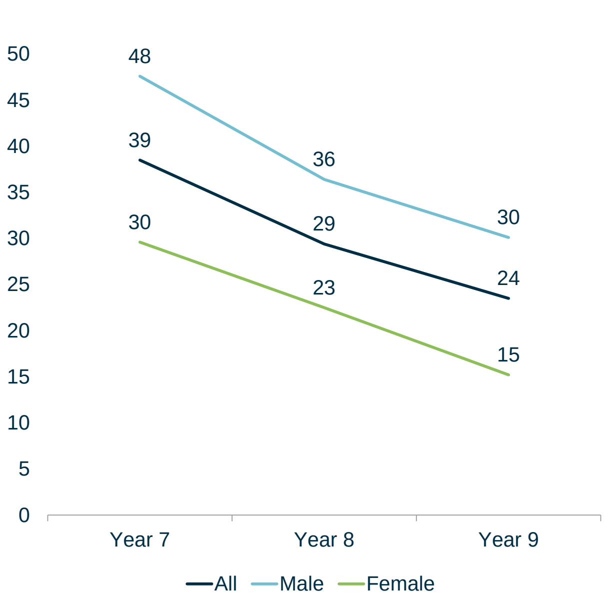
% of year 7–9s who have ever studied computer science saying nothing has encouraged them to learn it



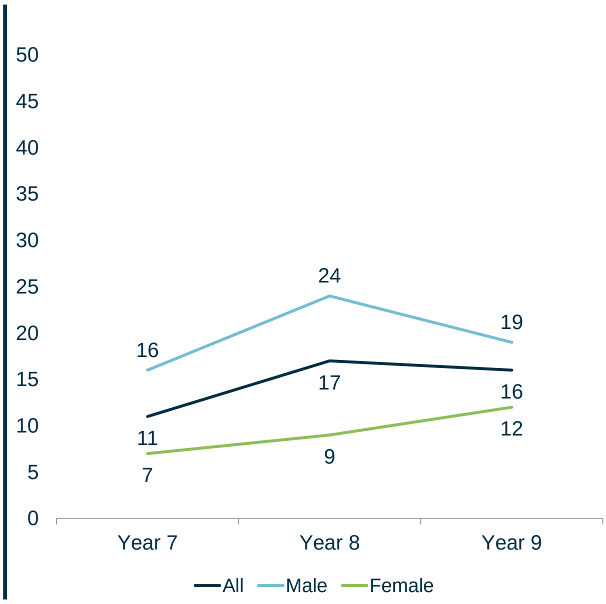
% of year 7–9s who have ever studied computer science saying they were encouraged by creativity



% of year 7–9s who have ever studied computer science saying they were encouraged by interest/enjoyment



% of year 7–9s who have ever studied computer science saying they were encouraged because it fits with future pathways

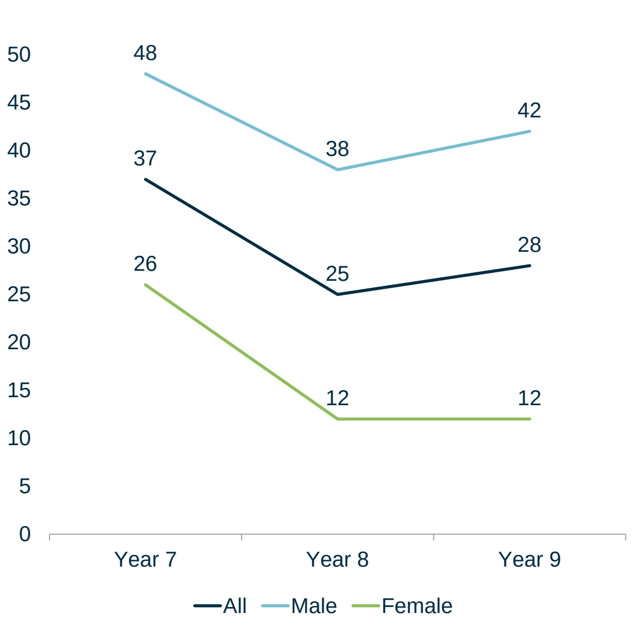


What has encouraged you to learn Computing/Computer Science? Choose all that apply (CompEnc)

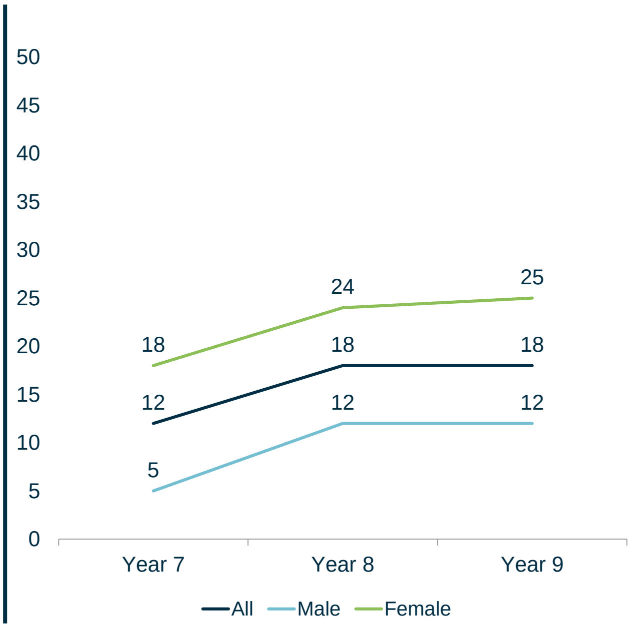
Bases: Year 7–13s who have ever studied computer science 2019, half sample A: All/male/female by year: year 7 (364/188/172); year 8 (388/194/191); year 9 (356/184/170)

Figure 6.10: Barriers to learning computer science by gender and school year

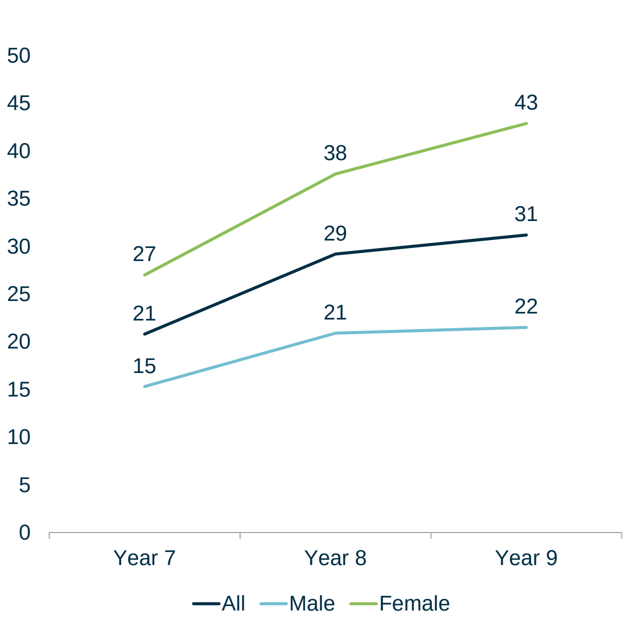
% of year 7–9s who have ever studied computer science saying nothing has put them off learning it



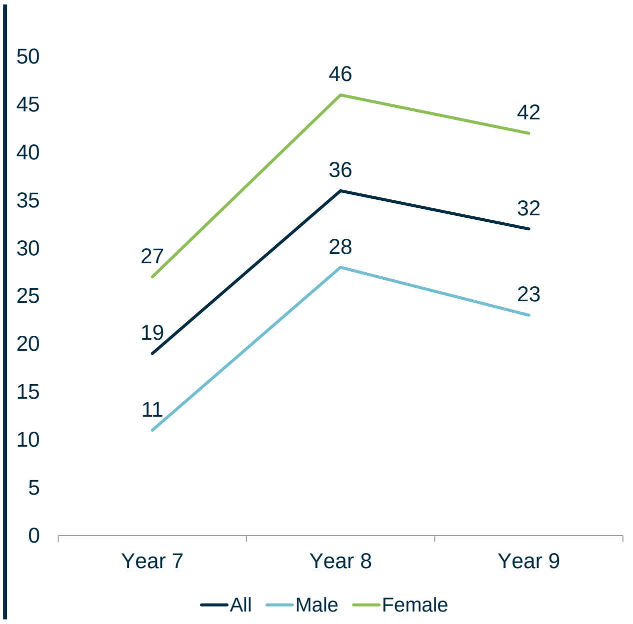
% of year 7–9s who have ever studied computer science saying it does not fit with future pathways



% of year 7–9s who have ever studied computer science put off as it can be difficult



% of year 7–9s who have ever studied computer science put off because they don't always find it interesting/enjoy it



And what has put you off learning Computer Science? Choose all that apply (CompDis)

Bases: Year 7–13s who have ever studied computer science 2019, half sample A: All/male/female by year: year 7 (364/188/172); year 8 (388/194/191); year 9 (356/184/170)

6.10. Uptake of computer science at GCSE

National trends in computer science access

Unlike the physical sciences, computer science is not a compulsory subject at GCSE. However, since 2014, computer science has been included in the EBacc as one of the eligible core science subjects, such that a three-science pathway can now include any three out of biology, chemistry, physics and computer science. However, Kemp at al. (2018) suggest that computer science is rarely taken as a replacement for one of the single science subjects but is usually taken alongside all three single science subjects by those taking this pathway.

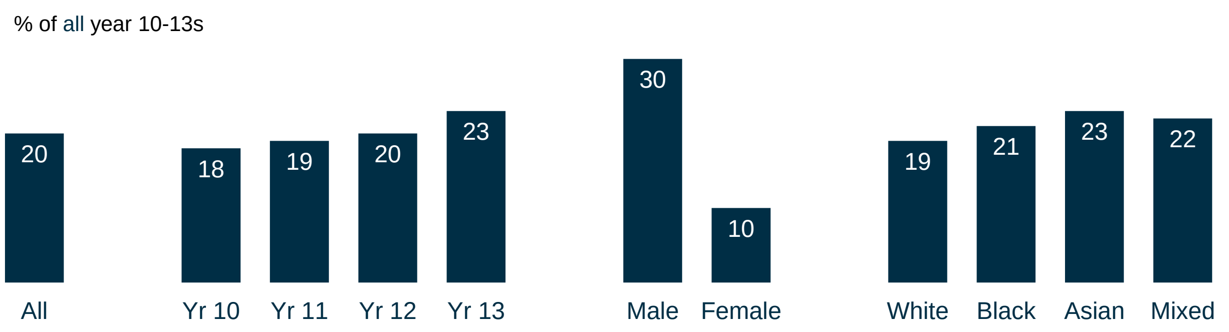
Appendix B provides charts based on national data published by the DfE (DfE, 2018a; Figures B.1 and B.2). Figure B.1 in Appendix B illustrates the increase in uptake of the computer science GCSE in England since it was first introduced in 2012/2013. This rises sharply until 2015/2016 but the rate of increase then slows and flattens off. It has clearly partially displaced the GCSE in ICT, with ICT entries declining over the same period. Provisional GCSE results for 2018/2019 suggest that there has been a further small increase of around 7% in computer science uptake in 2019, while ICT has been phased out (JCQ, 2019a). Therefore, when the two subjects are combined, a declining number of pupils are now taking a qualification in a computer-related subject at GCSE compared with before the changes to the curriculum in 2014.

There is also a clear gender gap in the uptake of both computing-related GCSEs in England, but the difference is relatively greater for computer science than it is for ICT, with over four times as many male students as female students being entered for computer science GCSE (Figure B.1, Appendix B). The data show that 12% of students were entered for the computer science GCSE in England in 2017/2018, higher at 19% of male students and much lower at 5% of female students, with no increase in uptake for either sex from the previous year and with an increasing gender gap over the longer term. The increased uptake seen in the provisional GCSE results suggests that around 13% of students were entered in total in 2018/2019 (JCQ, 2019). The rate of increase in uptake from 2017/2018 was faster for female students (14%) than for male students (6%); despite this, only 21% of students entered were female.

Access to computer science in SET 2019

In SET 2019, 20% of students in years 10–13 reported having studied computer science at GCSE (Figure 6.11). Changes to the question mean that comparison with SET 2016 is not possible. Of the year 11 respondents (who would have been entered for the GCSE in 2018/2019), 19% reported taking the GCSE, while provisional GCSE results put uptake at around 13% (JCQ, 2019a), suggesting that SET 2019 over-estimates uptake.

Figure 6.11: Proportion of year 10–13 students who are studying/studied computer science at GCSE



Are you studying/did you study Computer Science/Computing at GCSE? Please don't include ICT (CompGCSE)

Bases: All year 10–13s: All (4,095); year 10 (1,044); year 11 (1,093); year 12 (1,016); year 13 (942); male (1,943); female (2,106); white (3,015); Black (241); Asian (535); mixed (214)

The survey data also reflects the national picture in terms of gender disparities in uptake, with 30% of male students reporting taking computer science at GCSE compared with 10% of female students.

Other than the gender disparity discussed above (which can be seen fairly consistently within each of years 10–13), the reported uptake of computer science at GCSE was also higher for students from an Asian background (23% vs 19% of white students).

Students with a high science quiz score (used as a proxy measure for science ability) were also more likely to report taking the GCSE than those with a medium or low score (28% vs 16%).

7. Practical science

This chapter explores students' experience of practical work in science lessons, whether they feel they get enough exposure to practical science, and which students are most motivated by this aspect of science lessons. These questions were also asked in SET 2016 and findings are compared over time.

Key findings

Just under half (47%) of year 7–11 students reported doing hands-on practical work at least once a fortnight.

- Access to hands-on practical science was lower in London and for students in years 10–11 studying double rather than triple science.

The frequency of hands-on practical work declines by school year.

- In year 7, 63% reported doing hands-on practicals at least once a fortnight, though this falls rapidly by school year such that only 33% reported similar levels of frequency in year 11.
- This fall almost exactly matches the decline in the proportion of students who said that enjoying practical work was a key motivation to learn science (see also Chapter 5). This might suggest that as the frequency of practical work decreases, there is less enticement to study science.

Enjoying practical work was the top motivation for feeling encouraged to learn science, and most students wanted to do more of it.

- The students most motivated in science by practical work tended to be those also most engaged in science more generally: students in year 7; Asian students; students with a high science quiz score; and students with strong family science connections.
- 65% in years 7–9 and 57% in years 10–13 wanted to do more practical work than they currently do.

More disadvantaged students and those with the lowest levels of interest in science were most keen on doing more practical work.

- For example, 63% of year 7–11 students in the most deprived IDACI quintile compared with 56% in the least deprived quintile wanted to do more.
- 75% of year 7–11 students who said they were 'not at all' interested in science wanted to do more, compared with 50% of those who were 'very interested'. More generally, an appetite for more practical work was highest among students who are traditionally less engaged in science, for example students with lower science quiz scores and students on the double science pathway.

Students had less exposure to practical work in 2019 than in 2016, and this decline was more focused in affluent areas.

- The proportion of students in years 10–11 doing hands-on practical work has fallen since 2016 (from 44% to 37%), as has observing a teacher demonstration of a practical (from 47% to 38%).
- In 2016, year 10–11 students in the least deprived areas reported more practical work than students in the most deprived areas. However, the decline in hands-on practical work between 2016 and 2019 was concentrated in the most affluent IDACI quintiles such that in 2019 year 10–11 students in more deprived areas were as likely to experience practical work as students in less deprived areas.

7.1. Context

The importance of practical work in school science is widely accepted, and it is acknowledged that good quality practical work promotes the engagement and interest of students as well as developing a range of skills, science knowledge and conceptual understanding (SCORE, 2008) It also improves the likelihood of students going on to further study of science subjects (SHU, 2017).

However, a number of studies (see, for example, Abrahams and Millar, 2008) suggest that practical work can be ineffective in improving learning about scientific concepts or processes. Abrahams and Reiss (2017) argue that although many students enjoy practical work and learn certain technical skills while doing this, it is too rarely the case that they learn the relevant scientific concepts underpinning the practical. The authors argue that when students undertake practical work, they need to engage not only with their hands but also with their minds. This was confirmed by the SET 2016 findings, which showed that 46% of students in years 10–11 reported that a lot of the time or sometimes they just followed the instructions they were given without understanding the purpose of the practical work.

Practical work can be varied, both in terms of its content and in terms of how students experience it. SCORE (2013) defines practical work as ‘a learning activity in which students observe, investigate and develop an understanding of the world around them, through direct, hands-on, experience of phenomena or manipulating real objects and materials’. Gatsby (2017) adopts a similar definition but further classifies practical work as activity which directly involves students, either through hands-on experience or via practical demonstrations by teachers.

Gatsby (2017) conducted an in-depth study to compile a list of ten benchmarks that define the inputs needed for best-practice practical science in secondary schools. These ten benchmarks indicate that good-quality practical science should be: purposeful; taught by experts with relevant subject-specialist training; frequent and varied; carried out with access to relevant equipment and technical support; able to provide opportunities to do open-ended and extended investigative projects; not overly restricted by unnecessary risk aversion; and included as part of student assessment where appropriate.

As discussed in Chapter 5 of this report, practical work is the factor most frequently provided by students as encouraging them to learn science. This finding provides clear evidence of a link between practical work and student motivation and engagement in science and underlines the importance of students experiencing frequent and good-quality practical work. However, amid recent changes to the GCSE specification, coupled with budget pressures for many schools, there are heightened concerns that practical science in schools is being squeezed (Cramman et al., 2019).

This chapter describes the nature of practical work experienced by students and examines how the experience of practical work varies by school year and across different subgroups of the population.

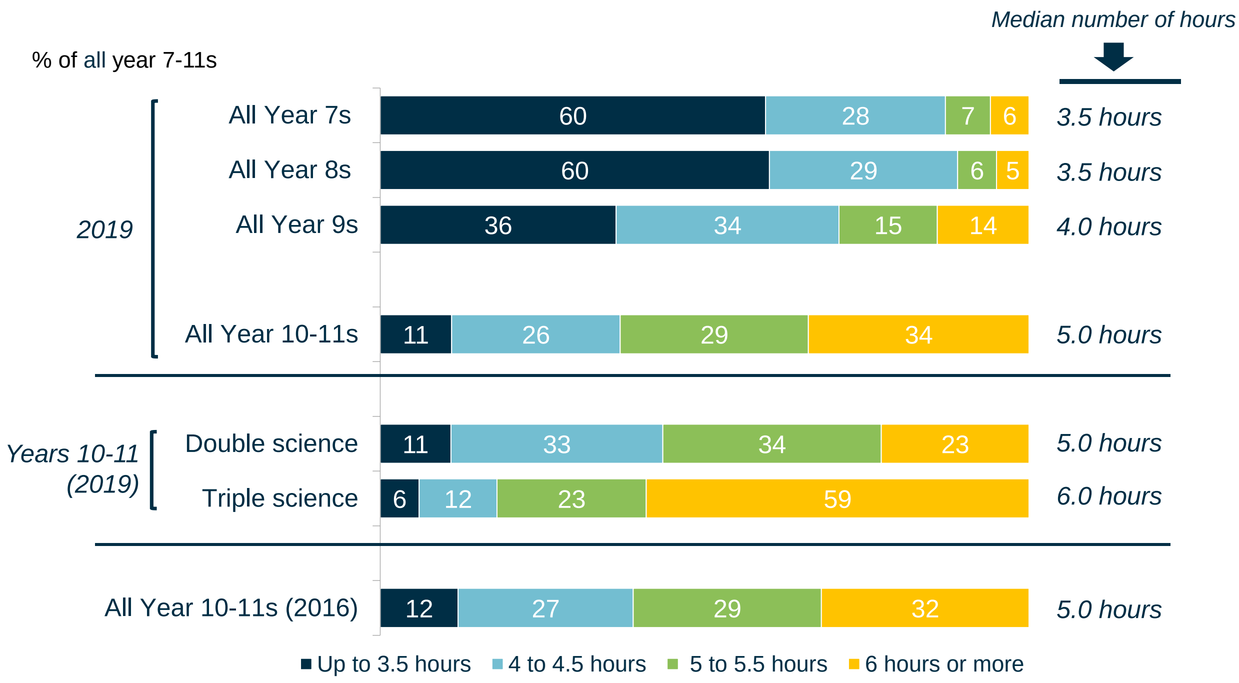
7.2. Number of hours of science education

Figure 7.1 displays the number of hours students said they spent learning science per week. In years 7–8, most students (60%) reported learning science for up to 3.5 hours a week. However, this increased over the school years: the median number of hours increased from 3.5 hours in years 7–8 to 4 hours in year 9 and 5 hours in years 11–12. The distribution of number of hours for years 10–11 remains unchanged from 2016 (year 7–9 students were not included in the 2016 survey so no time trend comparisons can be drawn). The overall median of 5 hours in both 2016 and 2019 is consistent with the findings from the 2015 PISA survey, which quotes an average figure of 4.7 hours in science lessons per week (OECD, 2016).

As in 2016, triple science students reported more timetabled science hours than double science students: 59% of triple science students reported 6 or more hours per week compared with 23% of double science students[26].

[26] As discussed in section 8.3, students’ self-reported classification of whether they study double or triple science is not wholly reliable due to student confusion associated with the terminology. Therefore, any findings associated with course type should be treated with a degree of caution.

Figure 7.1: Number of hours spent studying science by students in years 7–11; and by type of course for students in years 10–11 (2019 and 2016)



Over the last school year, how many hours of science lessons (Biology, Chemistry, Physics) did you have each week on average? (Sciles)

Bases: All year 7–11s 2019 (4,451): Year 7 (775); year 8 (814); year 9 (725); years 10–11 (2,137); double science (1,083); triple science (729); all year 10–11s 2016 (2,072)

Although the number of hours spent doing practical work was not collected in the survey, further research (Cramman et al., 2019) estimates that the average number of hours per week of science lesson time spent on practical work in English state schools is around 1 hour per week.

7.3. Experience of practical work at school

Overall frequency

Students were asked about the frequency and type of practical work which they were exposed to. Two of the ten Gatsby benchmarks (Gatsby, 2017) – as discussed in section 7.1 above – are relevant in the context of this survey:

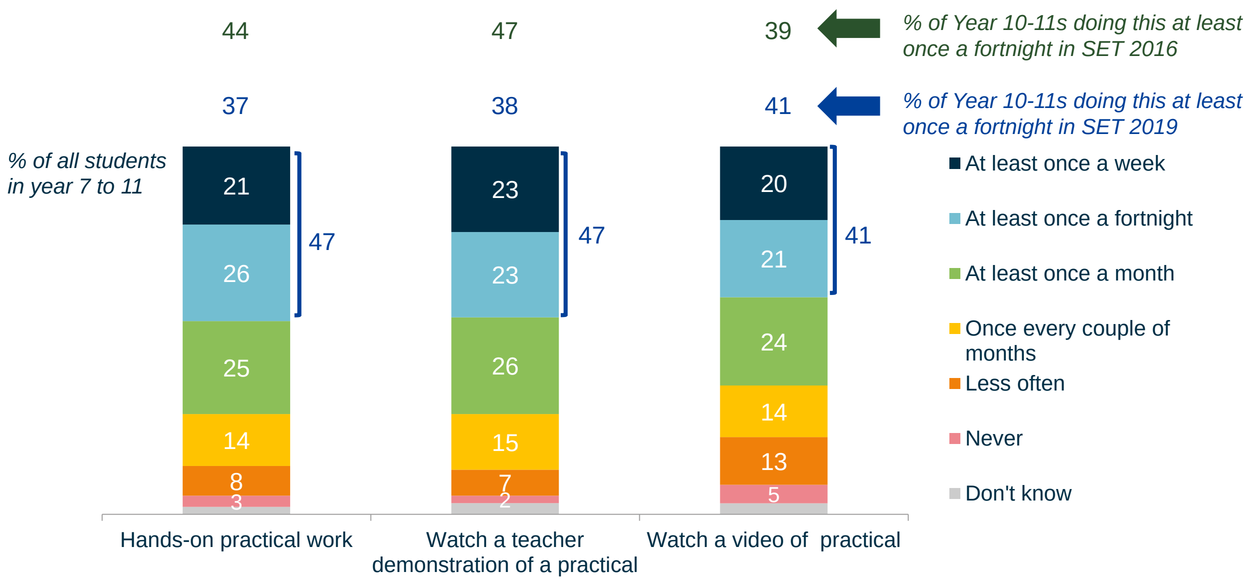
Gatsby benchmark 4: Students should experience a practical activity in at least half of their science lessons. On average, across the year and across all the sciences, at least half of lessons should involve direct practical activities, whether hands-on or teacher demonstration.

Gatsby benchmark 7: Teachers should use digital technologies to support and enhance practical experience, but not to replace it. Virtual environments and simulated experiments have a positive role to play in science education but should not be used to replace a good quality, hands-on practical.

Gatsby (2017) conducted a survey among science teaching leads in English secondary schools in 2017 and concluded that most schools in England were falling short of benchmark 4, with around two-fifths of science lessons in English schools involving practical activities. Gatsby also found that this varied widely by age and science subject, with greater frequency among younger age groups, and in physics and chemistry compared with biology. However, there was no widespread evidence of digital technologies replacing more hand-on practical work (benchmark 7): Gatsby found that 58% of schools used computers to replace practical sessions ‘little of the time’ and 33% did so ‘some of the time’.

In SET 2019, among all students in years 7–11, just under half (47%) reported doing hands-on practical work at least once a fortnight, and a similar proportion reported watching a teacher demonstration of a practical at least once a fortnight (47%), while 41% said they watched a video of a practical (Figure 7.2). When comparing results with 2016, it is necessary to re-base the results on students in years 10–11. This provides evidence of a fall in the more interactive forms of practical sessions: the proportion of GCSE-level students doing hands-on practical work dropped from 44% in 2016 to 37% in 2019, and the proportion watching a teacher demonstration dropped from 47% to 38%. It is possible that this fall could be associated with changes in the GCSE specification between 2016 and 2019, which has also included changes in the way that practical skills are assessed.

Figure 7.2: Frequency of different types of practical work among students in years 7–11 (2019 and 2016)



Still thinking about this last school year, about how often did you generally do the following in science lessons? (Pracquan)

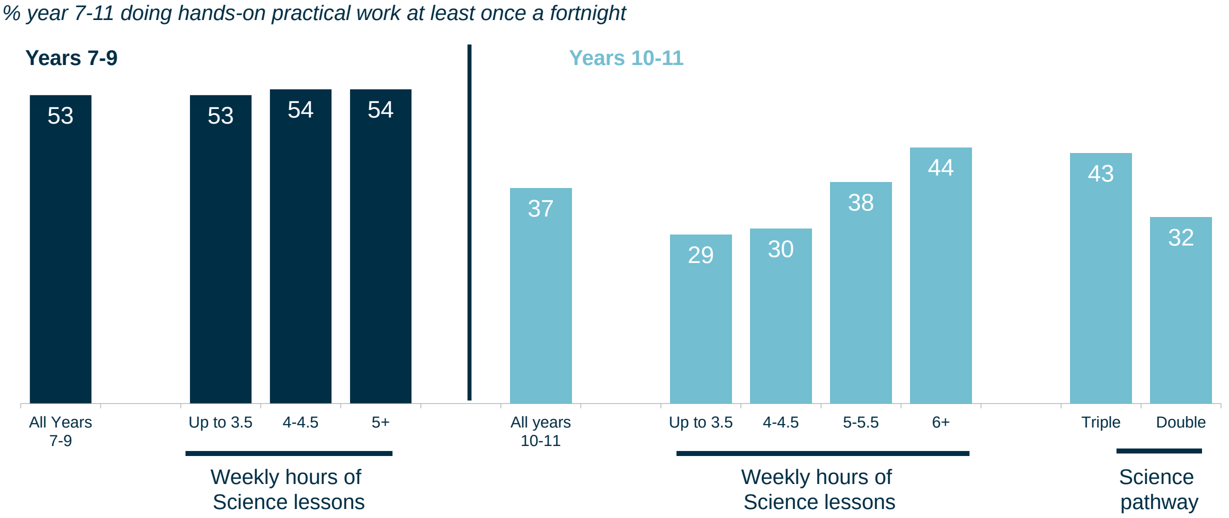
Bases: All year 7–11s 2019, half sample A (2,193): years 10–11 (1,040); all year 10–11s 2016 (2,072)

Variation in frequency of practical work by reported science hours and course type at GCSE

As shown in Figure 7.3, there was variation in the frequency of practical work experienced by the number of taught science hours, although only in years 10–11. Students in years 10–11 who reported more hours also reported more hands-on practical work: the fortnightly rate of hands-on practical work rose from 29% of students reporting up to 3.5 hours of weekly science lessons to 44% who reported at least 6 hours of weekly science lessons.

In years 10–11, triple science students were also more likely than double science students to do hands-on practical work at last once a fortnight (43% compared with 32%).

Figure 7.3: Proportion of years 7–11 who do hands-on science practical sessions at least once a fortnight by reported number of science hours and science pathway (2019)



Still thinking about this last school year, about how often did you generally do the following in science lessons? (Pracquan)

Bases: All year 7–9s, half sample A: All (1,153), hours of science <3.5/4-4.5/5+ (562/343/171), London (153), East Midlands (96); Years 10–11: All (1,040), hours of science <3.5/4-4.5/5-5-6/6+ (101/244/281/337), London (164), triple science (366), double science (584)

Variation in frequency of practical work by region and area deprivation

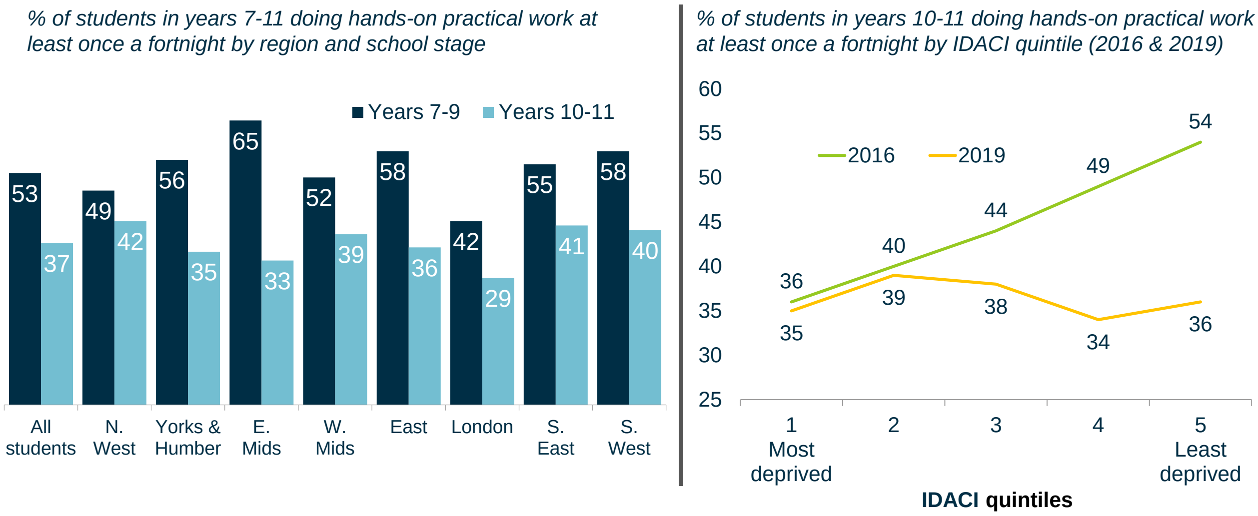
As shown in Figure 7.4, there were some variations in the experience of practical work by region. It was notable that access to hands-on practical work was lower in London than in all other regions, and this was the case among years 7–9 and years 10–11. In all regions, except London and the East Midlands, the participation rate of year 7–9 students doing hands-on practical work at least once a fortnight was in the 49%–58% range. However, in London, this rate was much lower, at 42%, while it was much higher in the East Midlands (65%). Similarly, while the participation rate of year 10–11 students doing hands-on practical work at least once a fortnight was in the 33–42% range for most regions, this was again lower in London (29%)[27].

In SET 2016, year 10–11 students living in the most deprived areas (IDACI quintiles) and those eligible for free school meals were less likely than those in the least deprived areas to say that they had experienced hands-on and teacher-demonstrated practical work. However, in SET 2019 there were no clear differences in these measures by levels of disadvantage, suggesting that although the overall rate of access to practical science has decreased since 2016, access to it has become more uniform.

To help unpick this finding further, the rates of fortnightly access to hands-on practical work among students in years 10–11 by IDACI quintile between 2016 and 2019 were compared. From this comparison, it appears that the decline in practical work is concentrated in the more affluent quintiles. For example, the rate of access declined from 54% to 36% in the most affluent and from 49% to 34% in the second most affluent quintile; while in the two most deprived quintiles, the rate of access remained unchanged (36% and 35% in quintile 1, and 40% and 39% in quintile 2 respectively). This means that although access to practical science has become more equitable, this has only been achieved by a decrease in practical work among more affluent schools.

[27] When comparing results by region, the results for the North East have been omitted due to small sample bases when split into years 7–9 and years 10–11.

Figure 7.4: Proportion of years 7–11 who do hands-on science practical sessions at least once a fortnight by region and school stage (2019); proportion in years 10–11 who do hands-on science practical sessions at least once a fortnight by IDACI quintiles (2016 and 2019)



Still thinking about this last school year, about how often did you generally do the following in science lessons? (Pracquan)

***Chart on left:** Bases: Half sample A, years 7–9/10–11: All (1,153/1,040); North West (161/129); Yorkshire and the Humber (117/108); East Midlands (96/86); West Midlands (153/109); East of England (143/132); London (153/164); South East (189/165); South West (103/114)*

***Chart on right:** Bases (2019): All years 10–11, half sample A: Most deprived quintiles: 1 (202), 2 (196), 3 (178), 4 (183); Least deprived: 5 (177)*

Bases (2016): All years 10–11, half sample A: Most deprived quintiles: 1 (441), 2 (429), 3 (432), 4 (439); Least deprived: 5 (455)

7.4. Frequency of practical work by school year

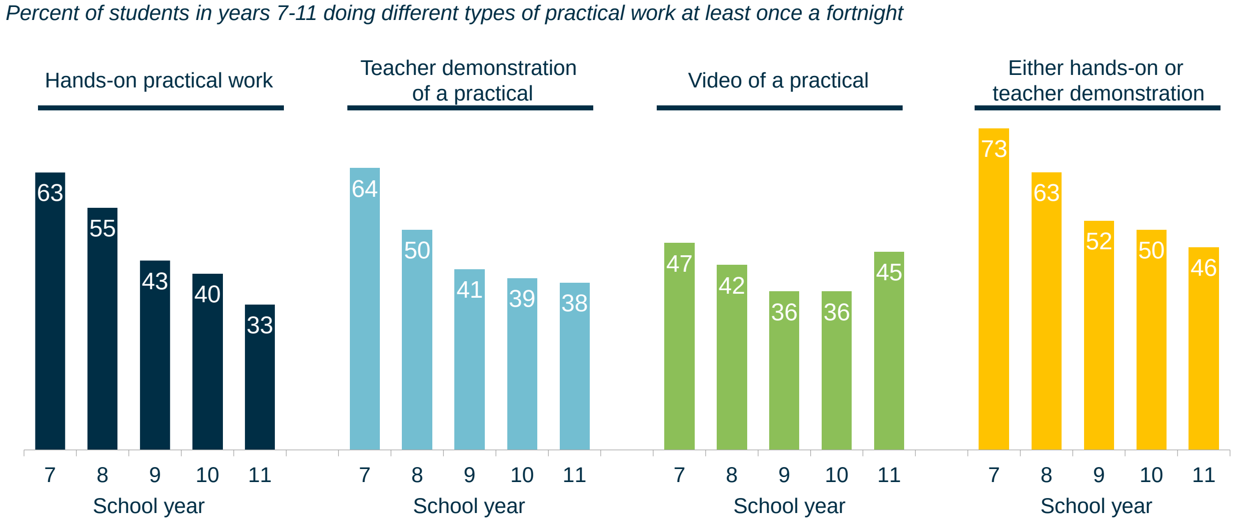
Figure 7.5 shows how the frequency of practical activity varies by school year. There was a clear pattern of decline by school year, with around three in five year 7 students having at least fortnightly exposure to either hands-on (63%) and/or teacher demonstrations of practical sessions (65%). However, this declined quite rapidly by school year. By year 9, only around two in five were undertaking this type of practical work at least once a fortnight, and by year 11 only 33% said that they experience hands-on practical work at least once a fortnight. This is likely to be linked to an increased focus on examinations during year 11.

Combining hands-on and teacher demonstrations (which is how Gatsby defines good-quality practical work), the level of exposure to either of these types of practical work at least once a fortnight declined from 73% in year 7 to 46% in year 11.

The pattern of exposure to practical work via a video platform was less clear-cut, although there was also a fall between year 7 and year 9. There was, however, evidence that this increases during year 11, possibly as a replacement for hands-on practical work which reduces in frequency during this school year, or it could be that videos are used as a revision aid.

The decline in exposure to practical work by school year based on student-reported data in SET 2019 mirrored a similar pattern found by Gatsby in their teacher-based survey (Gatsby, 2017). Gatsby found that the proportion of schools where on average at least half of science lessons involved direct practical activities was 68% in key stage 3 (years 7–9), declining to between 33% (for biology lessons) and 55% (for chemistry lessons) at key stage 4 (years 10–11).

Figure 7.5: Proportion of students in years 7–11 who do different types of practical work at least once a fortnight by school year (2019)

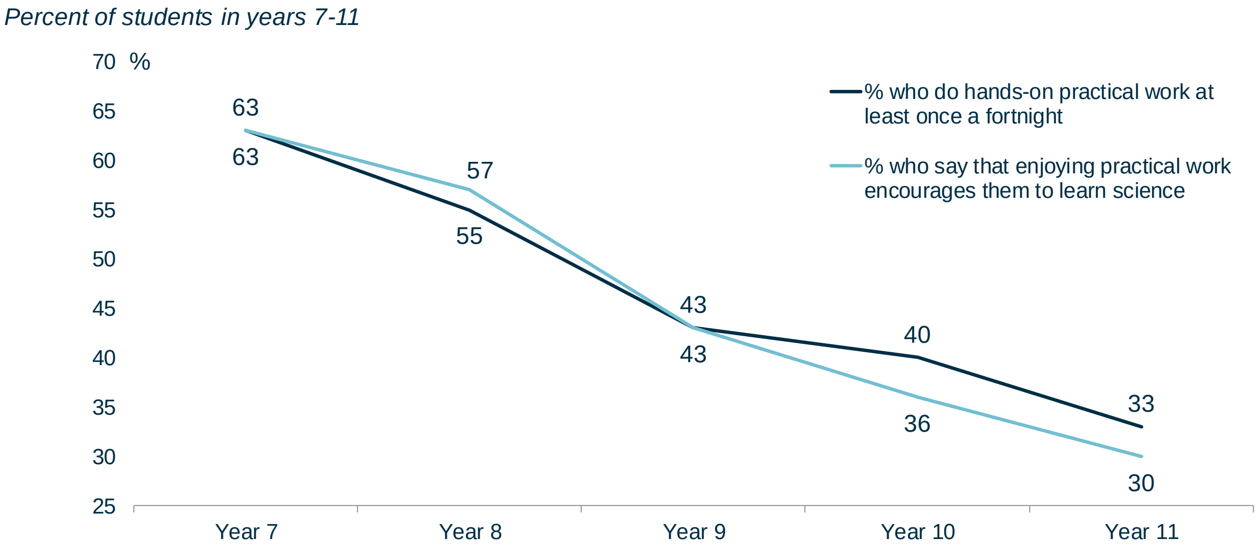


Still thinking about this last school year, about how often did you generally do the following in science lessons? (Pracquan)

Bases: All year 7–11s 2019, half sample A (2,193): Year 7 (372); year 8 (402); year 9 (379); year 10 (508); year 11 (532)

As seen in Chapter 5, practical work is one of the key motivating factors to learn science in the early years of secondary school. It is noteworthy that the decline in frequency of practical work is almost exactly matched by the proportion who said that enjoying practical work was a key motivation to learn science (Figure 7.6). This might suggest that if students have increasingly less exposure to practical work, it also becomes increasingly less of a motivator to learn science. The pattern of decline in the frequency of practical work across the first three years of secondary school also mirrored the pattern of decline in levels of interest in science more generally (Figure 4.5, Chapter 4). These findings in combination suggest that increasing the frequency of practical work in years 8 and 9 may help improve students' motivation and interest in science.

Figure 7.6: Proportion of years 7–11 who do hands-on science practical work at least once a fortnight by school year; proportion in years 7–11 who cite enjoying practical work as an incentive to learn science by school year (2019)



Still thinking about this last school year, about how often did you generally do the following in science lessons? (Pracquan): Bases: All year 7–11s 2019, half sample A (2,193): Year 7 (372); year 8 (402); year 9 (379); year 10 (508); year 11 (532)

What has ***encouraged*** *you to learn science? (Students who pick the response option 'I like doing practical work/experiments') (Scienc): Bases: All students (6,409): Year 7 (775); year 8 (814); year 9 (725); year 10 (1,044); year 11 (1,093)*

7.5. Which groups of students were most likely to be motivated by practical work?

As discussed in Chapter 5, enjoying practical work was the top reason for feeling encouraged to learn science: overall, 42% of students in years 7–13 selected this as a motivating factor. The following groups of students were the most likely to feel motivated by learning practical science:

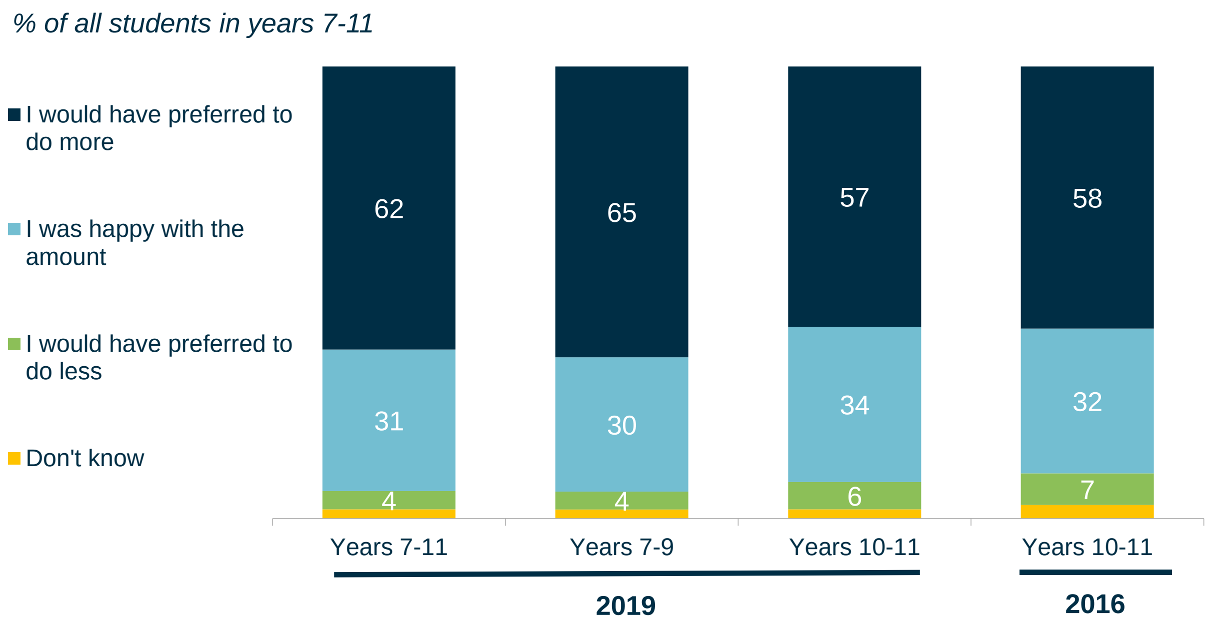
- Students in the early years of secondary school: 55% of students in years 7–9 vs 32% across students in years 10–13
- Asian students: 48% vs 41% of white students
- Students with a high science quiz score: 50% vs 34% with a low quiz score
- Students with many family science connections: 51% of those with a high FSCI score vs 34% with a low FSCI score
- Students who reported doing hands-on practical work at least once a fortnight: 52% vs 42% who did hands-on work less often

7.6. Whether students feel they do sufficient practical work

On balance, students in all school years 7–11 wanted to do more practical work (Figure 7.7). Overall, 31% thought they did enough practical work and 62% would have liked to do more; only a negligible proportion (4%) wanted to do less.

Year 10–11 students were slightly more content with the amount of practical work they did compared with year 7–9 students (34% compared with 30%), and the overall pattern of results for this age group remained unchanged compared with SET 2016.

Figure 7.7: Preference to do more practical work in years 7–11 (2019 and 2016)



Which of these best applies to you? (Pracres)

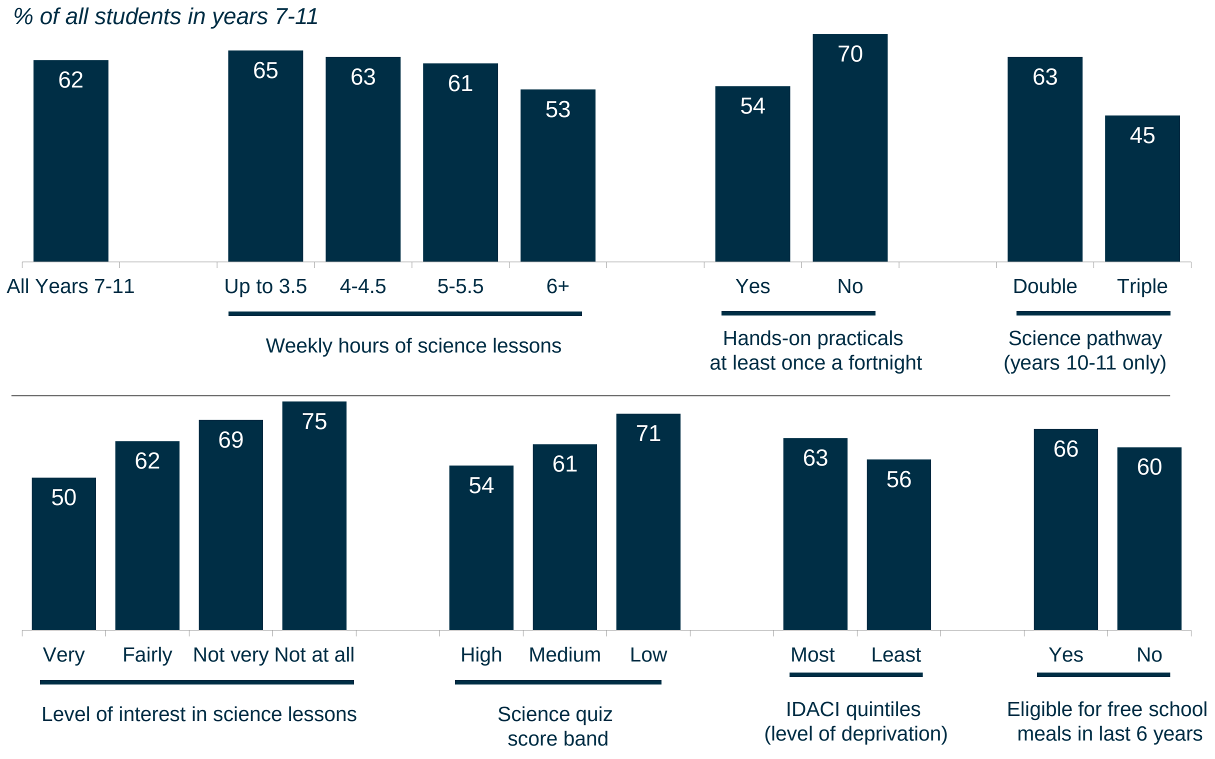
Bases: 2019 half sample A: All years 7–11 (2,193); years 7–9 (1,153); years 10–11 (1,040); 2016 all years 10–11 (1,061)

As shown in Figure 7.8, there were some clear trends in terms of the types of students who would have liked to do more practical work. The following groups were most likely to say they would have liked to do more:

- Students who reported the fewest number of hours of science lessons per week
- Students who did practical work infrequently
- Year 10–11 students on the double science pathway
- Students with lower levels of interest in science
- Students with lower science quiz scores
- Students with higher levels of disadvantage (as measured by IDACI quintiles and free school meal eligibility)

It is interesting to note that the appetite for more practical work was higher among students with lower ability (as measured by the quiz score), among those taking the double science route and among those with lower levels of interest in science. Given that these groups were less likely to want to study science or enter a career in science (chapters 10 and 11), increasing the exposure to practical science among these traditionally less-motivated groups (for example those in lower-ability groups or those who take double science) may be one way to help even out imbalances in science outcomes across the population.

Figure 7.8: Preference to do more practical work in years 7–11 by survey subgroup



Which of these best applies to you? (Pracres)

Bases: All years 7–11, half sample A (2,193): hours of science <3.5/4-4.5/5-5.5/6+ (663/587/374/415); hands-on practical fortnightly yes/no (998/1,140); double science (584); triple science (366); interest in science very/fairly/not very/not at all (434/1,113/479/144); quiz score high/medium/low (480/1,169/544); IDACI quintile most/least deprived (443/389); eligible for FSM yes/no (494/1,478)

As in SET 2016, SET 2019 also shows a connection between a teacher being seen as 'good' and the amount of practical work students experience: 40% of students citing a 'good teacher' as one of their reasons for enjoying science thought they did enough practical work, compared with only 27% of students who did not cite having a good teacher as a motivation for learning science.

8. Science pathways at GCSE

This chapter explores the influence of family on GCSE choices, science pathways taken by students in years 10–11, the profile of students who take triple and double science, and barriers to the uptake of triple science. Findings have been compared with the 2016 survey where relevant.

Key findings

Parents were the most influential factor in helping to shape students' GCSE choices.

- Young people in years 8–9 who had chosen their GCSE options mainly consulted parents about GCSE choices (64% had mostly talked to their parents about this). Parents were most likely to be consulted by students who were white, male, from more advantaged families, and when these parents were either university-educated and/or working in a science-related job.

A third (35%) of year 10–13 students said they had taken triple science.

- However, there is evidence that some young people misclassified double science as triple science; official DfE figures suggest that 29% of students in these year group cohorts have taken triple science.

Triple science take-up among year 10–13s was higher among students from more advantaged backgrounds and with stronger family science connections.

- Compared with the overall survey rate (35%), triple science take-up was higher among Asian males (39%), students living in the least deprived IDACI quintile (45%), those with many family science connections (52%), those with a university-educated parent (47%) and those with a high science quiz score (60%).

A fifth of year 10–13 students would have liked to study triple science but were not able to.

- While most students taking a non-triple science route were content with this, 20% of non-triple science students would have liked to study this if the option had been available to them.

Most year 10–13 students said they attended schools which offered triple science. The most common barriers to studying triple science related to perceptions of difficulty, volume of work and lack of interest.

- Among those who didn't study it, only 10% said that their school had not offered it. Instead, most students (68%) cited a personal barrier such as lack of confidence or interest or concerns about the volume of work; 43% cited a school-selection barrier such as not achieving the grade required.
- Females were more likely than males to choose not to study triple science because they thought it would be too difficult (34% vs 23%).

Compared with students in 2016, students in 2019 were more likely to have the opportunity to study triple science though more students rejected it because they felt it would be too much work.

- In SET 2019, 13% of year 10–13 students said their school did not offer triple science (down from 19% in SET 2016). The proportion of students taking a non-triple science pathway who didn't study it because they thought it would be too much work increased from 21% in 2016 to 32% in 2019.

8.1. Context

Over the past few years there have been several changes to the way that science has been taught at GCSE level in schools. Following GCSE reforms in 2006, the government set out a commitment for all state sector students to have an entitlement to study triple science. The default position until 2018 was that students would take either a single science GCSE, a double science GCSE (made up of core and additional science) or three separate sciences (triple science). Following the reform of the GCSEs that involved changing from A*–G grades to 9–1 grades, a combined science GCSE was introduced, replacing core and additional science. Combined science is therefore equivalent to a double award GCSE.

Further changes over the past decade include the introduction in 2010 of the English Baccalaureate (EBacc) as a performance measure to recognise the proportion of students securing a 'good' grade across a core of academic subjects, including the sciences. From 2013, computer science started to be included in the EBacc as one of the core science subjects. Other changes to science GCSEs over the past decade include modifications to course content, a move from modular to linear assessment and the removal of practical assessments, leaving only written exams.

All GCSE options provide students with teaching across the sciences to ensure coverage of the three core subjects (biology, chemistry, physics). Triple science is usually regarded as the 'gold standard' of science education at GCSE as it provides the opportunity to study science subjects in greater depth. It is also linked to more positive attitudes and confidence in science, higher rates of post-16 science uptake and raised aspirations to study STEM subjects (this report, chapters 4 and 9; Archer et al., 2016a).

Recent data suggests that the majority of state schools – around 90% – now offer triple science as an option (OPSN, 2015). However, there have been several publications citing regional, demographic and attainment imbalance in the entitlement to triple science. For example, OPSN (2015) found that schools in more deprived neighbourhoods were less likely to offer triple science than schools in more affluent areas, while Archer et al. (2016b) note that students from socially disadvantaged and lower-attainment groups were much less likely to study triple science, patterns which are repeated in the SET 2019 data (section 8.4). Archer et al. (2016b) further note that triple science is overwhelmingly seen as the route for those who are 'clever' and 'sciency' and suggest that the triple science route could actually be perpetuating social inequalities among pupils who are studying science and aspiring to work in a science career. These inequalities prompted the HM Chief Inspector of schools in 2018[28] to call for triple science to be made more equitable by allowing students to study this based on their aspirations and interest rather than their ability.

Against this backdrop, this chapter explores the profile of students in terms of the science course they have taken and barriers to uptake, including a detailed analysis of both school-based and personal barriers. This chapter also considers the role of family members in providing guidance to young people when making their GCSE choices.

8.2. Who influences young people in their GCSE choices?

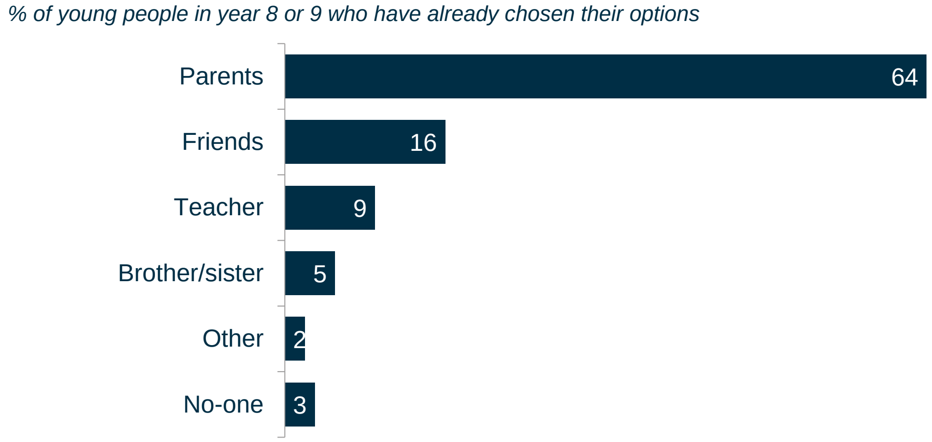
Students in years 8–9 were asked about influences on their GCSE choices. This question was asked of all year 8–9 students who had chosen their GCSE options. At the time of the survey, virtually all year 9 students had chosen their options (96%), while just under half (44%) of year 8 students had done so.

The potential influence of family on educational choices is well established; for example, Anders et al. (2017) found that pupils from lower socioeconomic backgrounds were less likely than their more advantaged peers to choose GCSE subjects that would enable them to go on to university – regardless of their academic ability. However, Anders et al. (2017) also found that parents' educational level did not appear to influence whether pupils took three or more STEM subjects.

SET 2019 also found that parents were highly influential in helping to shape students' GCSE choices (Figure 8.1). When asked who students had talked to *most* about their choices (the question was single choice), it was clear that parents were most influential: 64% had mostly spoken to their parents about this, while smaller proportions had mainly spoken to friends (16%), teachers (9%) and siblings (5%).

[28] https://www.gov.uk/government/speeches/amanda-spielmans-speech-at-the-association-for-science-education-annual-conference-2018

Figure 8.1: Who have young people in years 8–9 talked to most about their GCSE options?



Who have you talked to most about what subjects to take at GCSE? (Y89choose)
Base: All year 8–9s who had chosen GCSE options (1,073)

More detailed analysis of the data shows that parents were particularly likely to be influential in shaping students' GCSE options among males, more advantaged students, white students, and when these parents were either university-educated and/or working in a science-related job.

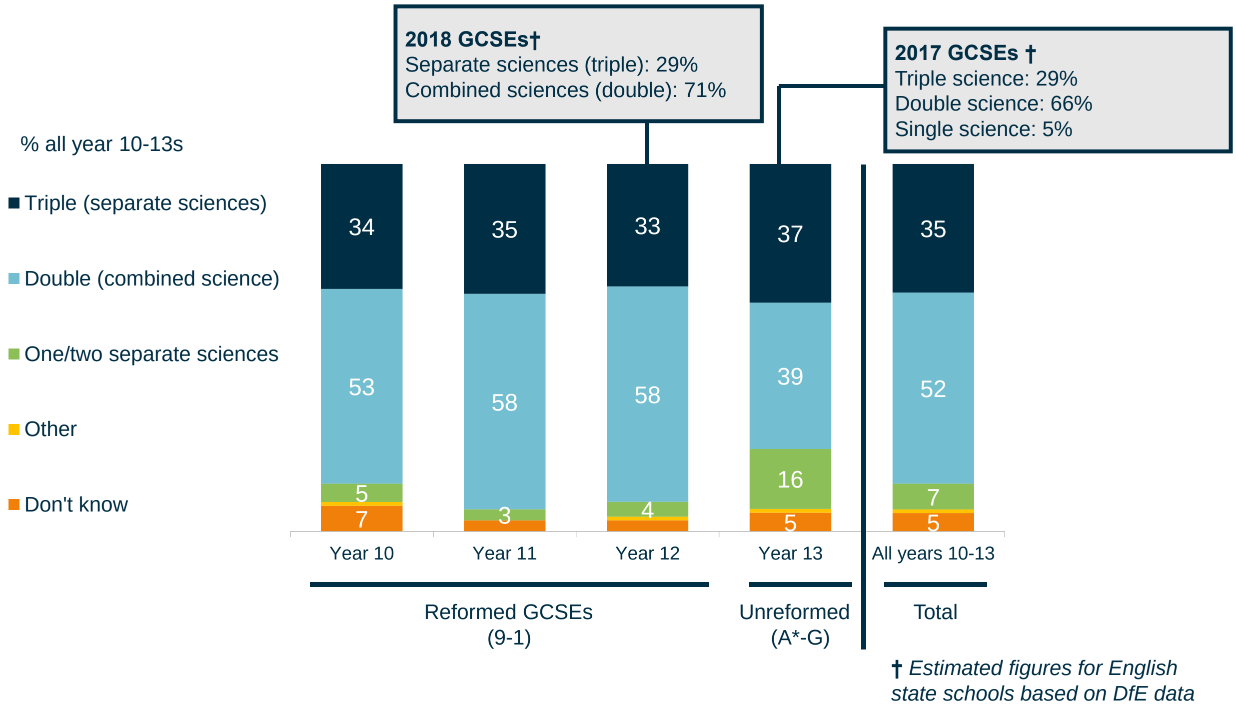
- Males (67%) were more likely than females (61%) to consult their parents, while females were more likely to consult friends (19% vs 12% of males).
- Compared with white students, pupils from Asian backgrounds were less likely to consult their parents (54% of Asian students vs 67% of white students), while students from a Black ethnic background were especially likely to consult siblings (13% vs 3% of white students).
- Students with at least one parent who worked in science or medicine were much more likely to consult their parents (75% vs 61% who did not have parents with a science-related job), suggesting that these students were able to draw on the science-related knowledge of their parents when making choices about their future. However, as there is an expected association between science-related jobs and social class, this could also be a function of social class more generally rather than just about the scientific nature of parents' jobs.
- Students with parents or siblings who had been to university were also more likely to consult their family for advice: 72% of students with university-educated parents consulted their parents (vs 60% whose parents did not) and 12% of students with older siblings who had been to or applied to university sought help from their siblings (vs 5% who had older siblings who had not been to university).
- Students from lower-income backgrounds were less likely to consult parents (57% of students eligible for free school meals vs 66% not eligible) and more likely to consult teachers (13% vs 7%).

8.3. Science pathway taken in years 10 and 11

The Science Education Tracker asked students to report their current (if year 10/11) or previous (if year 12/13) GCSE science course. Given changes in the exam specifications and terminology between the year 12 survey cohort and the year 13 survey cohort (when GCSEs switched from the A*–G to the 9–1 specification), the questions were presented slightly differently for these groups.

According to the survey, the proportion of year 13 students who took triple science GCSEs in 2017 was 37%, while double science accounted for 39% of courses and single science and other non-GCSE courses such as BTECs were taken by 16% of students (Figure 8.2). This pattern changed for younger cohorts: a smaller proportion of around a third (33–35%) said that they had taken the triple science pathway and 53–58% said they had taken the double pathway, while single science GCSEs were much rarer in the context of the new-style GCSE offerings (3–5%).

Figure 8.2: Science pathway taken at GCSE: survey-reported data among years 10–13 and DfE official statistics[29] (2019)



Which science course [did you take/are you taking] in year 10 and 11? GCSESciA/GCSESciB

Bases: All year 10–13s (4,095): Year 10 (1,044); year 11 (1,093); year 12 (1,016); year 13 (942)

However, it is important to note that these figures are based on student self-reported data, and there is clear evidence that the survey rate of triple science uptake was overestimated due to student confusion around what counts as 'triple' and 'double' science[30]. Similar confusion was also noted in SET 2016.

Figure 8.2 shows the science pathways reported by students in SET 2019 (in the main chart) against the official rate of triple and double science entries (in boxes), which have been estimated based on DfE statistics (DfE, 2018a; DfE, 2018b). The official figures indicate that 29% of students took triple science in 2017 compared with 37% of students from the equivalent SET survey cohort (year 13). Similarly, official figures indicate that 29% of students took triple science in 2018 compared with 33% of students from the equivalent SET survey cohort (year 12). The fact that the survey and official estimates were closer for the 2018 GCSE cohort than the 2017 GCSE cohort suggests that there might have been greater clarity around science pathways for young people since the introduction of the reformed GCSEs, although there is still clearly a degree of misclassification[31].

[29] DfE (2018a) GCSE and Equivalent Results: 2017 to 2018 (provisional) https://www.gov.uk/government/statistics/gcse-and-equivalent-results-2017-to-2018-provisional (see subject tables).

[30] In cognitive testing it was found that students studying all three sciences as part of a double or combined science curriculum sometimes thought they were studying triple science, as they still took exams in all three science subjects. It tended to depend on how the science course options were communicated to students and parents by the school.

[31] The overestimation of triple science by survey respondents was further confirmed when comparing survey responses with National Pupil Database (NPD) data for survey respondents who agreed to link their data. NPD data on GCSE entries was available for those in years 12 and 13 who agreed to linkage. According to the NPD, 31% of young people in year 12 had taken triple science and 29% had taken triple science in year 13; these figures correspond very closely with the official DfE estimates (Figure 8.2). By comparing survey responses with NPD data, we can find further evidence of double science students misclassifying as triple science students: 98% of those classified as studying triple science by the NPD also stated in the survey that they were studying triple science. However, among those classified by the NPD as studying double science or another science course, 10% of this group thought they were studying triple science.

8.4. Patterns of triple science uptake by population subgroups

The discussion in section 8.3 above has demonstrated that prevalence estimates based on science pathways taken should be interpreted with a degree of caution. However, it is still possible to investigate overall patterns associated with triple science uptake. Based on the survey classification, and compared with the overall survey rate (35%), triple science take-up among years 10–13 was higher in the following groups:

- Asian males (42%) (there were no differences by gender or ethnicity at an overall level)
- More advantaged: students living in the least deprived IDACI quintile (45%) and those with no eligibility for free school meals (39%)
- Students with strong family science connections (52% of those with a high FSCI score)
- Students with a parent who had been to university (47%)
- Students with a high science quiz score (used as a proxy for science ability) (60%)

Conversely, the rate of triple science, when compared with the overall rate of 35%, was lower in the following groups:

- Black males (24%)
- White students eligible for free school meals (23%)
- The most disadvantaged: students living in the most deprived IDACI quintile (26%) and those eligible for free school meals (25%)
- Students with no family science connections (26% of those with a low FSCI score)
- Students without a university-educated parent (29%)
- Students with a low science quiz score (used as a proxy for science ability) (17%)

These relationships were consistent with findings reported in the ASPIRES study (Archer et al., 2016a), which noted that the most socially disadvantaged students were almost three times less likely to study triple science than the most advantaged, while lower-attainment students in middle and bottom sets were also much less likely to study triple science than their peers in top sets. Together, these findings underline the importance of income and family science connections in explaining science-related choices and outcomes for young people.

8.5. Barriers to taking triple science

As in 2016, the reasons for not taking up triple science were classified into three categories:

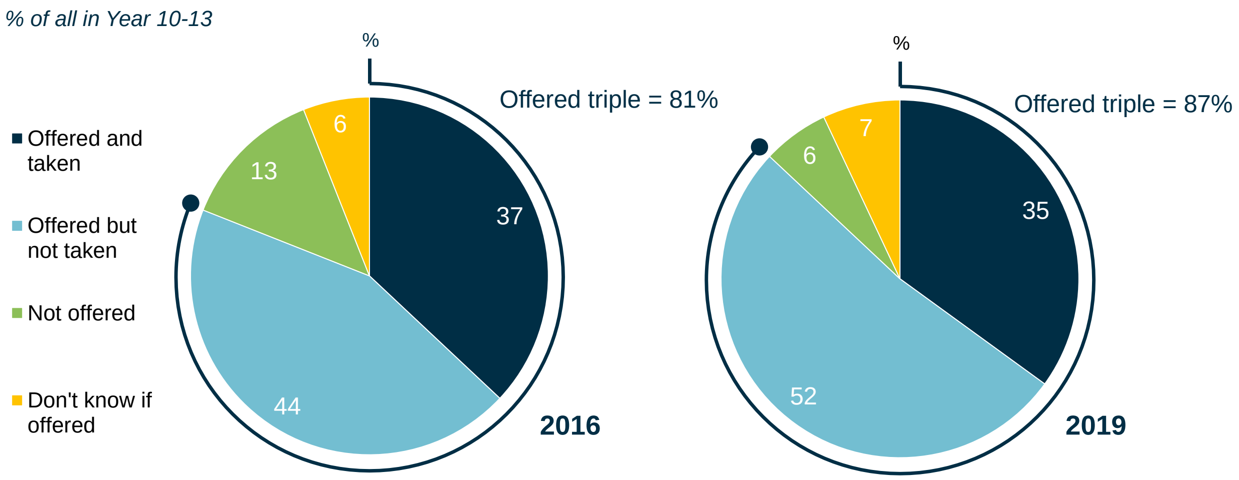
- **School-access barriers:** where schools do not enter any students for triple science;
- **School-selection barriers:** triple science is available, but schools are selective in who is given the opportunity or encouragement to study it;
- **Personal barriers:** triple science is available, but students choose not to take it due to a lack of interest or confidence.

We explore these barriers separately in the sections below.

School-access barriers

Figure 8.3 shows the proportion of students in SET 2016 and SET 2019 who believed that their school entered at least some students for triple science. Overall, according to the SET survey, the rate of access to triple science increased over the previous three years, from 81% of students saying that their school had offered it in 2016 to 87% in 2019. This figure is broadly consistent with data presented by the Open Public Services Network, which showed that in 10% of state secondary schools no pupils were entered for GCSE triple science (OPSN, 2015 based on 2013–14 data).

Figure 8.3: Whether triple science was offered to at least some students at their school: 2016 and 2019 (students in years 10–13)



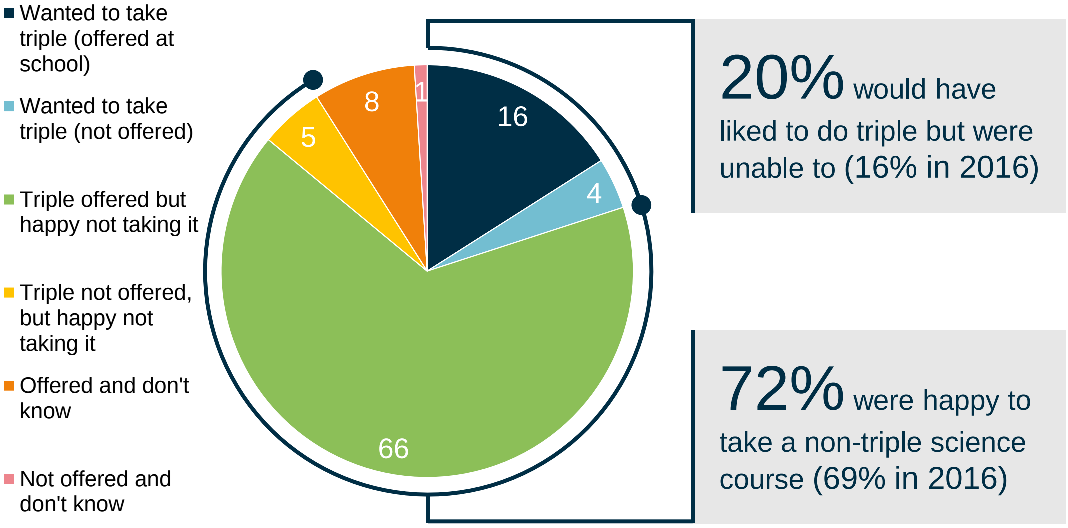
Which science course [did you take/are you taking] in year 10 and 11? (GCSESciA/GCSESciB)
When you were choosing your GCSE options, did your school offer Triple Science to any students? (TripSciSch)
Bases: All year 10–13s: 2016 (4,070), 2019 (4,095)

Consistent with other published reports which highlight the more limited availability of triple science within more socially disadvantaged areas (Archer et al., 2016b; OPSN, 2015), SET 2019 also found a link between access to triple science and socioeconomic status. Overall, 13% of students said either that their school didn't offer triple science or that they didn't know if it was offered. However, this rate was higher for more disadvantaged students: those living in more deprived IDACI quintiles (19% in the most deprived quintile reducing to 6% in the last deprived quintile) and students who were eligible for free school meals (19% compared with 10% of those not eligible).

Students who did not take triple science were asked whether this was their preference. Figure 8.4 shows that a large majority of students (72%, no change from 2016) were happy with the science route they took, while 20% (up from 16% in 2016) felt that they had been denied access to triple science by their school, either because it was not offered (4%) or because it was selectively not offered to them (16%). It might also be the case that the increase in students saying they were denied their preferred option is due to more students failing to meet school attainment targets for the new (and more demanding) science GCSE introduced in 2018 – although there is no direct survey evidence of a change (Figure 8.5).

Figure 8.4: If you did not study triple science, was this the preferred route? Students in years 10–13 (2019 and 2016)

% of all in years 10-13 who did not study triple science



(If triple science not offered by school) Would you have wanted to study Triple Science if your school had offered it? (TripSciNo) (If triple science offered school) At the time, did you want to study [Double Science / this science course] or would you have preferred to take Triple Science? (TripSci)

Bases: All year 10–13s who did not study triple science (excluding DK if offered): 2019 (2,321), 2016 (2,202)

Some groups of students were more likely than others to feel that they had been denied access to triple science (that is, they had wanted to study it but their school either didn't offer it at all or didn't offer it to them):

- Asian students (28% vs 18% of white students)
- Students with a high quiz score (29% vs 12% with a low quiz score)
- Students with many family science connections (30% vs 14% with no family science connections)

There were no differences by measures of disadvantage (IDACI quintiles and free school meal entitlement).

School-selection and personal barriers

Why didn't students take up triple science?

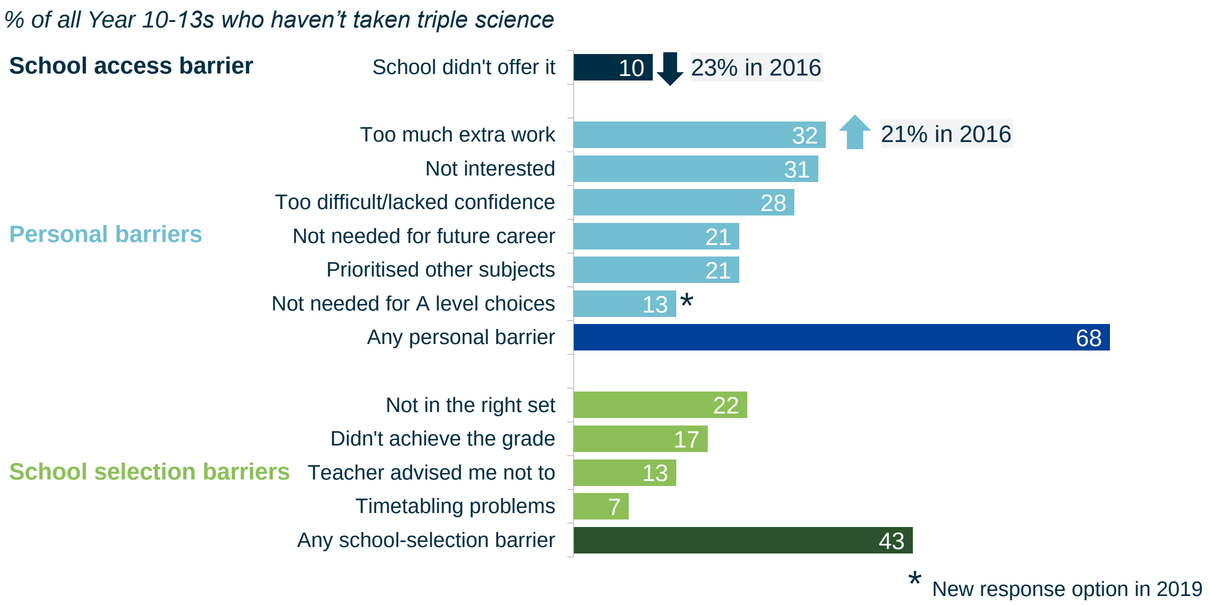
Analysis in this section is based on all students who did not take triple science. Figure 8.5 displays the key reported barriers to participation for 2016 and 2019.

Building on the findings discussed in section 8.5, Figure 8.5 confirms that school access was a less important barrier in 2019 than in 2016: of those who didn't take triple science, only 10% said this was a barrier in 2019 compared with 23% in 2016.

As in 2016, personal barriers were more important than school-selection barriers in explaining why students do not take up triple science: 68% cited at least one personal barrier and 43% at least one school-selection barrier. Personal barriers included concern about the volume of work (32%), lack of interest (31%), lack of confidence (28%), not needing triple science for future career plans (21%) and wanting to prioritise other subjects (21%). School-based barriers were mainly focused on not being in the right set (22%), not achieving the right grades (17%) and being dissuaded by teachers (13%).

Between 2016 and 2019, there was a notable increase in the proportion who cited 'too much extra work' as a barrier, which could be related to changes in the GCSE curriculum for triple science since the last survey.

Figure 8.5: Barriers to the uptake of triple science among those in years 10–13 who haven't studied it (2019 and 2016)



Why didn't you (want to) study triple science? (TripSciWhy);
Base: All year 13s who did not study triple science (excluding DK if offered) (2,321)

Variation in barriers by demographic subgroups

There was some variation in the types of barriers cited by different groups of the student population by gender, ethnicity, science ability (using quiz scores as a proxy) and social disadvantage (IDACI quintiles):

- Females were more likely than males to say they were put off studying triple science due to lack of confidence (34% vs 23%), which reiterates the gender divide in students' confidence in their own ability more generally (section 4.4).
- Asian students were less likely than white students to be put off by lack of interest (25% vs 32%) and because they wanted to prioritise other subjects (13% vs 24%).
- Students with a low quiz score were more likely not to take triple science due to lack of interest (33% vs 26%), while those with a high quiz score were more likely to say triple science wasn't needed for their A-level choices (17% vs. 9%).
- Students from more advantaged backgrounds generally gave a wider range of reasons for not taking up triple science. Students living in the least deprived areas (IDACI quintiles) were more likely than those in the most deprived quintile to say that they had prioritised other subjects (30% vs 16%), that they lacked confidence (35% vs 27%), that they thought it would be too much work (37% vs 29%) and that a teacher had advised them against taking it (19% vs 9%).

9. Science pathways in years 12–13

This chapter explores the subject choices and intentions of students in years 12–13, once science becomes a non-compulsory subject. The chapter covers early post-16 science aspirations for years 7–9, post-16 subject choices among those in years 11–13, and variation in aspirations and choices by demographic subgroups. Findings have been compared with 2016 where applicable.

Key findings

Between years 7 and 9, students increasingly reject a post-16 science pathway.

- 26% of year 7 students said they did not plan to study sciences after GCSE, with this proportion rising to 33% of year 8s and 41% of year 9s.

Early aspirations to follow a science pathway were strongly related to ethnicity, attainment, interest, perceived ability and family connections.

- Year 7–9 students most likely to reject science as a future pathway included those who lacked interest in science; had below-expected attainment at key stage 2; did not think of themselves as 'good' at science; had no family science connections; and did not have a university-educated parent.

A third of year 12–13 students had opted for a vocational pathway, and this varied by demographic subgroup.

- Overall, 57% of year 12–13 students were studying A levels and 34% were studying vocational qualifications. The choice of studying A levels was over-represented among females, Asian students, triple science students, those achieving at least two 'good' science GCSEs and those from the most affluent IDACI quintile.

When making post-16 choices, students were more likely to opt for a non-STEM than a STEM pathway.

- Of all year 11–13 students who were either already studying for post-16 qualifications or who had made their post-16 choices, 81% had chosen non-STEM subjects and 53% had chosen STEM subjects (many students had chosen a mixture – see paragraph below).
- In order, the most popular STEM subject choices were maths, biology, chemistry, physics and computer science.

Among students taking STEM post-16 options, most took STEM subjects as part of a mixed STEM/non-STEM pathway.

- A little under half (44%) of year 11–13 students who had made post-16 choices chose only non-STEM subjects, while 36% chose a mixed pathway and 16% only studied STEM subjects.
- An exclusive focus on post-16 STEM subjects was higher among students who were male, Asian, taking triple science, had many family science connections and who had achieved two+ science GCSEs at A*–B grades. In all of these groups, around one in five focused their post-16 choices exclusively on STEM.

There were strongly gendered differences in both STEM and non-STEM post-16 choices.

- Males were more likely to choose the most post-16 STEM subjects, including maths, physics, and computer science, while females were more likely to choose biology; chemistry was more balanced by gender.
- Females were more likely to choose many arts and social sciences subjects, including psychology, English and art/design. History was more balanced by gender while business studies was more popular among males.

9.1. Context

Once students reach the end of year 11, their pathways begin to narrow as they make their post-16 choices. However, Archer et al. (2013) suggest that science aspirations might be formed much earlier; the period between ages 11–14 (years 7–9) is a critical time for the development of young people's attitudes to science, because by the age of 14, attitudes to science start to become increasingly fixed.

Archer et al. (2013) noted that a feeling that science is not 'for me' among 10–14-year-olds was related to a lack of 'science capital' (which refers to a wider set of connections a young person has to science, including science-related networks within their family and social groups); a lack of awareness of the transferability of science qualifications; a restrictive view that scientists are 'clever' or 'brainy'; and socio-demographic imbalances. The role of socio-demographics is further highlighted by analysis of Next Steps data, which found clear socioeconomic, gender, ethnic and school-level differences in subjects chosen at GCSE which cannot be fully accounted for by prior attainment (Henderson et al., 2018).

As noted throughout this report, science-related interest, perceived ability and aspirations are heavily patterned by gender and there continues to be concern about how to address the under-representation of females in science at post-compulsory levels. This self-selection leads to the so-called 'leaky pipeline' of science participation by women, whereby women and girls participate in science in progressively smaller numbers as they move through their education and careers.

There has, however, been a positive upturn in female participation in post-16 science which suggests this trend is beginning to shift. In 2019, for the first time, participation by females overtook that of males in science A-level exam entries, with just over half (50.3%) of science A-level entries from female candidates (TES, 2019a). Females represented the majority of entries in biology (63%) and chemistry (54%), but they continued to lag behind males in physics (only 23% of entries) as well as maths – findings which are also reflected in the SET 2019 data (section 9.4).

To help address this persisting imbalance, there have been a host of initiatives intended to encourage more equitable gender participation in physics, maths and computer science. For instance, the Institute of Physics has run several projects intended to improve gender balance in physics (IOP, 2017). The Understanding Participation rates in post-16 Mathematics and Physics (UPMAP) project discovered that young people were more likely to continue with maths and physics post-16 if they had been encouraged to do so by a key adult such as a family member or teacher, and if they could see tangible benefits in terms of future job satisfaction or salary (Mujtaba and Reiss, 2013a, 2013b, 2014). Greater confidence among males than females (see also section 4.4) was also an important factor. The IOP (2013) also found evidence of a school environment effect, with most schools perpetuating gender divides between subjects such as biology and physics, while subject uptake was more gender neutral in single-sex schools.

This chapter explores the factors associated with post-16 choices in SET 2019, from the early aspirations of students in years 7–9 to the more confirmed pathways of those in years 10–13 and looks at the factors which appear to influence whether people choose STEM, non-STEM or mixed pathways in years 12–13.

9.2. Future intentions among year 7–9s

Although students in the early years of secondary school may not yet have a precise idea of a future career pathway, it is interesting to look at early aspirations in relation to science. Future follow-up longitudinal research can then track the extent to which these attitudes are fixed or susceptible to change.

Students in years 7, 8 and 9 were asked whether they thought they would carry on learning science after GCSEs, once this becomes an optional pathway.

As shown in Figure 9.1, a majority of students in year 7 were open to following a science pathway when they are older, with 70% saying that they would definitely or possibly choose this. However, this proportion falls quite rapidly over the first three years of secondary school, to 64% in year 8 and 55% in year 9. This increase in the proportion of young people feeling that science is 'not for me' mirrored a similar decline in levels of interest and perceived ability in science, and these findings together point to a wider problem of declining levels of motivation across these school years (see sections 4.3. and 4.4 for more discussion on this).

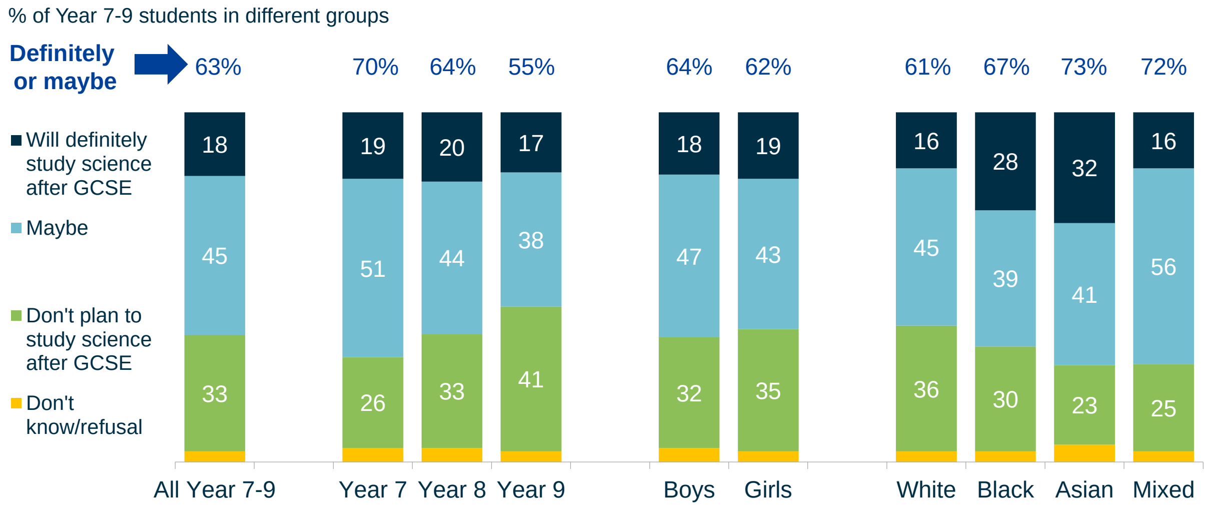
It is also interesting to note that the proportion of students who said they 'definitely' want to continue with science remained at around one in five over these school years. Although we do not (yet) have longitudinal data to affirm this, it would appear that the 'maybe' group is most vulnerable to being lost in the science pipeline.

Figure 9.1 indicates only a very small gender difference in future aspirations to study science post-16, which contrasts with a gender gap in the level of interest and perceived ability in science in the early years of secondary school (Figures 4.5, 4.6). Figure 9.1 also shows clear differences by ethnic group: compared with white students (16%), Black (28%) and Asian students

(32%) were around twice as likely to consider that they will definitely study science after GCSEs.

It is also interesting to note that the decline in interest in continuing with science between year 7 and year 9 was striking for white students but non-existent for Asian students[32]. Between years 7 and 9, the proportion of white students who said that they would definitely or probably consider a science pathway falls from 69% to 51%, while among Asian students there is no fall (73% in year 7 and 71% in year 9).

Figure 9.1: Whether students in years 7–9 think they will continue to learn science after it stops being a compulsory subject by year group, gender and ethnicity (2019)



Everyone has to study sciences at GCSE. After that, students can choose what they want to study, for example at A levels. Which of the following best describes your view? (SciGCSELik)

Bases: All years 7–9 (2,314); year 7 (775); year 8 (814); year 9 (725); boys (1,170); girls (1,122); white (1,723); Black (134); Asian (269); mixed (117)

There were some other clear demographic patterns in the types of young people who aspired to science pathways at this early stage. This shows that, aside from ethnicity, early aspirations were strongly related to attainment, interest, perceived ability and family connections (Figure 9.2).

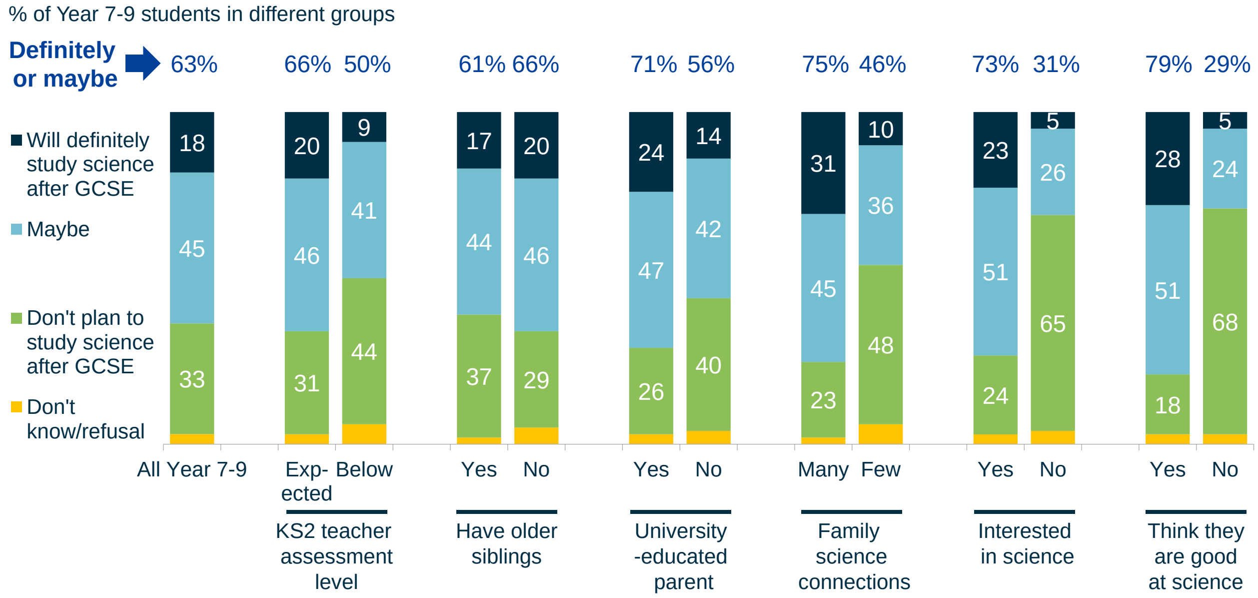
In summary, the following groups were most likely to reject science as a future pathway at this early stage in their education:

- Students with below-expected attainment, as measured by key stage 2 teacher-assessed scores (44% vs 31% who reached at least expected levels at key stage 2).
- Students who were not interested in science (65% vs 24% who were interested).
- Students who did not feel that they were good at science (68% vs 18% who felt that they were good at science).
- Students who had no family science connections (48% vs 23% who had many).
- Students without a university-educated parent (40% vs 26% with one).
- Students with older brothers or sisters (37% vs 29% with either no siblings or only younger siblings). As we know that the majority of young people choose non-STEM over STEM pathways in later life, this suggests that young people may be influenced by the choices of their older siblings.

Many of these patterns confirm similar findings noted in the ASPIRES study (Archer et al., 2013) and continue to underline the importance of family background in explaining STEM choices made by young people.

[32] Subsample sizes for students from Black, mixed and other backgrounds are too small to allow separate analysis.

Figure 9.2: Whether students in years 7–9 think they will continue to learn science after it stops being a compulsory subject by KS2 attainment, family connections and level of interest and perceived ability in science (2019)



Everyone has to study sciences at GCSE. After that, students can choose what they want to study, for example at A levels. Which of the following best describes your view? (SciGCSELik)

Bases: All year 7–9s (2,314); KS2 assessment: expected/below (1,819/253); older siblings: yes/no (1,348/779); university-educated parents: yes/no (1,096/1,024); FSCI many/few (588/488); interested in science: yes/no (1,766/552); think good at science: yes/no (1,320/291)

9.3. Post-16 educational pathways

Years 10 and 11

Among students in years 10 and 11, the large majority (73%) planned to study for post-16 qualifications such as A levels or post-16 vocational qualifications, while 16% said that they were considering this but had not fully decided. These figures remain largely unchanged from SET 2016.

This left 7% (n=135) of year 11 to 12s who were definitely not considering post-16 qualifications. Among this group, 33% were instead planning to start paid work, 46% an apprenticeship and 21% were undecided what they would do after year 11.

Years 12 and 13

Most students (61%) in year 12 and 13 had been studying at sixth form while 23% had been studying at a college of further education. A small proportion of students (mainly in year 13) were doing something else at the time of the survey, such as paid work (5%) or an apprenticeship (4%).

Of those students studying at sixth form or an FE college, just over half (57%) were studying for A levels, 28% for a BTEC and 12% for another type of qualification (NVQ level 3, City & Guilds or something else). Again, these findings remain unchanged from SET 2016.

Overall, 57% of students in years 12 and 13 who were at an educational institution had studied for academic qualifications and 34% had taken vocational qualifications[33]. The choice of an academic or vocational pathway was strongly associated with a range of demographic characteristics.

[33] These categories are not completely mutually exclusive as some students took a mixture of both types of qualification.

Compared with the average of 57% taking academic qualifications, females (62%), Asian students (68%), triple science students (76%), students who achieved at least two science GCSEs at grades A*–B (90%), and students from the most affluent IDACI quintile (76%) were more likely to take this route.

Compared with the average of 34% taking vocational qualifications, Black students (41%), double science students (39%) and students who did not achieve two science GCSE passes at grades A*–B (50%) were more likely to opt for this pathway.

9.4. Post-16 subject choices

The analysis in this section is based on the following groups of young people in the survey:

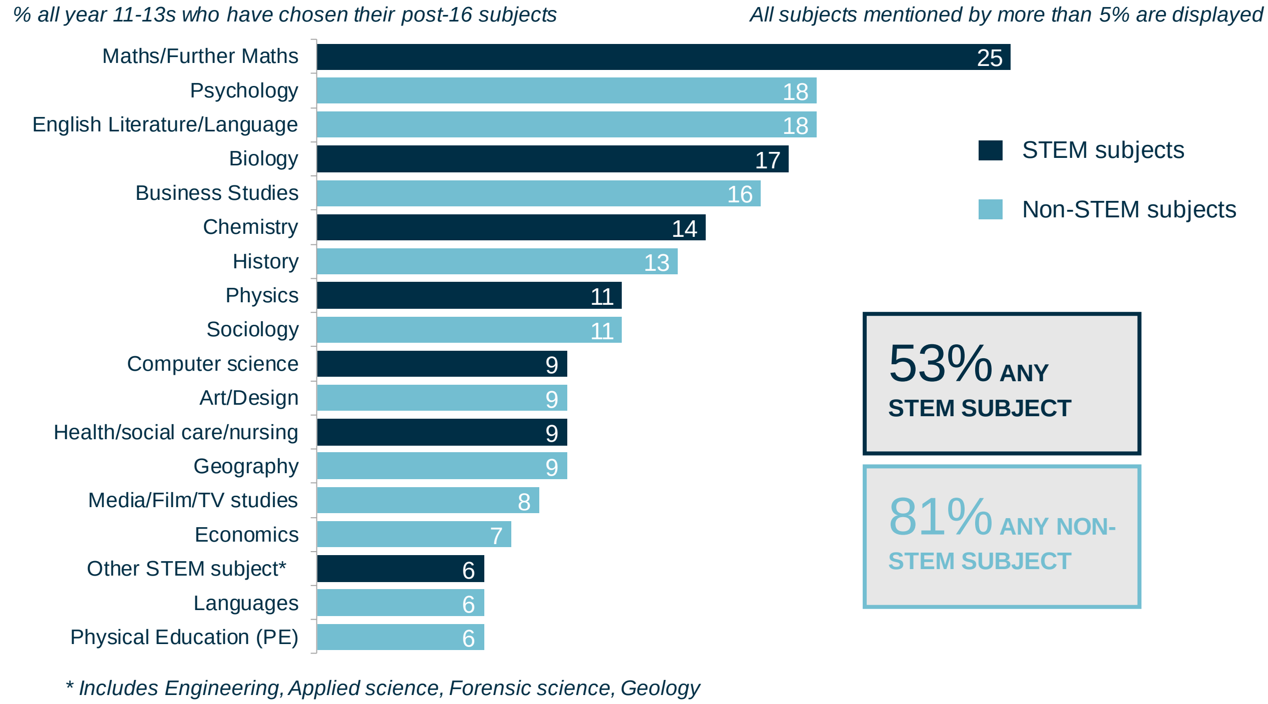
- All year 12 and 13 students who were *already* studying for post-16 qualifications in a school, sixth form or FE setting
- All year 11 students who *planned* to study for post-16 qualifications and had already made their post-16 choices about what they wanted to study.

Intended and actual subject choices have been combined, and the analysis covers all post-16 qualifications, including A level and vocational qualifications.

Figure 9.3 displays the subject choices of year 11–13 students who were studying or intending to study for post-16 qualifications. Maths was by far the most popular post-16 qualification choice (25% of this group were studying or planning to study this), then psychology (18%) and English (18%). Of the core sciences, 17% of this group had chosen biology, 14% chemistry and 11% physics. The relative ranking of these subjects is aligned with recent DfE statistics on A-level entries among young people (DfE, 2019a).

When combining the choices across all subjects, students in this group were considerably more likely to study or plan to study at least one non-STEM subject (81%) than at least one STEM subject (53%).

Figure 9.3: Post-16 subject choices among year 11–13 students who have either already started their courses (years 12–13) or who have made their choices for the next year (year 11) (2019)



(Year 11 students who have chosen their subjects for Year 12) Are you intending to study any of the following subjects in Year 12? (Y12SubL3); (Year 12–13 students studying in a school, sixth form or FE college) Which subjects have you been studying in Year 12 or 13? (CurSubL3)

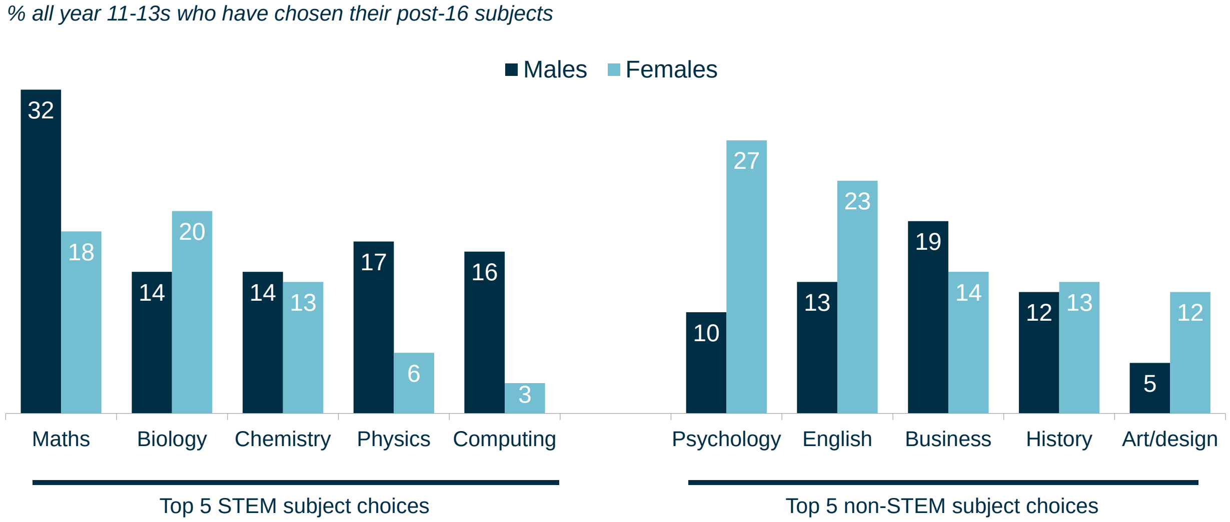
Bases: All year 11–13s who have chosen their post-16 subjects (2,257)

Figure 9.4 shows the gender differences for the five most popular STEM subjects and the five most popular non-STEM subjects, and this shows that subject choices were heavily patterned by gender. Males were more likely than females to choose most STEM subjects, including maths, physics and computer science; whilst females were more likely to choose biology, and chemistry was more balanced by gender.

Conversely, females were more likely to choose many arts and social sciences in the top 5, including psychology, English and art/design. History was more balanced by gender while business studies was more popular among males than females.

These patterns mirror very similar findings based on Next Steps data (DfE, 2019b), as well as official statistics on A-level entries (JCQ, 2019b).

Figure 9.4: Top 5 STEM and non-STEM post-16 subject choices among year 11–13 students who have either already started their courses (years 12–13) or who have made their choices for the next year (year 11) by gender (2019)



(Year 11 students who have chosen their subjects for Year 12) Are you intending to study any of the following subjects in Year 12? (Y12SubL3) (Year 12–13 students studying in a school, sixth form or FE college) Which subjects have you been studying in Year 12 or 13? (CurSubL3)

Bases: All year 11–13s who have chosen their post-16 subjects: males (1,043), females (1,184)

Figure 9.5 displays those groups that had chosen STEM-based subjects, based on all students who were either already studying or planning to study post-16 qualifications. Figure 9.5 also shows whether these students planned to exclusively study STEM subjects, exclusively study non-STEM subjects, or study a mixture.

Focusing first on the overall rate of STEM participation among students studying or planning post-16 qualifications, the overall rate of STEM participation was 53%. However, this STEM participation rate was higher among the following groups:

- Males (57% vs 48% of females)
- Asian students (69% vs 49% of white students)
- Students who had studied triple science (68% vs 42% who had studied double science)
- Students who had achieved at least two science GCSEs at grades A*–B (71% vs 39% who did not achieve this)[34]
- Students with many family science connections (68% of those with many connections vs 44% with no connections)

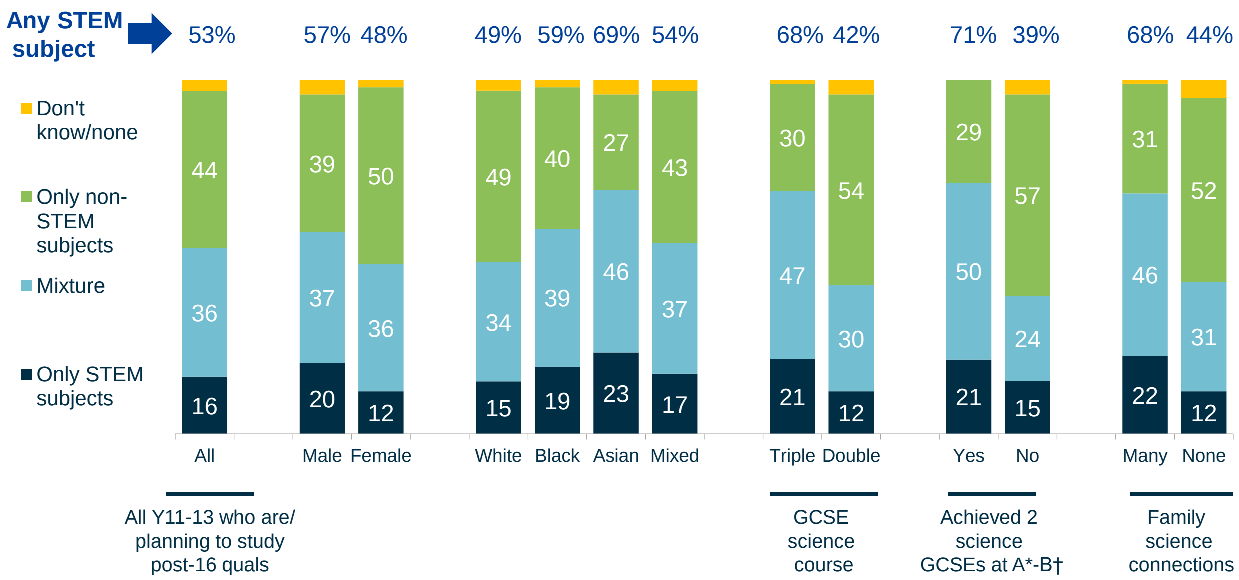
[34] This analysis was restricted to all students in year 13 who agreed to data linkage, where data was held on the NPD. A small number of year 12 students who took GCSE exams early are also included in this analysis.

It is worth noting that the gender imbalance remains even after controlling for attainment. Focusing only on year 13 students undertaking post-16 qualifications who achieved at least two science GCSEs at grades A*–B, a large majority of male students (82%) chose STEM options, while only 61% of female students with the equivalent qualifications did so. These findings reflect wider literature on post-16 choices among young people (section 9.1).

There was no difference in STEM participation at post-16 by disadvantage measures (IDACI quintiles and free school meals eligibility).

Figure 9.5: Post-16 subject choices among year 11–13 students who have either already started their courses (years 12–13) or who have made their choices for the next year (year 11); proportion who have chosen STEM, non-STEM or a mixture of subjects (2019)

% all year 11-13s who have chosen their post-16 subjects



† Only available for year 13 students who agreed to NPD data linkage

(Year 11 students who have chosen their subjects for Year 12) Are you intending to study any of the following subjects in Year 12? (Y12SubL3) (Year 12–13 students studying in a school, sixth form or FE college) Which subjects have you been studying in Year 12 or 13? (CurSubL3)

Bases: All year 11–13s who have chosen their post-16 subjects (2,257); males (1,043); females (1,184); white (1,654), Black (122), Asian (527), mixed (112); triple science (964), double science (1,162); 2 good science GCSEs: yes/no (315/300); family science connection: many/none (426/605)

Figure 9.5 also shows whether students chose post-16 subjects which were exclusively STEM, exclusively non-STEM or a mixture of the two. Overall, only 16% chose exclusively STEM options, 44% chose exclusively non-STEM subjects and 36% chose a mixture. This indicates that most students (60%) decided at the age of 16 to focus either on STEM subjects or on non-STEM (arts/social sciences/humanities) subjects. However, the latter was far more common; it was rare for students to focus exclusively on STEM subjects when making their choices.

As indicated in Figure 9.5, the proportion of students who chose only STEM post-16 subjects was higher among males, Asian students, students studying triple science, students with many science connections and students who achieved at least two science GCSEs at grades A*–B. In all of these groups around one in five (20–23%) focused their post-16 choices exclusively on STEM subjects.

10. Higher education science aspirations

This chapter explores young people's plans for higher education, including STEM and non-STEM subjects, and considers the potential influence of family experience alongside other factors on these choices.

Key findings

At all ages, most young people were considering higher education (HE), though females were more likely than males to have firm HE intentions.

- 76% of years 7–9 and 80% of years 10–13 were considering HE, though females were more likely than males to be definite in their plans (in years 7–9, 45% of females vs 35% of males were definitely planning this; in years 10–13 the gender difference was 58% vs 46%).
- Definite plans for HE declined from year 7 (43%) to year 9 (37%); this decline was driven largely by male students. However, HE intentions increased again between years 10–13, reaching 55% in year 13; this increase was driven more by female students. This gender gap was widest in year 13, when 62% of females and only 48% of males were considering HE.

HE intentions were strongly related to family university and science connections, and were also stronger among students from BAME groups.

- HE aspirations were stronger for students whose parents or siblings had been to university, as well as for those with strong family science connections, and these differences were apparent at all ages from year 7 to year 13. HE aspirations were similarly stronger for students from a Black or Asian background, and again this disparity was seen throughout all school years.

HE intentions were lower among more disadvantaged families, although these differences only became apparent from year 10.

- In years 7–9, students entitled to free school meals were as likely as those not entitled to them to definitely aspire to university (both 40%), while those in the most deprived quintile were more likely than average to definitely want to go to university (47% vs 40%). However, in years 10–13, students from more disadvantaged backgrounds were less likely to aspire to HE (46% entitled vs 55% not entitled to free school meals; 50% in the most deprived quintile vs 67% in the least deprived quintile).

Consistent with post-16 choices (Chapter 9), students were more likely to consider non-STEM than STEM subjects; aspirations became less gendered over time.

- Of all year 10–13s considering HE, 45% considered studying a non-STEM subject and 31% a STEM subject. Among year 10s considering HE, males were more likely than females to consider STEM subjects (41% vs 28%). However, as decisions were firmed up from year 10 through to year 13, the gender gap narrowed and largely disappeared.

In terms of HE subject choice, computer science and engineering were more popular among male students, while healthcare was more popular among female students.

- BAME students were also much more likely than white students to consider medicine or dentistry. These gender and ethnicity differences match similar findings on career aspirations (Chapter 11).

10.1. Context

STEM skills are crucial for the UK's productivity and economy and encouraging more people to follow higher education pathways in STEM will help address the well-documented skills shortage.

Research for the Sutton Trust (2019) found that 77% of young people aged 11–16 in England and Wales said they were likely or very likely to go on to higher education, with 39% saying very likely (this is in line with SET 2019 findings). The Sutton Trust found that disincentives to higher education included not enjoying studying, being put off by others, financial considerations and students' doubts about their own academic ability. Social constraints, including parents not having gone to university, were also an important factor. UCAS (2018) data shows that 33% of 18-year-olds in England were accepted onto a course in 2018.

Further analysis of the Next Steps survey found a greater desire to go to university for women, BAME students, those with a family history of university attendance and students with higher attainment levels (McIntosh, 2019; similar differences are highlighted in the work of Platt and Parsons, 2018). It also suggested that as the cohorts aged from 14 to 17, their responses became more realistic concerning their intention to apply to university, with a falling proportion of the lower-achieving groups intending to apply over time. Platt and Parsons (2018) found that at the age of 14, female students from a Black or Asian background had higher expectations of going to university than white females, while male students from a Black African or Asian background had higher expectations than males from a white or Black Caribbean background. HESA (2018) data confirms that new undergraduate enrolments in Higher Education each year are disproportionately among women (56%) and BAME students (particularly Asian), with lower-income students under-represented.

Beyond intentions for higher education more generally, there are many incentives and barriers to going on to study STEM specifically at higher education level, and these have their basis in motivations to study science at school, particularly at the post-16 stage, as discussed in Chapter 9. The Centre for Longitudinal Studies (2017) found that even though females were more likely than males to be sure they would go to university, teenagers continued to aspire to highly gendered career choices: this is likely to affect their choice of subject. The literature and uptake figures suggest that the shift for females away from studying maths and physics happens by the time of post-16 choices (Cassidy et al., 2018) and that this is influenced by a lack of self-confidence and perceived male dominance (see chapters 8 and 9 for discussions on STEM choices at GCSE and post-16).

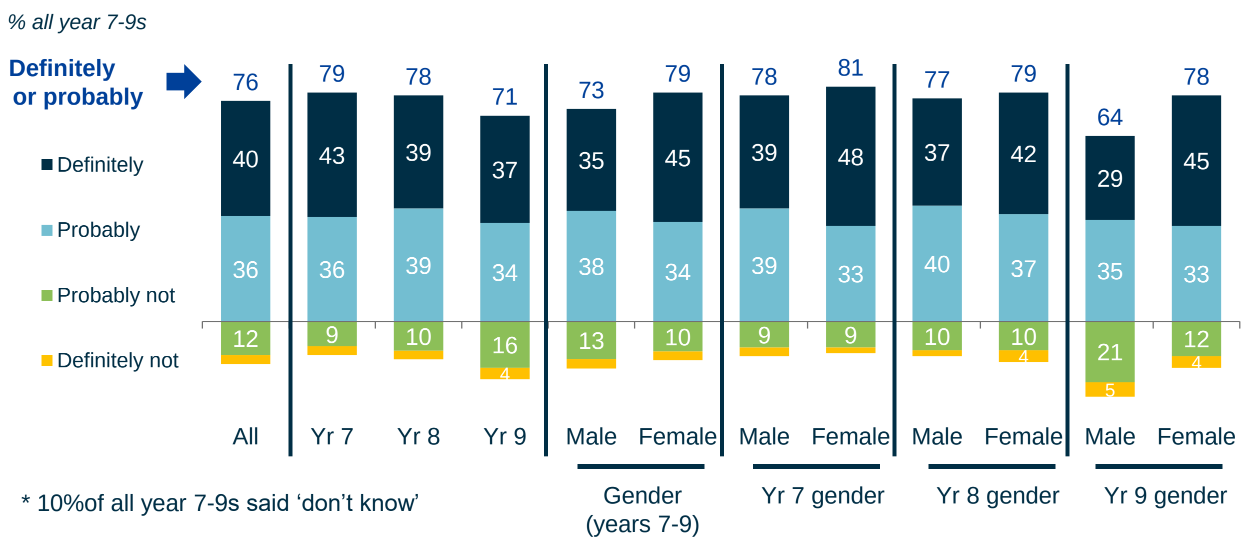
HESA (2018) data also shows that fewer undergraduate students in 2017/2018 enrolled for STEM (47%) than for non-STEM subjects (53%), though there was a slight shift towards STEM from 2013/2014 (when the balance was 45% STEM, 55% non-STEM). The increase over time in STEM uptake is observed within both genders and among students from all ethnic backgrounds. The overall higher level of uptake of HE among women, however, balances out their relatively lower level of choice of STEM subjects, with 51% of enrolments for STEM subjects among women and 49% among men.

More detailed data on the uptake of subjects by gender is given in section 10.4 and these show clear gender differences in the uptake of specific STEM subjects, with men more likely to choose engineering, technology and computer science, and women more likely to choose subjects allied to medicine (but not medicine itself) and biological sciences.

10.2. Intended pathways beyond year 13 among year 7–9s

In SET 2019, year 7–9 students were asked if they had any plans to go to university. As shown in Figure 10.1, around three-quarters of year 7–9s (76%) said that they were likely to go to university after they finished school, with 40% saying they definitely wanted to do this. These findings are in line with Sutton Trust research (2019) findings (section 10.1).

Figure 10.1: Proportion of year 7–9s who want to go to university by year group and gender (2019)



How much do you want to go to university after you finish school? (UniWant)

Bases: All year 7–9s; All/male/female 2019 (2,314/1,170/1,122); year 7 (775/412/357); year 8 (814/407/398); year 9 (725/351/367)

There were considerable differences in plans to go to university by demographic subgroup. This indicates that at this earlier school stage, HE intentions were positively associated with a younger age, females, high attainment (as measured by the quiz score), BAME groups and family university connections.

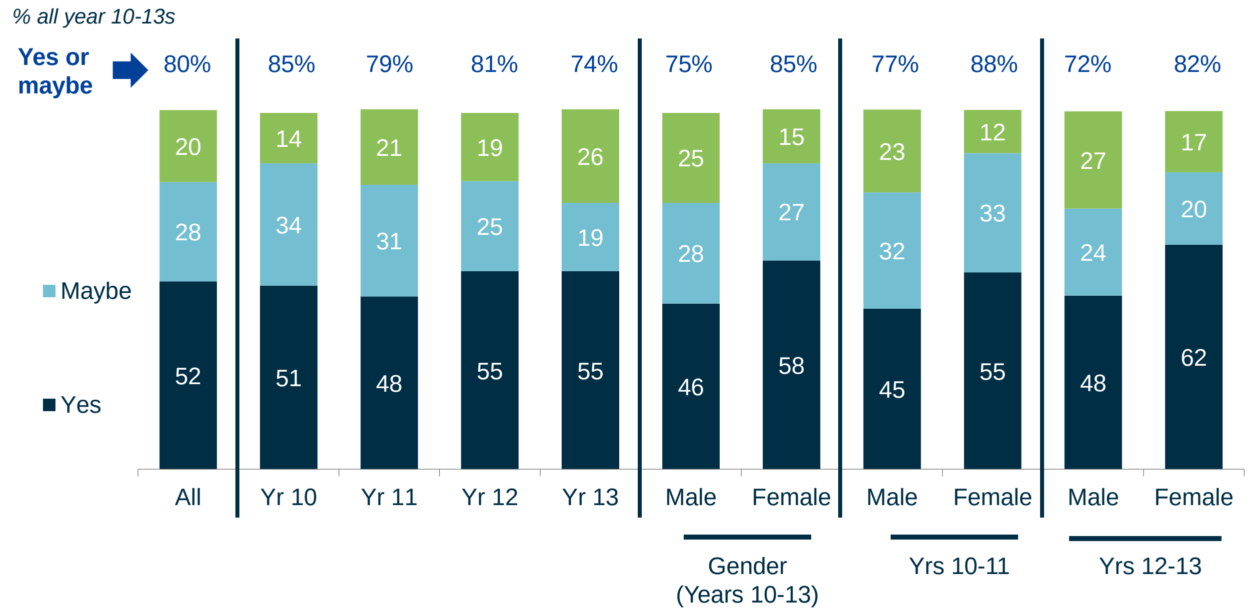
A definite intention to go to university was higher among the following subgroups in years 7–9:

- Females (45% vs 35% of males), with a wider female–male gender gap in year 9 (45% vs 29%). So, while university intentions remained stable for females by school year, for males, intentions fell away after year 8.
- Students from a Black or Asian background (65% and 67% vs 32% white and 47% mixed) and when English was not a first language (62% vs 36% of those for whom it was).
- Students with a higher level of science ability (using science quiz scores as a proxy): 53% of students with a high quiz score vs 38% medium and 31% with a low score).
- Those with family connections to university, including students with a university-educated parent (50% vs 31% of those whose parents had not been) and students with a sibling who had applied to or attended university (47% vs 33% with older sibling with no university experience).

In contrast to findings among older year 10–13 students, intentions to go on to HE were not affected by entitlement to free school meals, and year 7–9 students living in the most deprived decile were more likely than average for this age group to be definitely considering HE (47% vs 40%).

The higher education intentions of students in years 10–13 were explored in more detail, with some capacity for comparison with SET 2016 findings for this age group. The overall proportion of year 10–13 students who said they were considering going on to study at university or for a higher education qualification was a little higher than for years 7–9s, at 80%, with 52% saying that they were definitely planning this (Figure 10.2).

Figure 10.2: Proportion of year 10–13 students considering university or higher education (2019)



Are you thinking about going on to study at university or for a higher education qualification in any area of study? (FutHEQu)

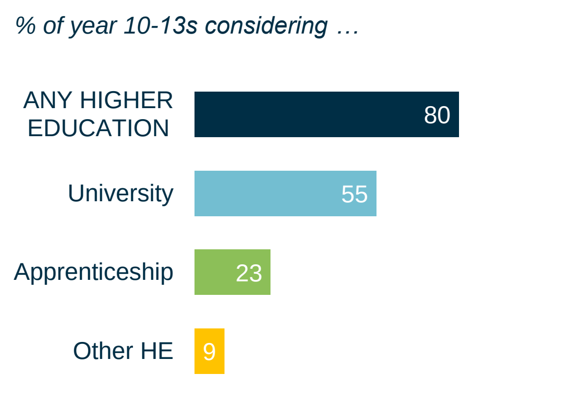
Bases: All year 10–13s (4,095); year 10 (1,044); year 11 (1,093); year 12 (1,016); year 13 (942); male (1,943), female (2,103); years 10–11, male/female (1,015/1,102); years 12–13, male/female (928/1,004)

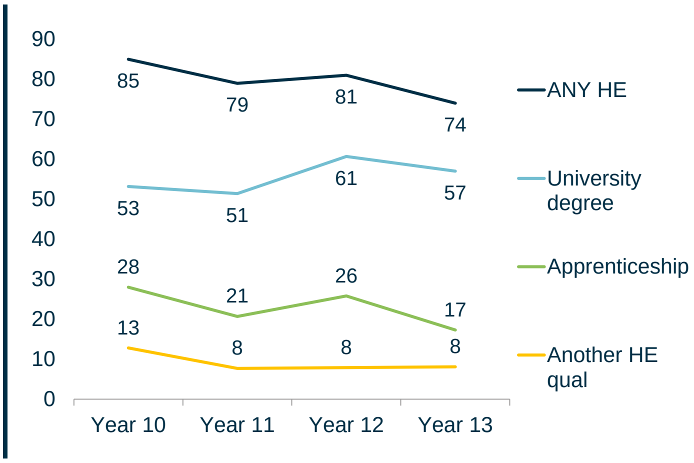
As for years 7–9, there were differences in intention by type of student, and these largely reflect the year 7–9 patterns as well as HESA (2018) statistics on entrant profiles (section 10.1). Among year 10–13 students, groups that were most likely to definitely aspire to higher education included the following:

- Female students (58% vs 46% of males), with the gender gap widening from years 10–11 (55% vs 45%) to years 12–13 (62% vs 48%). So, while intentions increased for female students from years 10–11 to years 12–13, they remained more stable for males.
- Students from a Black or Asian background and, to a lesser extent, a mixed ethnic background (72%, 70% and 60% respectively vs 47% of white students).
- Students for whom English is not their first language (71% vs 51% of those where English was their first language).
- Higher-ability groups (using science quiz scores as a proxy): students with a high or medium score (69% and 53% respectively vs 37% with a low score).
- Students with family university and science connections, including students with a university-educated parent (64% vs 48% without a university-educated parent), those with an older sibling with university experience (61% vs 39% whose older sibling did not go) and those with many family science connections (70% vs 40% with no connections).
- More advantaged groups: those not entitled to free school meals were more likely to intend to go on to higher education (56% vs 46% who were entitled), as were students in the least deprived quintile (59% vs 50% in the most deprived quintile).

When prompted with a list of options, those considering any form of higher education were, by far, most likely to say they were thinking about university (55%), while lower proportions said they were considering an HE apprenticeship (23%) or some other HE qualification (9%) (Figure 10.3).

Figure 10.3: Type of higher education year 10–13 students are considering (2019)





Are you thinking about going on to study at university or for a higher education qualification in any area of study? (FutHEQu); Which of the following are you thinking about? (FutHEWhat)

Bases: All year 10–13s (4,095): year 10 (1,044); year 11 (1,093); year 12 (1,016); year 13 (942)

It is broadly possible to compare the proportion who said they were considering going to university or on to some other form of higher education in SET 2019 (60% saying yes or maybe) with the proportion in SET 2016 who said they were thinking about going on to study for a higher education qualification (57%)[35]. Taking into account the limitations of comparability because of changes to the question, this suggests that there was little change in intention over the last three years.

Patterns of difference in intention regarding going to university in SET 2019 by school year, gender, ethnicity and social disadvantage were very similar to those in SET 2016, with a higher prevalence among older, female and BAME students and those with a higher level of attainment, family connections with science, and those from higher-income groups.

As shown in Figure 10.3, there was a clear trend in intentions from year 10 through to year 13, with a small increase in the proportion considering university (53% vs 57%) and a decline in enthusiasm for HE apprenticeships (28% vs 17%) and other HE qualifications (13% vs 8%).

- Female students were more likely to consider university (63% vs 49% of male students), with a similar disparity in every school year.
- Students from Black and Asian backgrounds were more likely to consider university (68% and 74% respectively vs 51% of white students). Other research suggests that these differences may disguise more nuanced differences, with males from a Black Caribbean background having lower aspirations (Platt and Parsons, 2018; also see section 10.1).
- Higher-ability groups (using science quiz scores as a proxy): students with a high or medium score were more likely to consider university (76% vs 37% with a low score).
- Students with family university and science connections were more likely to consider university, including those with at least one parent who had attended university (69% vs 50% who did not have a parent who had attended), those with an older sibling with university experience (66% vs 40% with an older sibling with no experience) and those with a high family science connection score (72% vs 58% with a medium score and 43% with a low one).
- Less disadvantaged groups: those not eligible for free school meals were more likely to consider university (62% vs 45% of those eligible) as were those in the least deprived IDACI quintile (67% vs 50% in the most deprived quintile).

[35] In 2016, young people were asked if they were thinking about going on to HE in a single question, with no option to say ‘maybe’; in 2019, students were asked first if they were considering HE or university at all, with options of ‘yes’ and ‘maybe’, then asked a follow-up question about the type of HE they were considering.

10.3. Family influence on decisions about higher education

Analysis in the previous section indicates that family experience of university is strongly linked to higher education intentions: students with a parent or an older sibling with university connections were more likely to be considering HE, particularly university, than those without family university connections. In support of this, McIntosh (2019) also suggests that university attendance by a family member is a strong driver of choice (section 10.1). A brief discussion below considers the extent of this family experience and how closely this experience may be linked to other potential influences on decision-making.

Four in ten students (41%) reported that one or both of their parents had gone to university, with clear differences by type of student, suggesting that differences in intention by family experience are also likely to be related to other factors: groups more likely to have a parent that had been to university included the following:

- Year 7–9s (46% vs 37% of year 10–13s)
- Students from a Black or mixed ethnic background (58% and 49% respectively vs 39% white and 41% Asian)
- High quiz score (54% vs 29% with a low quiz score)
- Less disadvantaged students: those in the least deprived IDACI quintile (58% vs 29% in the most deprived quintile) and those not eligible for free school meals (47% vs 25% of those eligible)

Sibling experience is also likely to play a role, and 27% of students reported having an older sibling who had applied to, attended or was currently at university, while 33% reported having an older sibling who was not in this position. Again, this experience was related to other factors: groups more likely to have an older sibling with experience included the following:

- Years 12–13 (34% vs 29% in years 10–11 and 21% in years 7–9), likely reflecting the age of siblings
- Black, Asian or mixed ethnic background (46%, 36% and 31% respectively vs 24% of white students)
- English not their first language (34% vs 26% for whom it was)
- High quiz score (31% vs 23% with a low score)
- More disadvantaged students, as measured by those eligible for free school meals, were more likely to have an older sibling who had not been to or applied to university (41% vs 30% of those not eligible).

10.4. Planned higher education choices

STEM vs non-STEM subjects

Contextual DfE data

Appendix B provides charts based on national data published by HESA (2018). Figure B.3 in Appendix B shows that in 2017/2018 a slightly lower proportion of students chose STEM subjects (47%) than non-STEM subjects (53%) but that there was a much greater STEM/non-STEM gap among women (42% vs 58%) than men (53% vs 47%). There has also been a very small shift for both male and female students towards choosing STEM subjects since 2013/2014.

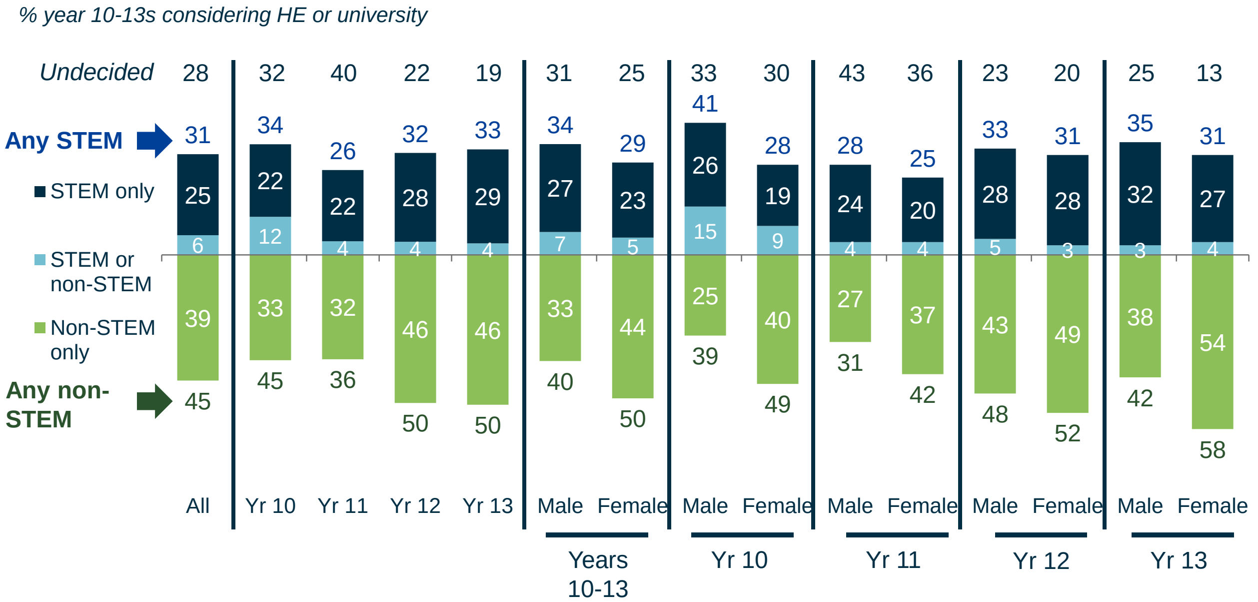
SET 2019 survey data

In SET 2019, it can be seen that among students who were thinking of going on to higher education, more students were considering non-STEM subjects (45%) than STEM subjects (31%). A quarter (25%) were exclusively considering studying STEM subjects and 39% were exclusively considering non-STEM subjects (Figure 10.4)[36]. Almost three in ten (28%) were still totally undecided, with firmer decisions being made as students progressed through the school years: indecision was highest at 35% in years 10–11 and fell to 19% in year 13. HE enrolment data from 2017/2018 (Figure B.3, Appendix B) suggests there will be a shift towards STEM in the final decision among those who go to university.

Figure 10.5 groups the responses given spontaneously in 2019 into STEM and non-STEM subjects.

[36] Students could mention more than one subject they were considering, and some mentioned both STEM and non-STEM subjects. Comparison with SET 2016 is not possible, given changes to the way the question was asked. In 2019, young people were asked to say what subject they wanted to study in their own words, and responses were later coded into categories, whereas in 2016 they had been prompted with a list of STEM subjects.

Figure 10.4: Subject types considered by students in years 10–13 who are considering higher education by age and gender (2019)



Thinking about university or higher education qualifications, what are you interested in studying? (FutHESu)

Bases: Year 10–13s considering HE or university: All/male/female: years 10–13 (3,358/1,498/1,823); year 10 (904/406/495); year 11 (881/387/480); year 12 (846/374/461); year 13 (727/331/387)

There was a complex pattern of differences regarding who considers STEM subjects among those in years 10–13 by gender and school year (Figure 10.5). Based on all who were considering HE or university, the following trends can be observed:

- Male students were a little more likely to consider STEM subjects (34% vs 29% of female students), but this difference was much greater in year 10 (41% vs 28%), with little gender disparity from year 11 onwards.
- Female students were much more likely to consider only non-STEM subjects (44% vs 33% of male students), with this gender difference seen in all school years.
- In year 10, 12% of students were considering both STEM and non-STEM subjects. By year 13, choices were more polarised.

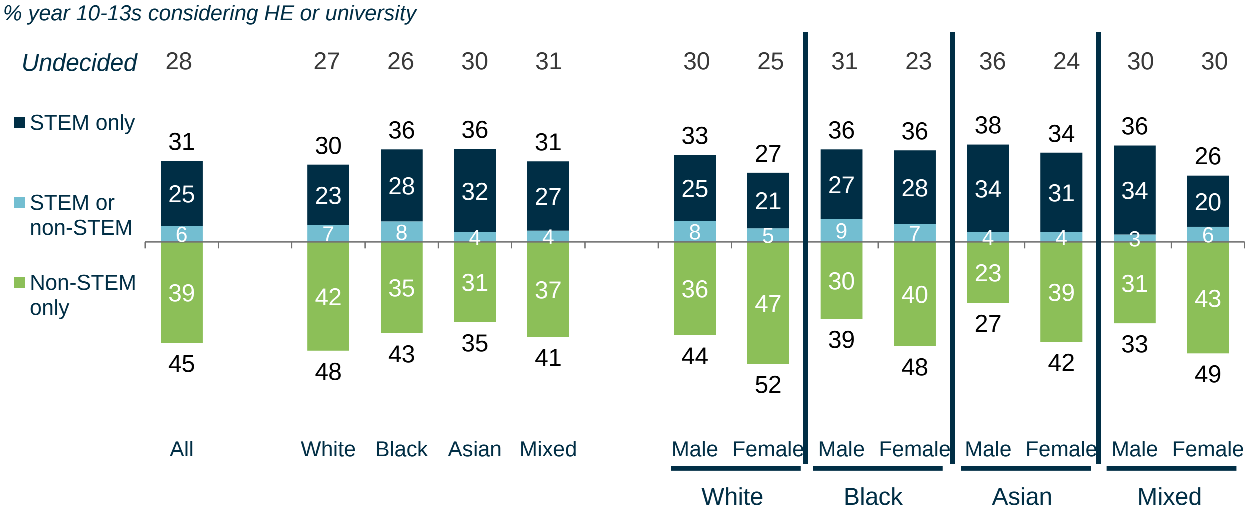
Patterns of change among years 10–13 differed by gender, as students decided more firmly:

- Male students became less likely to consider STEM subjects from year 10 to year 13 (41% to 35%) and more likely to consider non-STEM subjects only (25% to 38%).
- There was no decrease in overall consideration of STEM subjects for female students during years 10–13 (28% to 31%), but there was a considerable increase for non-STEM ones only (40% to 54%).

It is, in addition, worth noting that since female students were more likely than male students to consider going on to university or HE, some of the gender imbalance was cancelled out when looking at all students in years 10–13. In total, 26% of all male students and 24% of all female students were considering studying a STEM subject. When the data were re-based on all students, far more female than male students, however, were considering a non-STEM subject only (38% vs. 25%).

There were no differences in aspirations to study STEM subjects in HE by disadvantage measures (IDACI quintiles and free school meals eligibility). There were, however, clear differences by ethnicity, as shown in Figure 10.5.

Figure 10.5: Subject types considered by students in years 10–13 who are considering higher education by ethnicity (2019)



Thinking about university or higher education qualifications, what are you interested in studying? (FutHESu)
Bases: Year 10–13s considering HE or university: All (3,358); all/male/female: white (2,369/1,051/1,295); Black (224/104/120); Asian (499/236/261); mixed (188/77/106)

Students from a Black or Asian background were more likely to consider STEM subjects (36% vs 30% of white students), with white students more likely to consider non-STEM subjects only (42% vs 31% Asian students).

These findings are supported by HESA data on uptake of STEM in 2017/2018[37], which shows that undergraduate students from an Asian background were more likely to ultimately choose STEM subjects (54%) than those from all other backgrounds (47% white, 48% Black, 44% mixed).

Differences in intentions regarding studying STEM subjects at HE level were also observed by science ability (using science quiz scores as a proxy measure) and family connections:

- Students with a high quiz score were more likely to consider STEM subjects (43% vs 23% with a low score), while students taking triple science were more likely than those taking double science to consider STEM subjects (40% vs 26%).
- Students with a strong family science connection were more likely to consider STEM subjects (39% vs 23% with a low level of connections).

Specific subject choices

Contextual HESA data

Figure B.4 in Appendix A shows the level of HE enrolment in 2017/2018 by specific subject based on HESA (2018) data. Subjects allied to medicine and biological sciences were the most popular STEM subjects, but there were clear differences by gender, with a higher proportion of male students choosing engineering and technology (14%), computer science (10%) and physical sciences (6%), and relatively more female students choosing subjects allied to medicine (17%) and biological sciences (12%).

Taking into account total numbers of male and female students, with more female students going on to HE, men outnumber women in engineering and technology, computer science and, to a lesser extent, physical sciences and mathematics, while women outnumber men in all other STEM subjects. In particular, in 2017/2018 enrolments, 84% of engineering, technology and computer science students were men, and 81% of students of subjects allied to medicine[38] were women.

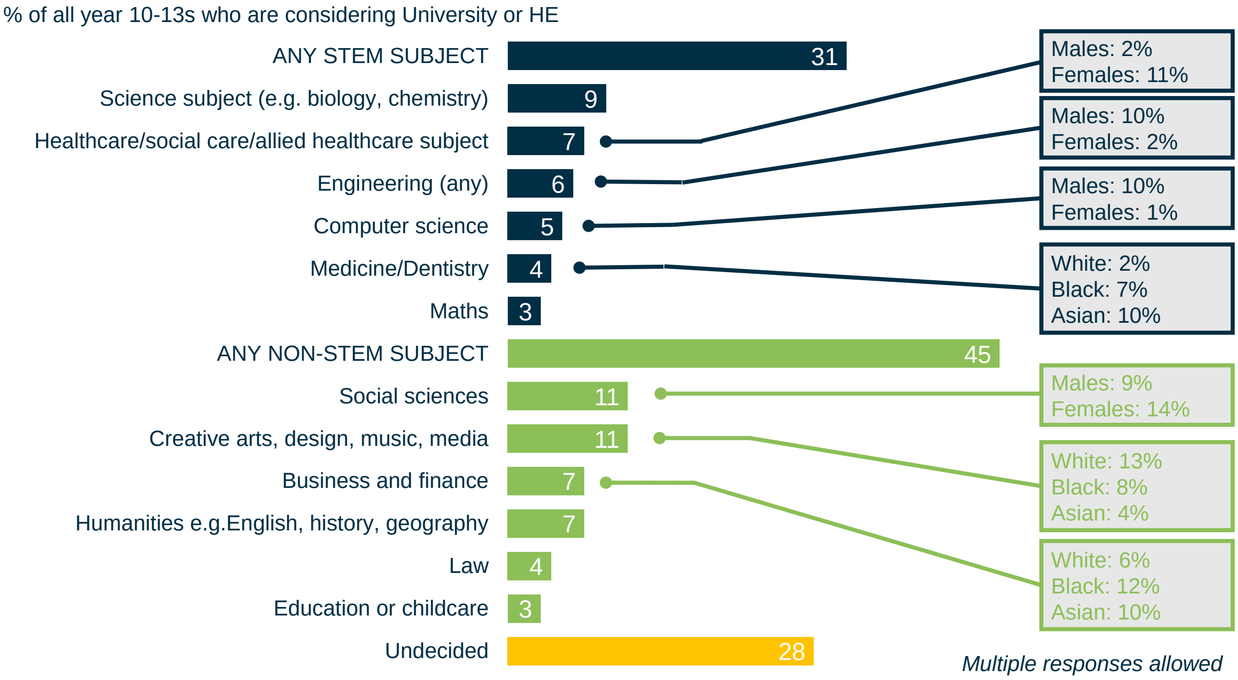
[37] HESA (2018) Higher Education Student Statistics: UK, 2017/18 https://www.hesa.ac.uk/news/17-01-2019/sb252-higher-education-student-statistics

[38] Subjects allied to medicine are those related to human health, such as nursing, pharmacy and anatomy. Over half of students in the subjects allied to medicine subject area study for nursing qualifications (HESA statistics, see previous footnote).

SET 2019 survey data

In SET 2019, while no subject areas stood out as being considered for further study (students could be considering a number of subjects at this stage), the most popular STEM subjects were the natural sciences (9%) followed by healthcare or social care (7%), with the most popular non-STEM subjects being social sciences (11%) and the creative arts (11% – see Figure 10.6).

Figure 10.6: Subject(s) considered for university or higher education among all year 10–13s considering higher education (2019)



Thinking about university or higher education qualifications, what are you interested in studying? (FutHESu)
Bases: Year 10–13s considering HE or university: All (3,358): male (1,498); female (1,823); white (2,369); Black (224); Asian (499)

While choice of STEM was discussed above, choice of subject also varied to some extent, primarily by gender and ethnicity:

By gender:

- Male students were more likely to consider computer science (10% vs 1% of females) and engineering (10% vs 2%).
- Female students were more likely to consider healthcare/social care (11% vs 2% of males) and social sciences (14% vs 9%).

These gender differences were seen in all school years and are reflected in the HESA (2018) data.

Ethnic background:

- Students from a Black or Asian background were more likely to consider medicine or dentistry (7% and 10% respectively vs 2% of white students) or business and finance (12% and 10% respectively vs 6%).
- White students were more likely to consider the creative arts (13% vs 8% Black and 4% Asian).

Students with strong family science connections were more likely than those with no family science connections to consider medicine or dentistry (9% vs 2%) and science subjects (12% vs 5%).

11. Science as a career

This chapter focuses on young people's attitudes to a future career in science, technology, engineering or maths (STEM). It begins by looking at uptake of careers advice and guidance before narrowing down to interest in a science-related career. It also presents findings on access to relevant work experience placements and specific career pathways that young people are interested in. Findings are compared with STEM 2016 where relevant.

Key findings

Parents were the most important source of careers advice for students in years 10–13.

- 68% had consulted their parents about careers advice. Students with many family science connections were also more likely to also consult friends, careers advisors, teachers and careers fairs.

Few students undertook STEM-based placements; access to STEM work experience was related to family science connections and level of disadvantage.

- 67% of year 10–13 students had completed work experience, though only 14% had completed a STEM-based placement. A quarter (27%) reported that they had wanted to secure STEM-related work experience but had been unable to do so.
- STEM work experience take-up was higher among students living in more affluent areas and with many family science connections. For these more advantaged groups, STEM work experience was more likely to be arranged through family and friends compared with less advantaged groups.

In 2019, interest in a STEM career declined with school year, although interest increased between 2016 and 2019.

- 67% of year 7 students and 66% of year 8 students were interested in a STEM career, though this gradually dropped thereafter to only 44% of students in years 12 and 13. About half (48%) of year 10–13s were interested in a STEM career, which represents an increase since 2016 (when 43% were interested).

Motivations for pursuing a science career focused mainly on interest, pay and range of career options, while barriers mainly focused on lack of interest and having alternative plans.

- Females expressed a wider range of reasons for being disinclined towards pursuing a STEM career and were more likely than males to be discouraged by a lack of enjoyment or preference for other subjects, or because they lacked confidence either in their ability generally or in their ability to reach the required grade thresholds.

Year 10–13 students with some idea about what they wanted to do as a future career were twice as likely to aspire to a non-STEM career than a STEM career. STEM career aspirations varied by gender and attainment.

- Future career aspirations were collected in an open format: 68% mentioned a non-STEM career and 34% mentioned a STEM career.
- Males were much more likely than females to aspire to engineering and computing (11% vs 2% in both cases), while females were more likely than males to aspire to a job in healthcare (19% vs 4%).
- Aspirations to study medicine or to be a scientist were much higher among year 12–13 students with strong science GCSE results, while students with weaker science GCSEs were more likely to favour a career in healthcare. An aspiration to a career in computing was not related to GCSE science attainment.

11.1. Context

The availability of good-quality careers information, advice and guidance is critical to enable young people to make relevant and appropriate choices. The House of Commons Sub-Committee on Education, Skills and the Economy stated that although schools have a statutory duty to provide independent careers guidance to pupils in years 8 to 13, in practice the guidance available is 'patchy and often inadequate' (House of Commons, 2016).

The Department for Education published an updated careers strategy in December 2017 containing a range of measures designed to improve the careers advice available to young people (DfE, 2017). This includes a commitment for all schools to meet the eight Gatsby benchmarks that define excellence in careers provision (Gatsby, 2014). The benchmarks include, for example, a stable schools career programme, personal guidance, employer encounters, and linking curriculum learning to careers.

The need for good-quality careers advice is especially important in the context of STEM careers, given the growing skills gap in sectors such as engineering and technology. The Institute of Engineering and Technology found that 46% of UK engineering employers faced recruitment difficulties due to a lack of suitably skilled applicants and 25% reported skills gaps/limitations in their workforce (IET, 2017).

However, there are also concerns about equality of access to careers education and work experience. Archer and Moote (2016) found that careers provision in schools was not just patchy but was also patterned by social inequalities. Female students, those with a minority ethnic background, lower-attaining pupils and those from lower socioeconomic groups were all significantly less likely to report receiving careers education. Indeed, the gender imbalance in engineering is an ongoing concern: Engineering UK estimates that only 12% of UK engineers are women (Neave et al., 2018).

There are signs, however, that initiatives to improve perceptions of STEM careers are having an impact on young people. The DfE found that 69% of male pupils and 51% of female pupils named a STEM subject as the subject that would most likely lead to a future job (DfE Research brief, 2019b), while the 2018 PISA survey found that 33% of UK students aged 15 felt that a science-related career was an expectation for them (OECD, 2019a), which represented an increase from 18% in 2006 (OECD, 2015b). Furthermore, Engineering UK has shown that there has been an increase in the proportion of those aged 11 to 19 who would consider a career in engineering, from 40% in 2013 to 51% in 2017 (Neave et al., 2018).

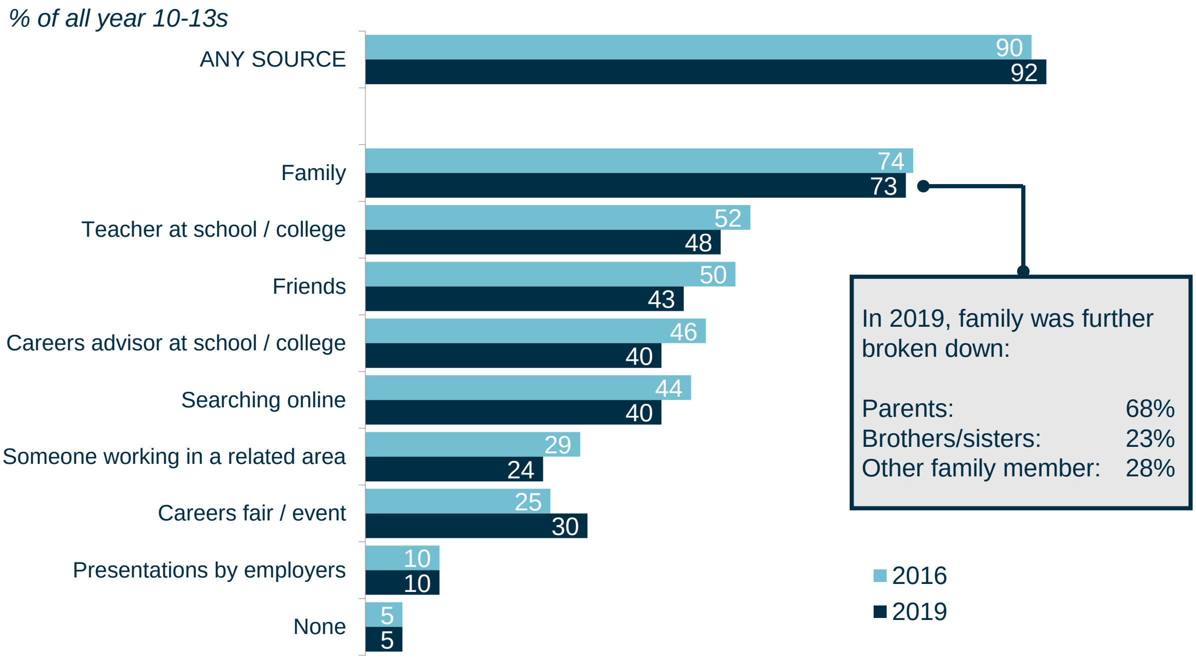
11.2. Where do young people get advice and guidance about careers?

Throughout this report, family networks have been shown to be a key influence on future aspirations throughout school life. It is therefore of no surprise that family is also the most important source of careers advice for young people (Figure 11.1). Three-quarters (73%) mentioned this as a source, which mainly comprised parents (68%) but also to a lesser extent brothers or sisters (23%) and other family members (28%)[39].

Other important sources of advice included teachers, friends, careers advisors and searching online, each mentioned by around 40–50%. Sources consulted for careers advice remained broadly in line with those consulted in 2016, although slightly lower proportions consulted non-family members (friends, someone working in a related area) and school careers advisors, while attendance at careers fairs slightly increased.

[39] The question changed between 2016 and 2019 such that instead of 'family' (as in 2016) the response options were split into parents, brothers/sisters and other family members. The 2019 responses have been combined into a composite 'family' measure for the purposes of comparison with 2016.

Figure 11.1: Sources of careers advice: 2019 and 2016



Have you ever received any information or advice from any of these sources about what you may do for a career in the future? (CarAdv)

Bases: All year 10–13s: 2019 (4,095), 2016 (4,045)

There were some differences by demographic subgroup in terms of sources of advice used:

- Students with strong family science connections were more likely than those with no family science connections to consult a range of sources, suggesting that these students were able to use their family connections to tap into wider networks. For example, this group was more likely to consult friends (50% vs 37% with no family science connections), parents (80% vs 58%) and someone working in a related field (37% vs 16%). However, they were also more likely to consult a range of other sources outside their social networks, including careers advisors (44% vs 34%), teachers (56% vs 43%), online searching (51% vs 32%) and careers fairs (40% vs 21%).
- More disadvantaged students, as measured by free school meal entitlement, were less likely to consult parents (59% vs 72% with no entitlement) or someone working in a related area (18% vs 26%) and less likely to attend a careers fair (26% vs 33%) and to proactively search online (35% vs 43%).

These findings suggest that disadvantage and lack of family connections are likely to influence the extent to which students can draw on wider networks to find out about the different types of careers available.

11.3. Access to work experience in STEM and other areas

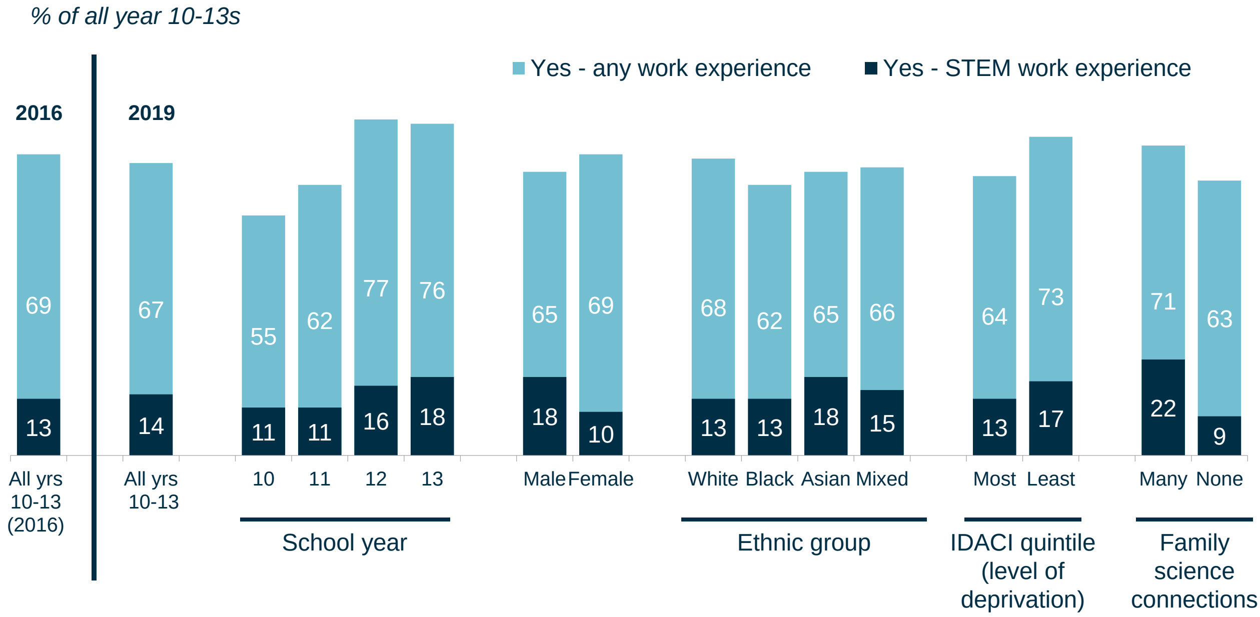
Overall rate of access to work experience

The majority of students in years 10–13 (67% overall) had completed work experience of some kind, and 14% had completed STEM-related experience (Figure 11.2). Therefore, most work experience placements were related to non-STEM sectors. These figures remain unchanged from SET 2016.

The propensity to have done any work experience increased with school year (55% had undertaken work experience in year 7, rising to 76% and 77% respectively in years 12 and 13) and was also more prevalent among students in the least deprived IDACI quintile (73% vs 64% in the most deprived quintile) and among those with many family science connections (71% vs 63% with no such connections).

When looking specifically at STEM work experience, this was higher than the average (14%) among males (18%), Asian students (18%) and those with many science connections (22%). Having access to family science connections was a particularly important factor here; students with many family science connections were twice as likely as those with no science connections to have done STEM work experience (22% vs 9%).

Figure 11.2: Whether years 10–13 have ever done work experience (2019 and 2106); and by school year, gender, ethnicity, IDACI quintiles and family science connections (FSCI) (2019)



Have you ever done any work experience? (Work exp)

Bases: All year 10–13s: 2016 (4,045), 2019 (4,095); year 10 (1,044); year 11 (1,093); year 12 (1;016); year 13 (942); males (1,943); females (2,106); white (3,015); Black (241); Asian (535); mixed (214); IDACI quintiles most/least deprived (792/733); FSCI high/low (719/1,217)

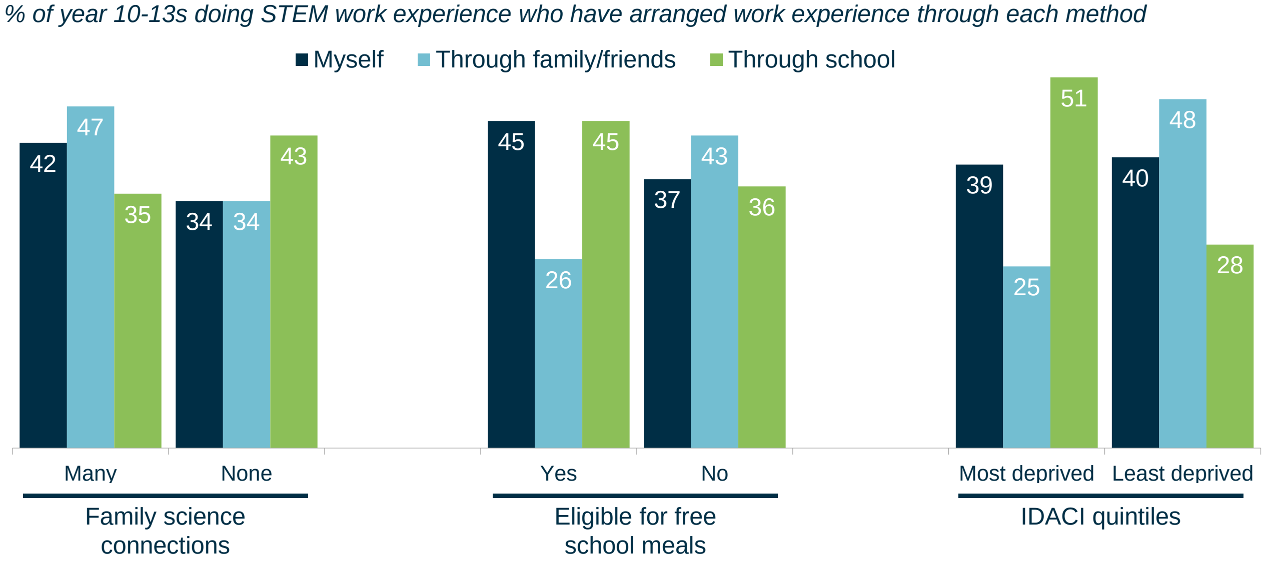
How STEM work experience was arranged

Young people in years 10–13 that had been on at least one science-related work experience placement were asked how their most recent science-related work experience had been arranged (Figure 11.3). Young people could indicate if they used more than one means of securing a placement. Two in five (39%) indicated that they arranged their placement personally, while 39% relied on family or friends and 38% arranged it through their school. These findings are broadly in line with SET 2016, although a slightly smaller proportion in 2019 arranged their placement by themselves (46% in 2016, 39% in 2019).

The routes by which young people secured STEM placements varied by school year. In year 10, placements were most likely to be made through the school (49% vs 38% overall); in year 11, family and friends was the most common route (49% vs 39% overall); while in years 12–13, STEM work experience placements were most likely to be self-sourced (45% vs 39% overall).

The means by which STEM work placements were arranged also varied by levels of disadvantage (as measured by free school meal entitlement and IDACI quintiles) and family science connections (Figure 11.3).

Figure 11.3: How STEM-related work experience was arranged by FSCI, free school meal entitlement and IDACI quintiles (2019)



Thinking about your most recent work experience involving Science, Computer science, Engineering or Maths, how was this arranged? (Workexparr)

Bases: All year 10–13s who have ever had STEM work experience 2019 (602): high FSCI (165); low FSCI (121); FSM eligible (92); FSM not eligible (442); IDACI quintiles most deprived (108); least deprived (129)

Figure 11.3 shows the following findings:

- Students with many family science connections were more likely than those with no science connections to arrange STEM work experience through family and friends (47% vs 34%).
- Students from more disadvantaged backgrounds, as measured by free school meal entitlement, were less likely than those not entitled to arrange placements via family and friends (26% vs 43%). The pattern of results when comparing students living in the most deprived quintiles with those in the least deprived quintiles was very similar.

This indicates that more disadvantaged pupils and those with fewer family science connections did not have the same access to work experience through personal networks. This underlines the importance of schools, and the education system more widely, in helping students who are not able to find relevant work experience through their own family networks.

Barriers to obtaining STEM work experience

Students lacking opportunities to participate in STEM work experience

More than a quarter of young people (27%, no change from 2016) reported wanting to secure science-related work experience but being unable to do so. The types of student who were most likely to feel they had been denied this opportunity were also those who were most likely to aspire to science pathways, as evidenced throughout this report. Therefore, this proportion was higher among Black and Asian students (both 44%); among those with many family science connections (38%); and among those with a high quiz score (39%). Males (31%) were also slightly more likely than females (23%) to feel that they had missed out on a STEM-related work experience opportunity.

Barriers to accessing STEM work experience also varied by region and population density. The proportion of students who wanted to participate in a STEM work placement but were unable to was higher than average in London (36%) and the North West (33%) and in major urban areas (34% compared with 23% of students living in rural areas).

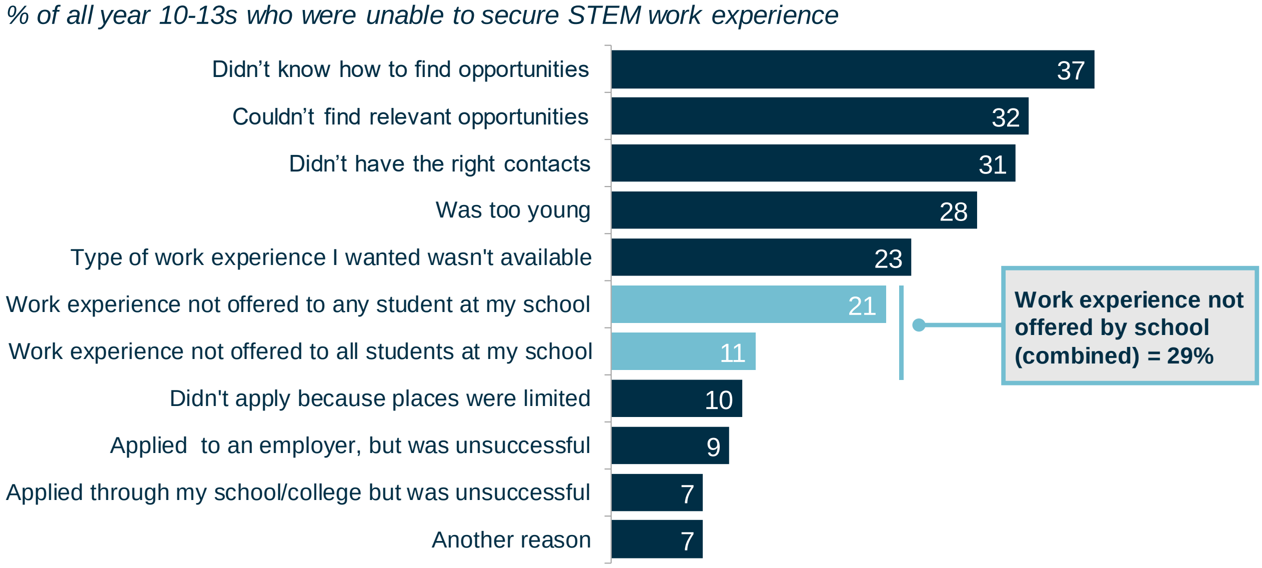
Reasons for being unable to secure STEM work experience

The most common reasons for not being able to secure STEM-related work experience related to difficulty knowing how to find relevant opportunities, either because students didn't know how to go about it (37%) or because they couldn't find relevant opportunities they were interested in (32%). The other key reasons were lacking relevant contacts (31%), not meeting age criteria (28%) and the school not offering work experience (29%). The latter response option was made up of students either saying that *no* students were offered work experience at their school (21%) or that it was selectively not offered to all students (11%) (Figure 11.4).

The question was not directly comparable with the one that was asked in 2016 as some of the response options had changed; however, for those responses that remained the same across the two survey years, the pattern of results remained very similar.

It is notable that not having access to the right contacts was a greater barrier to students not eligible for free school meals (33% vs 26% of those eligible) and to those from the least deprived IDACI quintiles (38% vs 24% in the most deprived quintile).

Figure 11.4: Reasons for not being able to do STEM work experience among year 10–13 students who wanted to (2019)



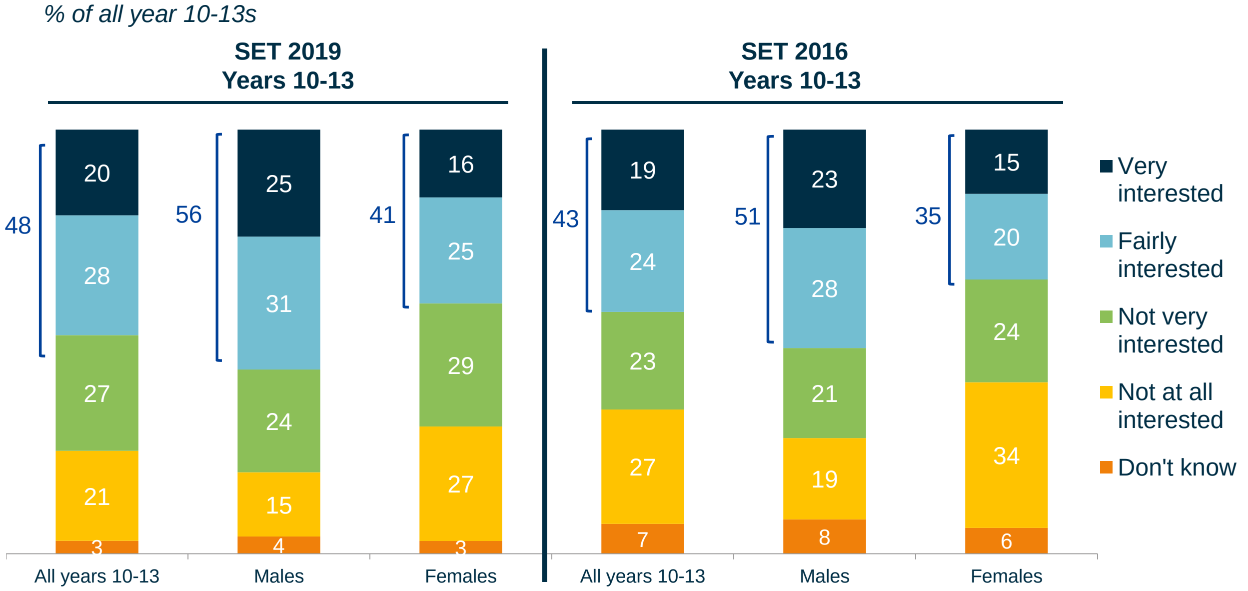
Why were you unable to do this work experience? (Workexpwhy)
Base: All year 10–13s who wanted to do STEM work experience but were unable to (1,119)

11.4. Level of interest in a STEM career

As shown in Figure 11.5, around half of students in years 10–13 (48%) were interested in a STEM career (20% very interested, 28% fairly interested). Consistent with the gender differences observed throughout SET 2019, males in years 10–13 (56%) were more interested in a STEM career than females (41%).

The overall level of interest among students in years 10–13 represents a five-percentage point increase since 2016 (from 43% to 48%) and increases were observed among both males (from 51% to 56%) and females (from 35% to 41%).

Figure 11.5: Level of interest in a science career among years 10–13 by gender (2019 and 2016)



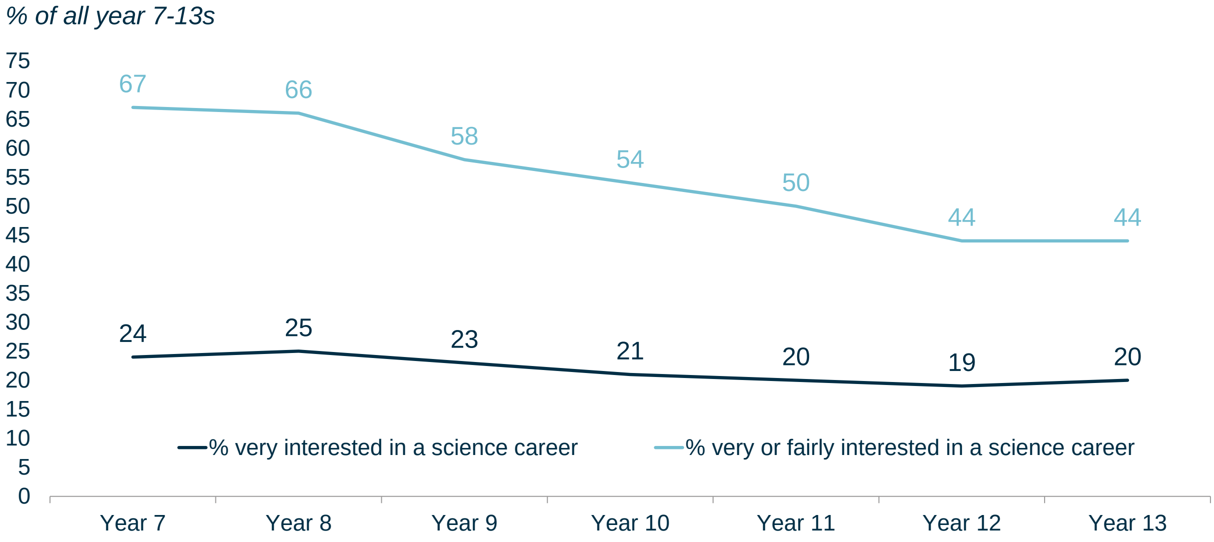
How interested are you in a future career that involves any of the following: Science, Computer Science, Engineering or Maths? (CarInt)

Bases: 2016: All years 10–13 (4,081); males years 10–13 (1,931); females years 10–13 (2,115);
2019: All years 10–13 (4,095); males years 10–13 (1,807); females years 10–13 (1,722)

In SET 2019, this question was also asked of those in years 7–9. As also shown in Figure 11.6, the overall level of interest in having such a career declined by school year, with year 7 and 8 students most interested (67%, 66%), then interest falling away quite rapidly between year 8 and year 12 (from 66% to 44%). The proportion who were 'very interested' also fell by school year, although the gradient of decline was much shallower, suggesting that there may be a core group of people interested in science careers who hold onto their intentions more firmly. This hypothesis can be tested more firmly when students are followed up as part of the longitudinal study in the future.

The reason for this decline by school year could also be related to a narrowing of choices as students get older. Younger students may be more open to careers in a range of different areas but then become more focused as they progress through school; their academic performance and interest in different subject areas could also be relevant.

Figure 11.6: Level of interest in a science career by school year (2019)



How interested are you in a future career that involves any of the following: Science, Computer Science, Engineering or Maths? (CarInt)

Bases: All years 7–13 (6,409): year 7 (775); year 8 (814); year 9 (725); year 10 (1,044); year 11 (1,093); year 12 (1,016); year 13 (942)

Overall, 55% of students in years 7–13 were interested in a science career (combining the proportion who said they were 'very' or 'fairly' interested). As shown in Figure 11.7, this proportion was raised in the following subgroups:

- Students from Asian, Black and other ethnic backgrounds (73%, 64%, 65% respectively vs 51% of white students)
- Students with many family science connections (68% vs 42% with none)

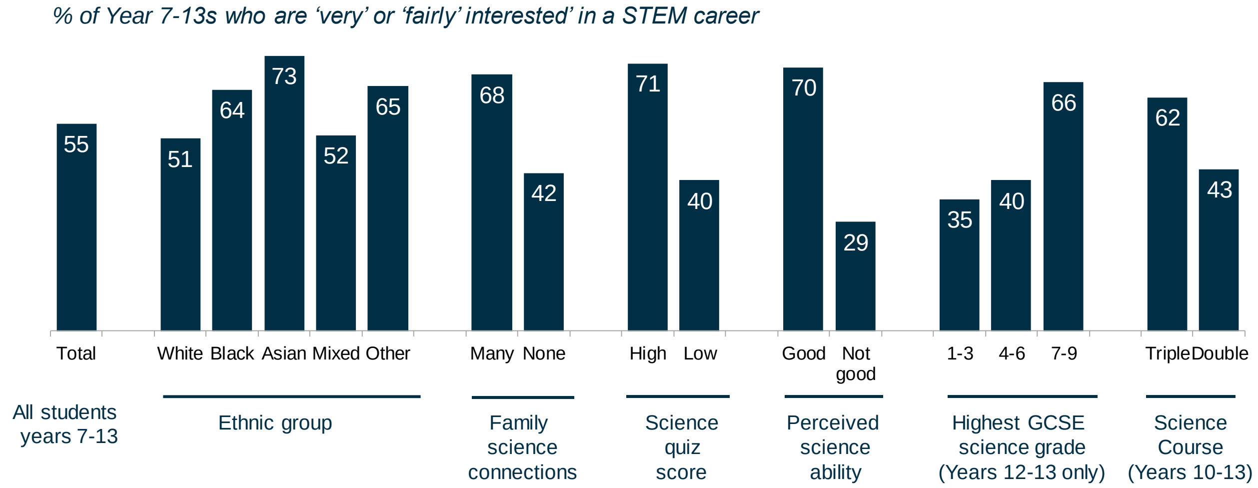
This proportion was also much higher for students who score highly on a range of measures related to attainment and ability:

- Students with a high science quiz score (71% vs 40% with a low quiz score)
- Students who thought of themselves as 'good' at science (70% vs 29% who thought of themselves as 'not good')
- Students who had followed the triple science pathway (62% vs 43% on the double science pathway)
- Students in years 12–13 whose highest GCSE science grade was equivalent to a 7–9 grade (66% vs 35% with grades 1–3)[40]

The large differences observed between those who scored highly for attainment and perceived ability clearly demonstrate that science careers are still seen as a pathway for the more 'clever' and 'sciency' students, reflecting the findings of Archer et al. (2013). There was no difference in the level of interest in a science career by disadvantage measures (IDACI quintiles and free school meals eligibility).

[40] This analysis was restricted to all students in years 12 to 13 who agreed to data linkage where data was held on the NPD. The measure relates to the highest pass point score achieved in science GCSE and equivalents. For a double (combined science) award, this represents the overall average score.

Figure 11.7: Proportion of years 7–13 who are interested in a science career by ethnicity, FSCI, science quiz score, perceived science ability, GCSE science attainment and science course taken (2019)



How interested are you in a future career that involves any of the following: Science, Computer Science, Engineering or Maths? (CarInt)

Bases: All year 7–13s (2019) (6,409); white (4,738); Black (375); Asian (804); mixed (331); other (90); FSCI high/low (1,307/1,705); science quiz high/low (1,416/1,537); perceived ability good/not good (3,403/1,009); highest GCSE science grade 1–3/4–6/7–9 (281/875/475); science course triple/double (1,529/2,124)

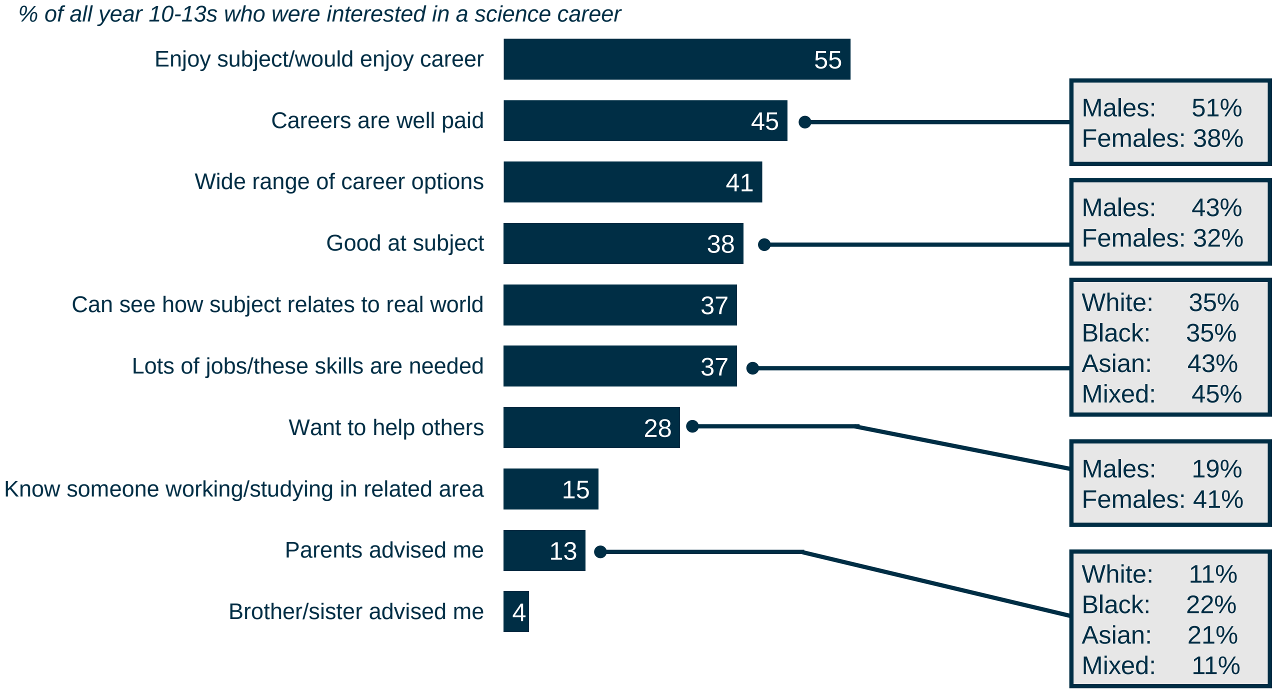
11.5. What are the motivations for and barriers to pursuing a science career?

To investigate what is driving interest in a science career, young people in years 10–13 who expressed any interest in a STEM career were asked why, and they were able to choose as many answers as they wished from a list (Figure 11.8). It is not possible to compare with SET 2016 due to changes in the composition of the list.

The main motivation was simply based on enjoyment of the subject or potential future career (55%), although level of pay (45%) and variety of career options (41%) were also important motivations. Other motivations mentioned by around 30–40% of this group included perceived ability in the subject, relevance to the 'real world', an ability to meet required skills and a desire to help others.

Influence from parents and other people they knew played a more limited role in students' interest in STEM careers: 15% mentioned being inspired by someone they knew who was working in STEM or studying a STEM subject, while 13% mentioned advice from their parents.

Figure 11.8: Reasons for interest in a STEM career among year 10–13s who are interested (2019) by gender and ethnicity



Why are you interested in a career involving Science, Computer science, Engineering or Maths? (Carwhy)

Bases: All year 10–13s interested in a science career (2019) (1,989): white (1,343); Black (140); Asian (356); mixed (100); males (1,111); females (863)

As shown in Figure 11.8, there were some demographic differences:

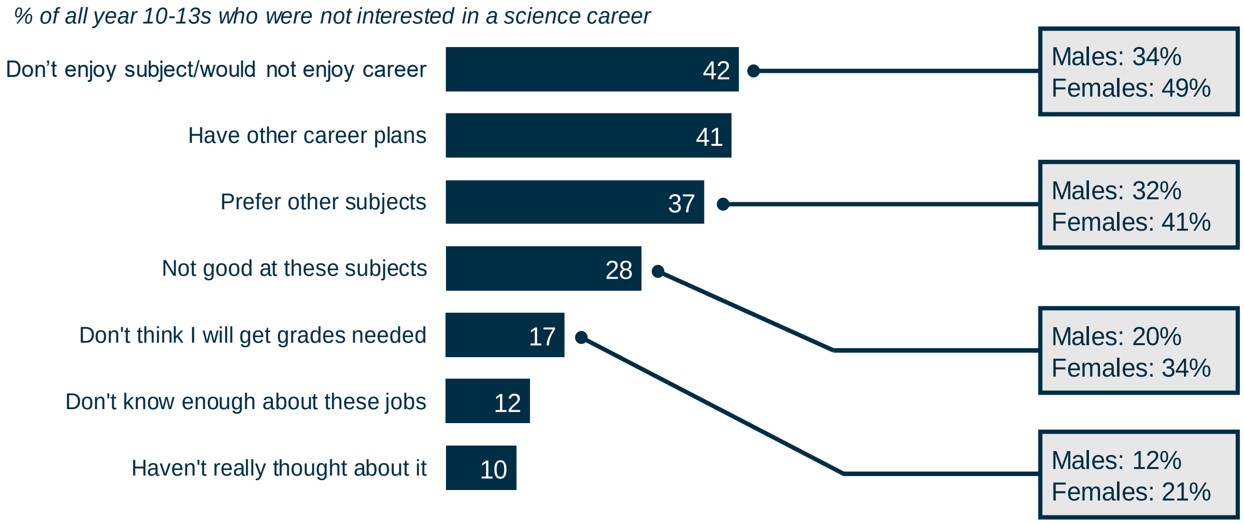
- Males and females were motivated by different aspects of a STEM career: males were more motivated by pay and because they felt they were good at the subject, while females were more incentivised by a desire to help people (which was also reflected in their specific career aspirations – see section 11.6). The link between STEM careers, pay and gender is further supported by DfE research which found that when young people were asked about the subject area they thought would lead to the highest salary, the most popular choice for both genders was science, though more so among females (39%) than males (31%) (DfE Research brief, 2019b).
- Students from a Black or Asian background were twice as likely as white students to be influenced by parents in their desire to pursue a STEM career, and students from an Asian or mixed ethic background were more likely to be encouraged by the number of jobs available requiring these skills.

Students with many family science connections generally selected a wider range of reasons than students with no such connections, as did students who were not eligible for free school meals compared with those who were.

Conversely, having little or no interest in a science-related career was primarily a result of not enjoying the subject/career (42%), having other career plans (41%), a preference for other subjects (37%) and a lack of perceived ability; the latter point was expressed as students thinking that they were not good enough in the relevant subjects (28%) or thinking they would not get the grades required (17%). Around one in ten (12%) said that not knowing enough about the jobs available was a disincentive. (Figure 11.9).

In general, females expressed a wider range of reasons for being disinclined towards a STEM career and were more likely than males to be discouraged by a lack of enjoyment or preference for other subjects or because they lacked confidence either in their ability or to get the grades required. This lack of confidence supports the findings on gender and perceived ability discussed in section 4.4.

Figure 11.9: Reasons for no interest in a STEM career among year 10–13s who are not interested (2019) by gender



Are there any particular reasons why you are not interested in a career involving Science, Computer science, Engineering or Maths? (Carwhy)

Bases: All year 10–13s not interested in a science career (2019) (1,955): males (749), females (1,184)

11.6. What careers are young people interested in?

Interest in STEM and non-STEM careers

Overall, 82% of students in years 7–13 said they had at least some idea of a future career. There was little variability by school year. Among year 7–9s, 82% had at least some idea (34% some idea and 48% a firm idea). The pattern among year 10–13s was virtually identical (82% at least some idea, 36% some idea, 46% a firm idea).

All year 10–13s[41] who had at least some idea of a future career were asked what careers they were interested in. Respondents could give as many answers as they wished; answers were collected in an open format and later coded into categories[42]. Figure 11.10 displays all careers mentioned by at least 5% of this subgroup. A more detailed explanation of some of the STEM-based categories are footnoted below the chart.

This shows that the large majority of year 10–13 students with at least some idea of a career were thinking about a non-STEM rather than a STEM career: students were twice as likely to aspire to a non-STEM career than a STEM career (68% vs 34%)[43]. Furthermore, students could give multiple responses and not all students interested in a STEM career were exclusively interested in this: 22% only mentioned a STEM career, and 12% were thinking about a range of ideas, including both STEM and non-STEM careers.

Overall, 68% were interested in a non-STEM career and the most popular choices were trade jobs, teaching, entertainment-related jobs (actor/TV/film/model, etc.), creative jobs and business.

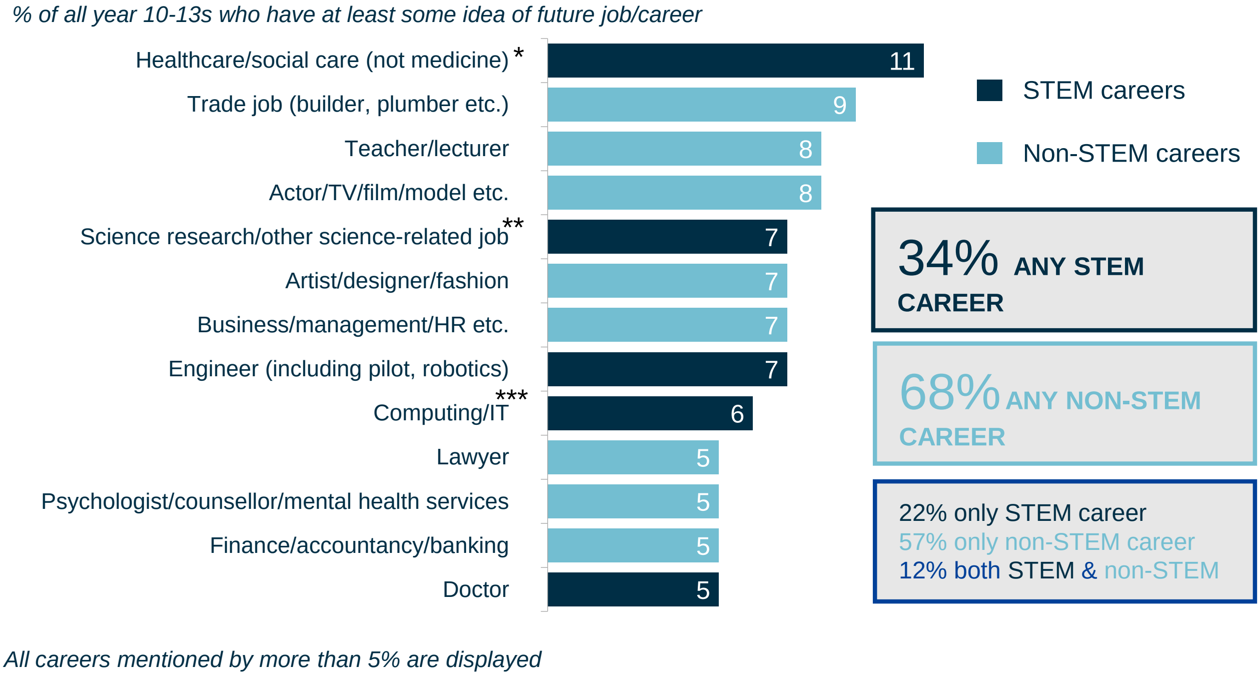
[41] This question was tested among year 7–9s at the cognitive testing phase. However, among these younger pupils, career ideas tended to be very vague and therefore this question was focused on the older age groups (years 10–13) only.

[42] Due to changes in the question format and coding, answers cannot be compared with SET 2016.

[43] The classification into STEM vs non-STEM is based on the general nature of the career, although it is appreciated that some non-STEM careers may also require STEM subjects (e.g. finance/accountancy/banking would require maths).

Overall, 34% were interested in a STEM career and the most popular choices were healthcare or social care, another science-related job (examples included physicist, biologist, lab work, etc.), engineering, computing and medicine.

Figure 11.10: Career aspirations among year 10–13s who have at least some idea of a future career (2019)



What careers are you interested in? (Carwht)

Bases: All year 10–13s who have at least some idea of future career (2019) (3,359)

**Includes, for example, paramedic, nurse, midwife, pharmacist, physiotherapist, healthcare, social care, social worker, optician and any other jobs related to health or social care*

***Includes science-related jobs or science-related research, e.g. physicist, biologist, astronomy, medical research, biochemist, forensic scientist and working in a lab*

****Includes any job related to computing, e.g. software engineering, software developer, web design, computer games design, cyber-security and artificial intelligence (AI)*

Other science careers (not shown here as < 5%) included vet, dentist and other STEM careers

It is worth noting that of those in years 10–13 with some idea of a future career, 51% said that they were very or fairly interested in a STEM career when asked in a general way (see section 11.4 above). However, when this same group of students (those with at least some idea of a career) were asked to give examples of specific careers they were interested in, the proportion who mentioned a specific STEM career was only 34%. This suggests that for many young people of this age, aspirations to study STEM subjects were not necessarily based on any fixed ideas or detailed knowledge of individual careers. In fact, of the 51% who said they were interested in a STEM career, only about half (54%) of them mentioned a STEM career in response to the open question. This suggests that although there is a general desire to pursue a career in STEM for a sizeable proportion of young people, there is a need for students to be better informed about the range of STEM career options available.

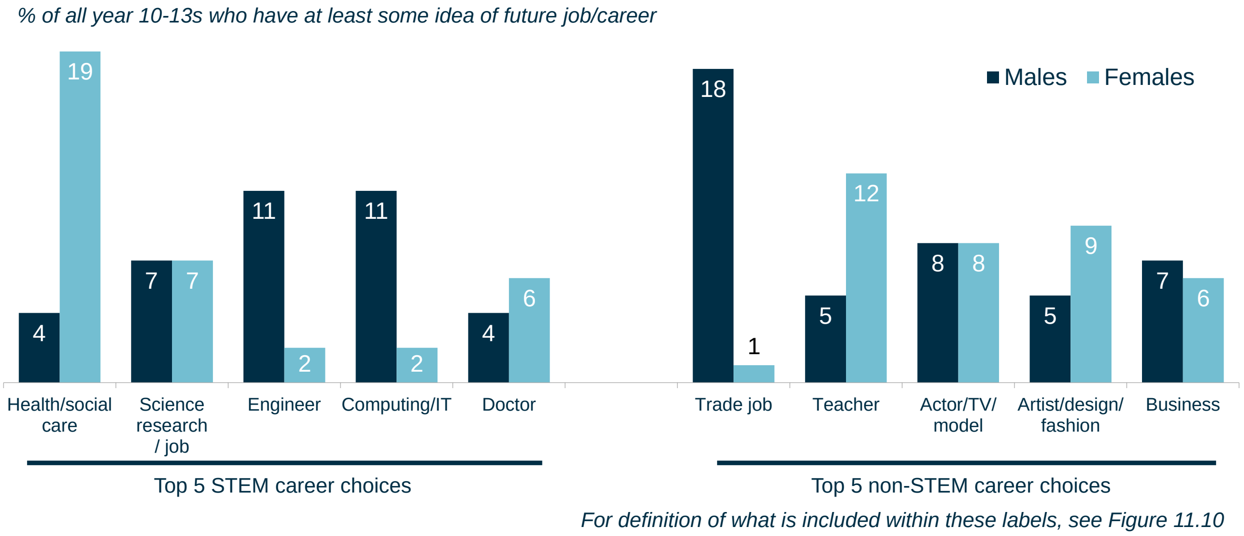
STEM and non-STEM careers by gender and attainment

Figure 11.11 displays the top five STEM and non-STEM choices among those in years 10–13 who had at least some idea of a future career by gender. This shows that some career choices were heavily gendered.

Female students were much more likely to aspire to a career in healthcare or social care (19% females vs 4% of male students) and slightly more likely to aspire to a career in medicine (6% vs 4%). These career choices align with the reasons given for wanting to have a STEM career, where females were more likely than males to be inspired to choose a STEM career because they want to help people (section 11.5). Male students, on the other hand, were much more likely to express interest in engineering (11% males vs 2% females) and computing/IT (11% vs 2%).

Of the non-STEM career choices, male students were more likely to aspire to a trade profession, while females were more inclined towards a career in teaching or art/design/fashion.

Figure 11.11: Career aspirations among year 10–13s who have at least some idea of a future career: top 5 STEM careers and top 5 non-STEM careers by gender (2019)



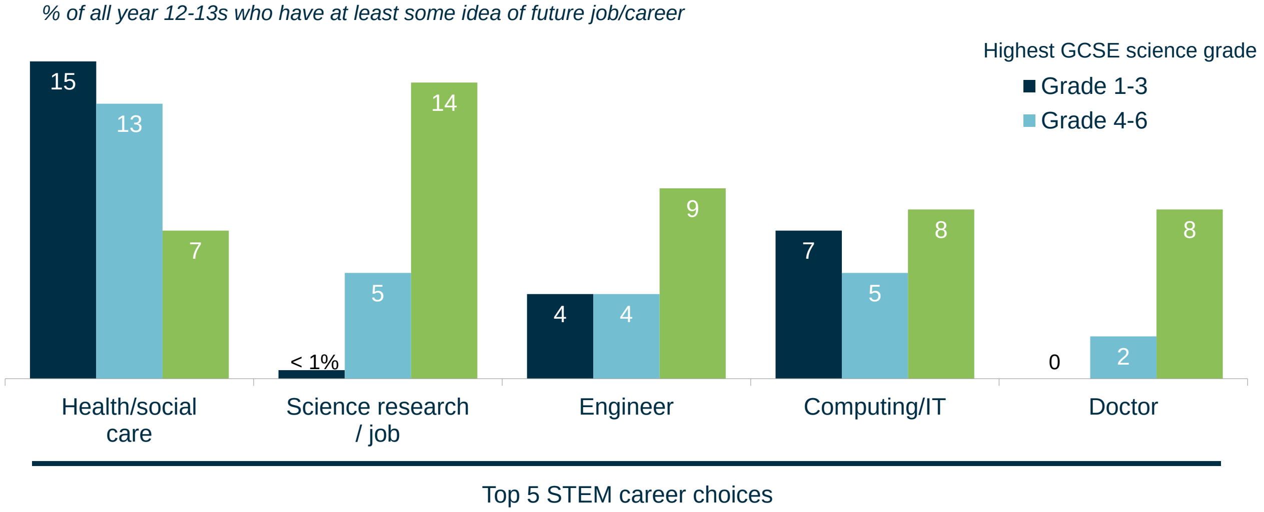
What careers are you interested in? (Carwht)

Bases: All year 10–13s who have at least some idea of future career (2019) (3,359): males (1,573), females (1,756)

Figure 11.12 shows the top 5 STEM career choices by attainment, based on all students in years 12 to 13 where we were able to obtain linked data from the NPD to classify students in terms of their highest GCSE grade (see footnote below Figure 11.12).

This shows that medicine and science jobs were mainly chosen by the most high-achieving GCSE science students, while computing, and engineering to a lesser extent, were more balanced in terms of ability: in particular, those with low GCSE science grades were as likely as those with high GCSE science grades to aspire to a career in computing. Jobs in healthcare or social care were more attractive to those with lower GCSE science grades.

Figure 11.12: Career aspirations among year 12–13s who have at least some idea of a future career: top 5 STEM careers and top 5 non-STEM careers by GCSE attainment (2019)*



For definition of what is included within these labels, see Figure 11.10

What careers are you interested in? (Carwht)

Bases: All year 12–13s who have at least some idea of future career (2019) (1,626): grades 1–3 (230); grades 4–6 (727); grades 7–9 (413)

**This chart is based on all students in years 12 to 13 who agreed to data linkage, where data was held by the NPD. The measure relates to the highest pass point score achieved in science GCSE and equivalents. For a double (combined science) award, this represents the overall average score.*

PISA 2018 data (OECD, 2019c) shows that even when high attainment is taken into account, gender gaps similar to those shown in Figure 11.11 persist. PISA 2018 found that even among 15-year-olds who excel in mathematics or science, males and females have very different expectations for their future occupation (see figures B.5 and B.6, recreated from PISA data in Appendix B). PISA found that, based on an OECD average, more than one in four high-performing males reported than they expected to work as an engineer or science professional when they were 30 years old, but fewer than one in six high-performing females reported this. Almost one in three high-performing females, but only one in eight males with the same proficiency, reported that they expected to work as health professionals.

12. Interest in biomedicine

This chapter considers interest in medical research among students in years 10–13. The number and format of questions relating to biomedical research changed between SET 2016 and 2019. In SET 2016, four questions were asked. However, in SET 2019, only one of these questions was repeated: 'Are you interested in any of these areas of medical research?'. Three new answer options were added to this question and three were removed. Therefore, comparison between SET 2016 and SET 2019 on this measure should be treated with caution.

Key findings

The main areas of medical research that young people reported being interested in were mental health issues, how the brain works, the workings of the body and the development of new drugs, vaccines and treatments.

- Overall, 48% of young people in years 10–13 said they were interested in mental health issues, 43% in how the brain works, 36% in the workings of the body and 29% in the development of new drugs, vaccines and treatments.

Females expressed more interest in medical research than males.

- Females reported more interest than males in all medical research areas, apart from nutrition, where there was no significant gender difference.
- In particular, females were nearly twice as likely to cite mental health issues as an area of interest (62% compared with 34% of males). Similar gender differences were noted in 2016.

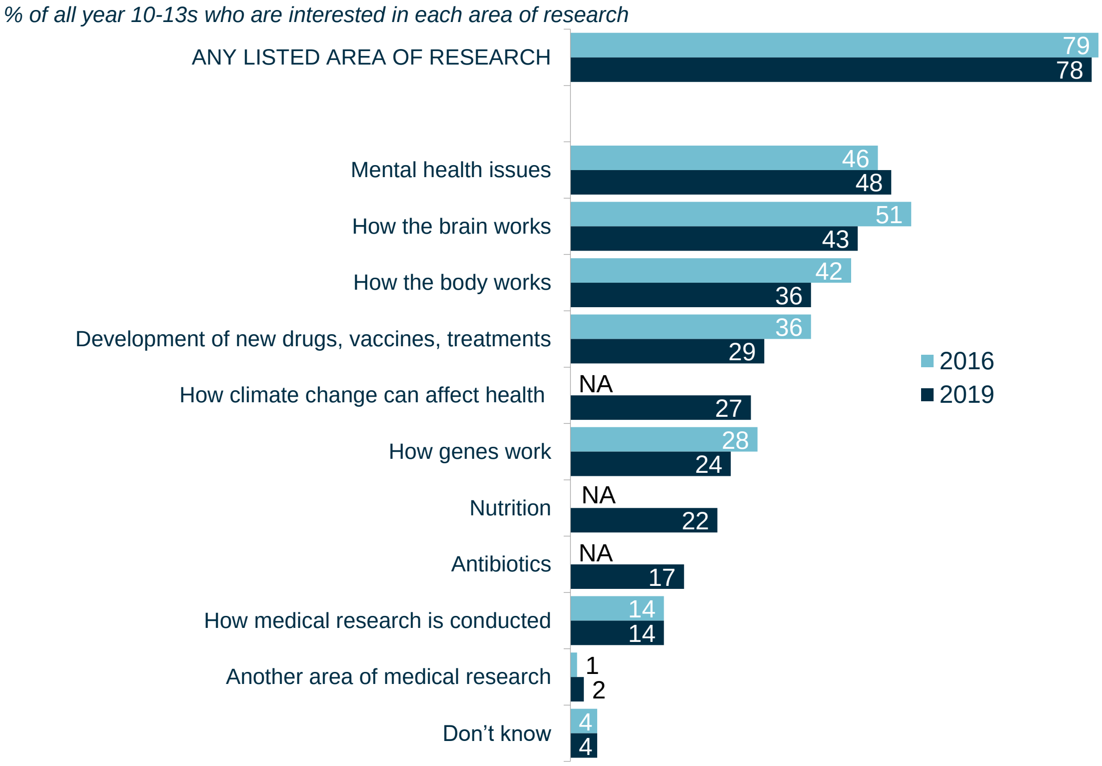
12.1. Specific areas of interest in medical research

The main areas of medical research that young people in years 10–13 said they were interested in were mental health issues (48%), how the brain works (43%), the workings of the body (36%) and the development of new drugs, vaccines and treatments (29%) (Figure 12.1).

Three new answer options were included in SET 2019: how climate change affects health; nutrition; and antibiotics. Of all those in years 10–13, 27% said they were interested in how climate change affects health, 22% in nutrition and 17% in antibiotics.

Interest in all research areas decreased between 2016 and 2019, except for mental health issues and how medical research is conducted, where there was no significant change between the two surveys. However, these differences should be interpreted with some caution as it is possible that these differences were partly caused by changes in question context and wording over time, as noted above.

Figure 12.1: Areas of medical research that year 10–13 students are interested in (2019 and 2016)

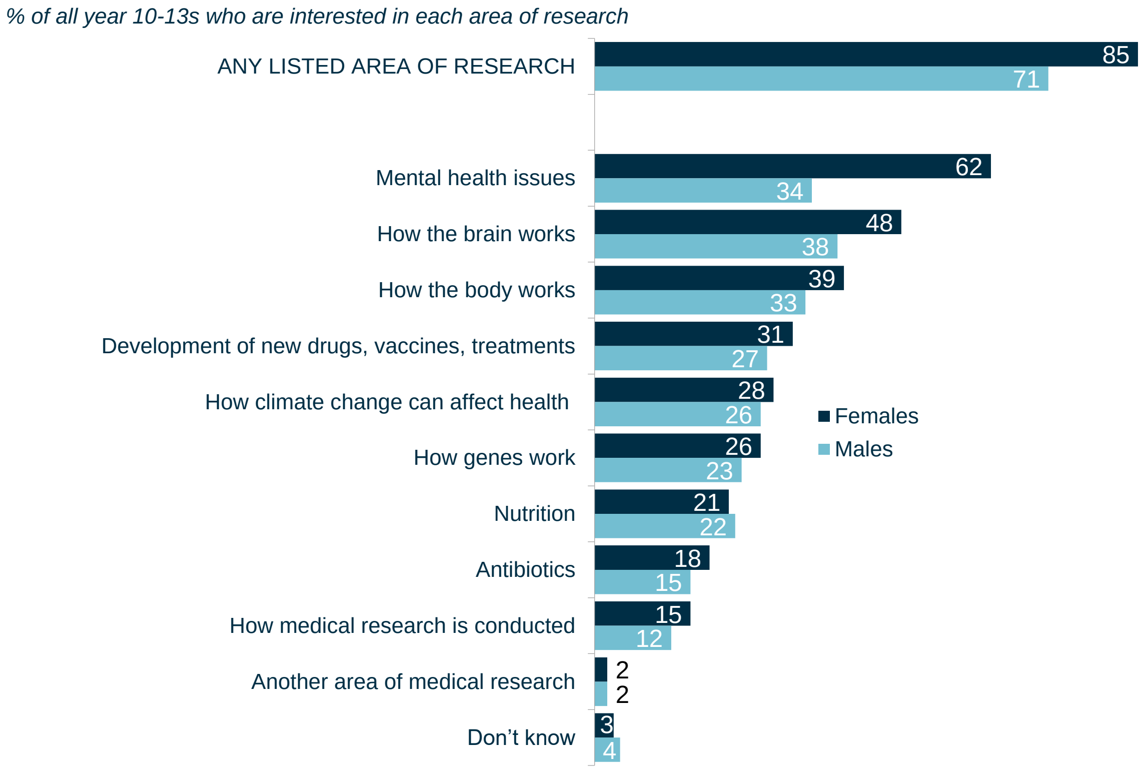


Q. Are you interested in any of these areas of research? Choose all that apply. (BioINtSp)
Base 2019: All year 10–13s, sample B: Total 2,098; Base 2016: All year 10–13s, half sample: Total 2,037

12.2. Interest in medical research by gender

Females expressed greater interest than males in many medical research areas. For example, females were nearly twice as likely to cite mental health issues as an area of interest (62% vs 34% of males) and were also 10 percentage points more likely to express interest in how the brain works (48% vs 38% of males). Similar gender differences were found in 2016.

Figure 12.2: Areas of medical research that interest year 10–13 students by gender (2019)



Q. Are you interested in any of these areas of medical research? Choose all that apply. (BioINtSp)
Bases 2019: All year 10–13s: Total 2,098; females (983); males (1,092)

Reflections

The Science Education Tracker, which was conducted in 2016 and 2019, explores young people's experience of science learning in England and provides insight into what shapes their experiences, perceptions and educational choices. In addition to being interesting in its own right, the findings of the 2019 survey (SET 2019) will prove useful to a range of audiences, from practitioners in schools, to policymakers, to employers – essentially to stakeholders with a concern in increasing and widening participation in STEM. It provides some challenging food for thought, particularly concerning issues related to equity and diversity. This reflection on the report builds upon the key findings of SET 2019 and draws out and contextualises key messages and themes, concluding by considering implications for education policy and practice.

Family science connections

As with SET 2016, family science connections (e.g. science 'social capital', or people that students know who are connected to science) continue to be a key factor shaping young people's experience of science, in and outside of the classroom, including participation, attitudes and aspirations. Young people with higher scores on the Family Science Connections Index (FSCI)[44] were more likely to participate in science outside of school, to find school science interesting/enjoyable, to feel they are 'good' at science, to feel motivated to continue with science, to study triple science, to consult with their parents about GCSE options and to participate in STEM work placements. It is noteworthy that these findings align well with existing research on science capital. As with students with higher FSCI scores, the wider literature similarly notes that students with higher levels of science capital also participate more in science both inside and outside the classroom and are more likely to develop and maintain science aspirations over time – which is all consistent with seeing science as 'for me'. Given that research highlights the key role of family (e.g. a parent's science qualifications) in an individual's science capital (cf. Archer and DeWitt, 2017; Archer et al., 2015), the similarities in findings between SET 2019 and research on science capital are to be expected and, indeed, reinforce the value and validity of the way in which the SET survey considers young people's family science backgrounds when exploring their experiences of science. Put succinctly, although family science connections and science capital are not identical constructs, with science capital encapsulating a broader range of resources, the FSCI would seem to be a reasonable proxy for a fuller measure of science capital.

The relationship between family science connections and dis/advantage is also noteworthy and resonates with the emphasis that research on science capital places on equity. As with SET 2016, young people from disadvantaged families in SET 2019 were more likely to have low FSCI scores, compared with those from more advantaged backgrounds. This connection, while not surprising, is of particular concern because of ample evidence that engagement with science, including but not limited to participation in post-compulsory science, can support later success in life, such as by increasing access to career opportunities. Moreover, if students with low FSCI scores also face disadvantage in other areas, such as economic ones (e.g. with parents lacking the financial capital to support science engagement outside of school, or encountering limited community resources), this intersection places an onus on schools and teachers to provide additional support, an obligation which can be challenging to fulfil in the current educational system (DeWitt and Archer, 2017). This situation also reinforces the importance of other resources in the wider community, such as youth programmes, as well as university and industry outreach programmes and others, being sufficiently funded and available to young people and being developed thoughtfully to encourage engagement with STEM.

[44] For terms, abbreviations and acronyms, please refer to the glossary in this report (Table 1.2).

It is useful to remember that background factors – whether economic, social, ethnic/racial, gender or otherwise – are not determinative and that all individuals have some resources, some science capital, which can be built upon to strengthen connections to and engagement with science. For instance, although social disadvantage and ethnicity all too often overlap, it is encouraging that SET 2019 students from Black ethnic backgrounds were more likely to report stronger family science connections than students from other ethnic backgrounds (including white). When developing programmes, whether in schools, in the informal science learning sector or in the wider community, to engage young people with science, it is helpful to get to know the young people involved and identify the resources, or assets, they already possess that could serve as useful starting points and bridges to engage them more deeply and meaningfully with science.

The gender gap

The findings from SET 2019 reflect that little seems to have changed in terms of the persistent, seemingly intractable, gender gap in STEM. While ample research, including the 2018 PISA survey, highlights that there is little gender difference in terms of attainment in science, strong gender differences in attitudes and aspirations remain. In particular, SET 2019 confirmed that females feel less confident in their ability in science, perceive more barriers to studying science (especially those related to difficulty and perceived ability) and report more anxiety around science tests (as well as tests in maths and English) compared with males. Males are also far more likely to aspire to careers in engineering and computer science, while females are more likely to aspire to work in health/medicine. These findings about engineering and physical sciences align with those from PISA 2018, for both the UK and the wider group of participating countries, as well as with results from the ASPIRES research highlighting that gender was by far the most significant factor predicting engineering aspirations (Moote et al., 2020). The stark gender differences in interest in computer science found in SET 2019 are also a concern in light of policymakers' interest in encouraging uptake of the subject to support future economic prosperity, and further research could usefully explore more carefully what might underpin this disparity.

Gender differences in aspirations have formed the focus of substantial research and are often considered through the lens of identity. That is, aspirations can be regarded as indicative of the extent to which young people perceive a particular area, such as science, to be 'for me'. Research on science identity has highlighted that science – and physics in particular – is often aligned with masculinity, presenting challenges for girls and young women to find a place for themselves in science (Archer et al., 2017; Carlone and Johnson, 2007; Jones et al., 2000). Such research also makes the point that classroom practices can reinforce these messages about who science is 'for' and present challenges for females, and especially females of colour, to assume and maintain a science identity (Calabrese Barton et al., 2008; Carlone, 2004; Carlone et al., 2011; Mujtaba and Reiss, 2013a). At the same time, the research also reflects the potential for out-of-school science experiences, when well designed and developed, to support the science identities of individuals from diverse backgrounds (Calabrese Barton and Tan, 2010; Gonsalves, 2014; Gonsalves et al., 2013).

Gender differences in aspirations also correspond to attitudes towards subjects within science. SET 2019 found that while interest in science overall seems comparable for males and females, this masks a strong difference among subjects within science. In terms of reported interest, subject choices and aspirations, females expressed a strong preference for biology, while males strongly preferred physics and computer science. Some of these gradients become steeper as young people go through their school lives, with the difference in interest between males and females in computing (with males being more interested) becoming even more pronounced.

Although years of initiatives have aimed to increase the representation of females in the physical sciences and engineering, the findings from SET 2019 reiterate those from PISA 2018 – that there is still considerably more to be done. We turn to a consideration of areas that could be considered in future initiatives later in this chapter.

Ethnicity

As would be expected, SET 2019 also highlighted differences among students of different ethnic backgrounds. What seems to be particularly salient, however, are the positive attitudes, aspirations and interest in science among students from BAME backgrounds, compared with white students, as well as their participation in science outside of school. For instance, students from Asian backgrounds were more likely to participate in science-related extra-curricular activities at school, to be encouraged to study science by a range of factors and to have stronger perceived abilities in science. Asian and Black students were also more likely than white students to be interested in science and to want to pursue science post-GCSE. However, students from BAME backgrounds were less likely to consult their parents about GCSE choices.

These findings resonate with other research but should be considered within the broader context of participation, particularly who continues to study science post-GCSE and ultimately pursues a career in science. For example, students pursuing three sciences at A level are substantially less likely to come from Black Caribbean backgrounds than from Asian backgrounds, especially Indian and Pakistani ones (Campaign for Science and Engineering, 2014). Moreover, while the picture of ethnicity in the STEM workforce is extremely complex, it is notable that individuals from Black backgrounds are under-represented in more senior roles (Royal Society, 2014).

That disparities in participation are unlikely to be simply related to the level of interest in the subject is supported by the findings from SET 2019 and reinforced by findings from other research showing that Black students in secondary school report participating in unstructured science-related activity (e.g. watching science-related programmes on television or online) and school-led science enrichment, but are less likely than other groups to engage in more structured activity (e.g. visits to science centres), which often have associated costs (DeWitt and Archer, 2017). Put differently, when opportunities to translate their interest into practice are accessible, students from marginalised groups are likely to do so, but policies and practices in many schools (e.g. only allowing pupils in top sets to go on school trips or participate in other forms of enrichment) act against this. This situation also further highlights the key role that could be played by broader facets of the learning ecosystem, such as community programmes and youth development activities.

The learning mindset

A learning, or 'growth', mindset can be defined as a belief that abilities and intelligence are not fixed or innate but can be built. Pupils with this view are likely to attribute difficulty or lack of success as something that can be addressed and changed with effort, and research highlights the benefits of such a mindset for resilience (Dweck, 1986; Haimovitz and Dweck, 2017). Interestingly, and encouragingly, SET 2019 found that the majority of students in years 7–13 espouse beliefs consistent with a learning mindset, being more likely to agree that exam success in science is attributable to hard work rather than natural ability. This finding also resonates with PISA 2018, which found that a majority of students across participating countries had a growth mindset, and this proportion was particularly high among UK students. That this is the case holds some promise around reducing the gender gap in STEM, particularly as it resonates with research suggesting that females in particular may identify, and be identified, as 'hard workers' in school science (Carlone, 2003, 2004). That is, while females may lack self-confidence in their abilities, particularly in physics, maths and computer science, they may feel more confident in subjects where hard work is perceived to be required more than 'natural brilliance'.

Interest in science

While it is encouraging that interest in science has not declined since SET 2016 among students in years 10–13, SET 2019 offered the opportunity to also examine interest in science during the early part of secondary school. Closely echoing the findings from ASPIRES, there was a pronounced drop in interest from year 8 to year 9, with 23% of year 8 students but only 14% of year 9 students agreeing that they were 'very interested' in science. While this dip was present among most subgroups, it is of particular concern that it was more apparent among those who considered themselves to be 'good' at science (a drop in the proportion who were 'very interested' from 38% to 26% between year 8 and year 9) and those with high science quiz scores (a drop from 47% to 21%). While these students were still more interested in science than those with, for instance, low quiz scores or those who did not consider themselves to be 'good' at science, it is a concern that these students, who would seem particularly likely to continue with science and have the attainment required to do so, are those losing interest most dramatically.

Although SET 2019 did not explicitly ask about reasons that may underpin this dip in interest, it may be linked with students' reduced experience of practical work from year 7 to year 9, as well as an increase in the proportion of students perceiving science as 'difficult' and as involving 'a lot to learn'. It is also perhaps no coincidence that it corresponds with the beginning of the GCSE syllabus in many schools. It has been estimated that nearly two-thirds of schools now start the GCSE syllabus in year 9 (TES, 2019b). Moreover, students beginning the GCSE syllabus in year 9 in the SET 2019 cohort will have encountered the revised GCSEs (the course was introduced for science in autumn 2016, with exams in 2018), which cover increased and more challenging content. This raises the question as to whether the necessity of covering an increased volume of content may be limiting the amount of time teachers feel they can devote to activities and approaches, such as practical work, extended enquiry, linking to careers, and others, that would support interest among a wide range of students – including not just those who may be less interested to begin with but even those who have been attaining well.

Practical work

The SET 2019 data demonstrate that practical work continues to play a key role in motivating young people to study science, with 55% of students in years 7–9 and 32% of those in years 10–13 agreeing that it has encouraged them. However, the frequency of practical work declines year on year, with 63% of year 7 pupils but only 37% of year 10–11 pupils reporting doing hands-on practicals at least once a fortnight, a notable drop from the 44% of year 10–11s in SET 2016. Given the important role practical work plays in enthusing young people to learn science, a reduction in the quantity of practical work may be correspondingly contributing to the drop in interest from year 8 to year 9. It is also noteworthy that it is disadvantaged students (those from the most deprived IDACI quintiles) and those who are least interested in science who are most keen to do more practical work. Although, encouragingly, students in more deprived areas are as likely to experience practical work as those in less deprived areas, this should be considered in light of an overall drop in practical work among schools in less deprived areas since SET 2016 and a drop in practical work as students progress through school.

While the SET dataset cannot identify the reason for this decline in practical work, a likely contributory factor is the revised GCSE syllabus and examinations. Practical work seems to be less of a focus in the revised GCSEs, leading to less classroom time being available for teachers to devote to these activities. It would be interesting to examine whether the increased volume of content is squeezing out practicals. Moreover, and in a change from assessment at the time of the SET 2016, science practicals no longer count towards a student's final GCSE grade, which probably also influences the extent to which teachers feel able to emphasise practical work.

There have been a number of critiques of the way in which practical work is conducted in schools, which can involve a focus on simply 'repeating the phenomenon' or being overly 'recipe-like' rather than engaging students in discussion that helps them link the activities to underlying science concepts (e.g. Abrahams and Reiss, 2012, 2017; Millar and Abrahams, 2009; Wellcome, 2017). Nevertheless, SET 2019 shows that practical work does continue to be generally enjoyable and motivating for a range of students, and thus its diminished presence in school science is problematic. It is also concerning from an equity perspective, in that students from disadvantaged backgrounds, particularly those who might otherwise be interested in science and inclined to continue their learning, may not be receiving a key element of the support they would need to do so.

The next section, 'Possible implications for policy and practice', represents the reflections of an independent researcher and is not necessarily endorsed by all funders.

Possible implications for policy and practice

The findings from SET 2019 have a number of implications for policy and practice. If we aspire to science being something to which any young person, regardless of their background, can engage with and find a place in, more effort and new approaches will be required. Doing more of the same will not address the issues around participation and progression in STEM currently faced in the UK and internationally.

The decline in interest in science from year 8 to year 9 is particularly telling in terms of what might need to change and is consistent with other research highlighting that interest in science overall is not the problem, nor is the problem with young people themselves.

One area for consideration may be the current science curriculum. While we remain wary of advocating for yet another reform, the timing of the reduction in interest (from year 8 to year 9), and the proportion of students – particularly females – reporting that the volume of content is putting them off science together reinforce that policymakers may want to continue to consider how the scope and framing of the curriculum could be further reshaped.

It is also possible that an overcrowded curriculum may be excluding other activities, including practical work, that motivate students, particularly those from disadvantaged backgrounds. Moreover, the scope of the current curriculum may be pushing teachers to focus almost relentlessly on covering content, a situation compounded by league tables and performance pressures, putting schools into a position where they find themselves needing to focus nearly exclusively on test scores.

Such pressures may also be contributing to problems of teacher retention, with research suggesting that science teachers are more likely to move school than teachers in other subjects (Allen and Sims, 2017). More broadly, issues around workload, work–life balance and job-related stress are leading many to leave the profession, to the detriment of pupils. The experience required to deeply engage a range of students with science (or other subjects) is developed over time. When teachers leave the profession, that experience is lost. Moreover, research, including the 2018 PISA, also highlights that issues around teacher retention may be disproportionately impacting schools in more disadvantaged areas, compounding the challenges their pupils are likely already facing.

The requirements of the UK education system for early specialisation, as well as restrictions on who can progress, further compounds inequities. While the need for a rigorous and challenging curriculum is appreciated, policymakers and funders could be encouraged to challenge the educational gatekeeping practices that place limitations on who can progress in a subject, perhaps by broadening the role that other factors (such as effort or interest) could play.

All of this together also has serious implications both from an equity perspective, risking leaving children from disadvantaged backgrounds further behind in their attainment and less engaged with science overall, and from a STEM pipeline perspective, with those young people – disadvantaged or not – who are most inclined to continue at risk of losing interest and facing more and more hurdles to progressing in the subject.

There are other aspects of school practice and policy that could usefully form a focus in efforts to support more equitable STEM experience, participation and progression. For instance, students could be supported to manage stress and anxiety around exams more effectively, an effort which could improve the experience of all students but is likely to particularly benefit females, who were found in SET 2019 to be more anxious about science tests than males. Schools could also enhance STEM engagement and reinforce inclusive messages about who STEM is ‘for’ – that it can be for everyone, not just the highest attaining – by paying attention to who is selected for opportunities and not selecting only top performers for STEM engagement and enrichment programmes. Such efforts at school level may usefully be underpinned by an emphasis in teacher training (both ITT and CPD) on strategies to promote engagement with STEM among disadvantaged and/or diverse students at classroom and wider school levels.

In order to promote equity, careful consideration of the dominant representations of science, and STEM more broadly, is also needed in the curriculum and outside of school. These propagate the message, albeit unintentionally, that science is a subject for the elite or the exceptionally clever only. Physics in particular is broadly viewed as a masculine subject for the ‘very clever’ (Archer et al., 2017; DeWitt et al., 2019; Kessels et al., 2006; Varelas et al., 2011), and research shows that the image of the ‘clever scientist’ can serve to dissuade individuals, particularly females, from pursuing the subject, a situation that is exacerbated for physics. Challenging and dismantling the reputation of physics as an elite field that strongly favours clever males is a task that will take years if not decades of concerted effort on the part of stakeholders in the field – including businesses aiming to recruit individuals with physical sciences qualifications; changes are also needed to the practices of educational gatekeeping, which set exceptionally high bars for entry into the field (e.g. into physics A level). It is possible to start taking steps towards this aim in the shorter and medium term, such as by supporting young people, especially females, to see links between physics and their specific desired careers and by considering loosening the exceptionally high grades required by schools for entry into A-level physics. The media can also have a role to play here, by considering how characters in scientific roles are portrayed and by being proactive in featuring more diverse individuals, including females, working in STEM and especially in physics, engineering and technology. Overall, active and coordinated steps among policymakers, STEM employers and educators – such as considering what curriculum is really necessary to prepare young people for STEM careers and other ways that young people might develop the necessary skills – will be needed to make inroads in this area.

SET 2019, and related research, also contains implications for STEM employers concerned with recruiting and retaining a talented and diverse workforce. In the first instance, employers can continue – and even accelerate – their efforts to improve conditions for women and individuals from other under-represented groups in the STEM workforce so that a career in STEM becomes more appealing. Doing so has the potential to help young people come to perceive STEM workplaces as ‘for me’. Additionally, and acknowledging the pressures on schools to focus strongly on the curriculum and their limited resources for careers advice and guidance – which impacts particularly heavily on students from more disadvantaged backgrounds – employers could consider what they could do to support overburdened schools, such as approaching schools with work experience opportunities and reducing administrative demands. Employers may also be able to work with schools to think critically about who is offered work experience and whether it is possible to go beyond the 'obvious choices', such as students in top sets. Such approaches are particularly needed given that SET 2019 showed that students from more disadvantaged backgrounds (which in many cases overlap with those with fewer family science connections) are less likely to utilise family connections to obtain work experience placements. It is these individuals who are more reliant, then, on schools and others for support in gaining work experience, including in STEM. These efforts could also be further extended by increasing the number and types of work placements available in STEM. Government support could be provided to encourage and enable SMEs to offer work placements, especially in areas located outside the South and South East.

In light of the wide array of STEM jobs that will be needed to fulfil the ambitions of Britain in the future, government could usefully continue to expand its focus beyond elite career tracks to ensure that work placements and other interventions provide young people with opportunities to learn about and engage with the wide range of opportunities available in the STEM workforce. These would include apprenticeships and technician roles, located in areas across the country. Related to these efforts, Widening Participation funding should continue to go beyond targeting HE access in general to include a specific focus on STEM when appropriate and, particularly, to highlight and demonstrate the value of a range of routes other than university. Such paths may often be more effective routes to some STEM careers and can be additionally appealing when compared with the high financial costs associated with university attendance.

Finally, it is clear from SET 2019 that there is no 'one size fits all' when it comes to engaging young people from the widest possible range of backgrounds with science and encouraging progression in the subject, a finding which resonates with existing research. SET 2019 reiterates that different factors seem to motivate males and females, and individuals from different ethnic backgrounds, to continue with science, and such differences are complexified further when intersections among gender and ethnicity, for instance, are taken into consideration. This report highlights the critical importance of treating students as individuals when trying to increase engagement with science, although doing so is challenging in the best of circumstances. Nevertheless, by considering the broader science learning 'ecosystem', which includes not just schools but also community organisations, STEM learning organisations, employers and others, we may be able to make substantial progress in engaging more, and more diverse, young people with science.

By coordinating efforts around the variety of STEM engagement and extra-curricular programmes on offer across the ecosystem, schools and other stakeholders in STEM education could fruitfully ensure they are designed equitably, distributed geographically and complement, rather than compete with, each other. Additionally, organisations developing interventions – including science centres, museums and other cultural organisations – should continue in their efforts to target disadvantaged young people intentionally by how they are promoted and designed (e.g. to allow for flexible participation). Science centres and museums – as well as other providers – should also continually reflect on all the ways in which they may be sending messages about who the experience is 'for' and to foreground considerations of equitable access.

Attention can also continue to be paid to expected outcomes of such efforts to ensure they are aligned with equity-related goals. For instance, government-funded programmes that aim to support STEM engagement can be mindful of the importance of recognising and valuing non-cognitive outcomes, such as those related to identity and self-belief. Policymakers could also consider funding the development and adoption of an outcomes framework for such programmes to ensure quality and impact within an equity focus. Doing so would lay important groundwork for the work of other stakeholders and funders in this area. Likewise, government could consider the ways in which funding for informal STEM learning opportunities in programming for young people or in youth groups could further support disadvantaged and underserved youth to engage with STEM. Finally, government and other stakeholders could collaborate to develop a roadmap to help families and schools navigate the STEM offers available to them and their children.

The data from SET 2019 highlight the key role that young people's family science connections play in their engagement with and participation in science. While some aspects of these (e.g. jobs or qualifications of family members) are beyond the scope of influence of various organisations, the elements of the FSCI do point towards certain areas that could be a productive focus in efforts to engage more young people in science. For instance, community or youth development organisations could be supported to create programmes that encourage young people to engage in conversations related to everyday science with their families (e.g. to find the science in their family activities and communities). In so doing, young people may become more aware of family interest in science or of science-related aspects of family members' work, which is particularly important in light of the finding that only 41% of students in years 7–13 think that science is relevant to everyday life (and 40% of those in years 10-13, a decrease from SET 2016). Such initiatives could also support families to actively challenge gender and ethnic stereotypes among their children and promote the perspective that no profession is off limits because of gender or ethnicity.

Community groups can also encourage young people's interest in and identification with STEM by linking STEM interventions with problems the local community might be grappling with, such as recycling, pollution or crime. Such approaches not only demonstrate the 'real world' value of STEM but also importantly support the agency of young people to use STEM to address issues of concern to themselves and their communities. Youth groups in particular play a major role in supporting young people struggling with many forms of deprivation and disadvantage. These groups can be encouraged and supported to include STEM-focused activity and content in their programming as a method to engage young people who might not encounter STEM outside of school and to support the development of a STEM identity. Curiosity[45] – a joint initiative between Wellcome and BBC Children in Need – represents a development along these lines in its emphasis on bringing science activities into everyday, familiar youth work settings. While such efforts are not inevitably unproblematic (Dawson, 2019) and do require careful consideration to ensure that young people and their experiences and strengths are foregrounded, research suggests they offer considerable promise that by working with young people across a range of organisations, within and beyond school, and including their families when possible, young people's relationship with science can be strengthened.

Of course, the relatively low numbers of young people participating in science and the inequitable patterns of participation continue to be a cause for concern. However, reflecting on the findings of SET 2019 in the context of current education policy and practice, there seems to be support for arguments that these unequal patterns of participation should not be attributed to deficits among young people but may be better explained by structural and institutional inequalities within science education (and the broader field of science). Considered in this light, policymakers, educators, employers and other stakeholders should be encouraged to think critically about the structures they support and how these might be modified to make science, in school and beyond, a more welcoming field that builds upon the interest in and enthusiasm for science that young people bring to secondary school. Such shifts are never easy but do hold great promise for a future in which young people from any background can enjoy, attain and progress in science.

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[45] https://wellcome.ac.uk/reports/role-informal-science-youth-work-findings-curiosity-round-one

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Appendix B: Additional charts

B.1. Additional charts referred to in Chapter 6

Figure B.1: Total number of pupils in England ('000s) entered for GCSE computer science and ICT (DfE data)[46]

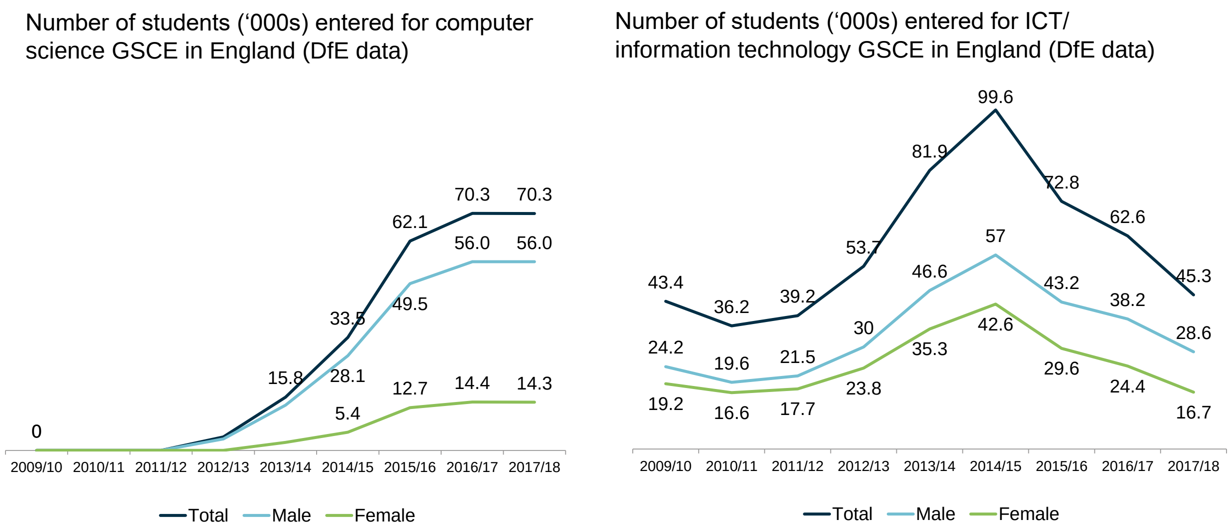
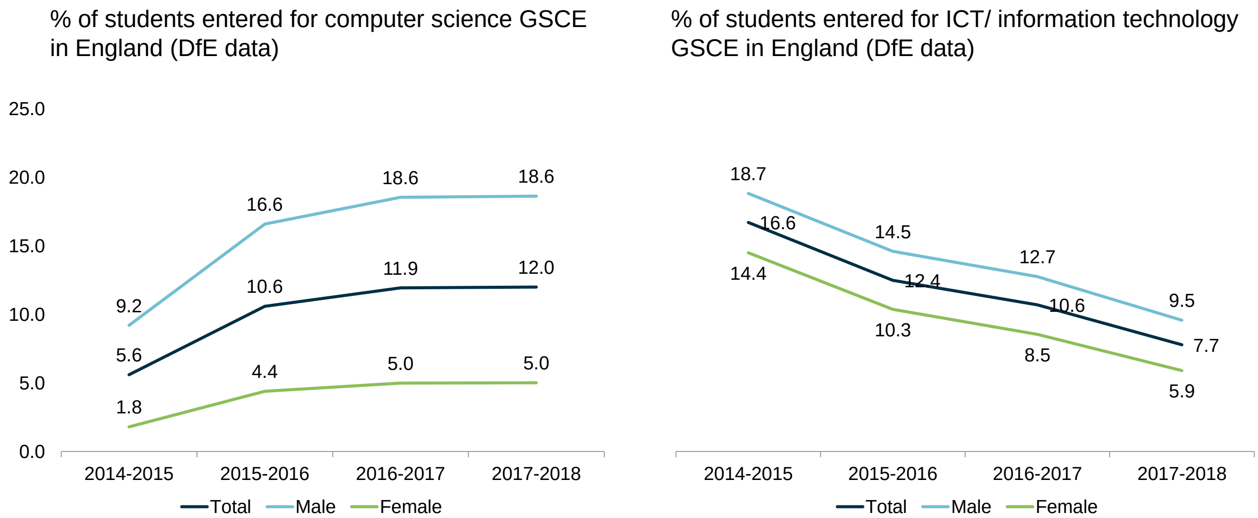


Figure B.2: Total proportion of pupils in England entered for GCSE computer science and ICT at the end of year 11 (DfE data)[47]



[46] DfE (2018a) GCSE and Equivalent Results: 2017/18 (provisional). See subject tables 2018 Table S1a (and equivalent tables from 2015, 2016 and 2017). https://www.gov.uk/government/statistics/gcse-and-equivalent-results-2017-to-2018-provisional

[47] DfE (2018a) GCSE and Equivalent Results: 2017/18 (provisional). See subject tables 2018 Table S1a (and equivalent tables from 2015, 2016 and 2017). https://www.gov.uk/government/statistics/gcse-and-equivalent-results-2017-to-2018-provisional

B.2. Additional charts referred to in Chapter 10

Figure B.3: 2017/2018 student enrolments in STEM and non-STEM subjects by gender (HESA data)[48]

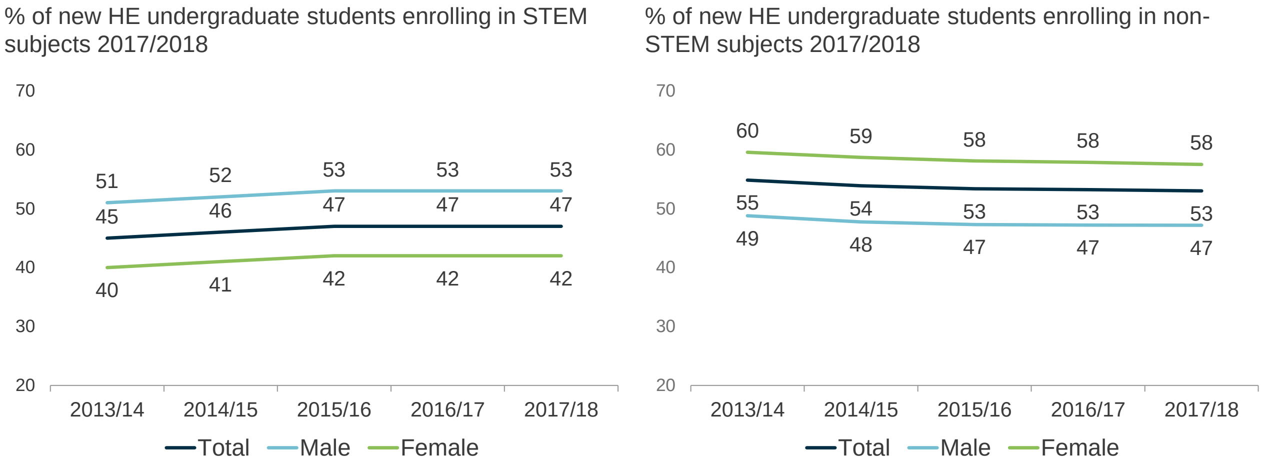
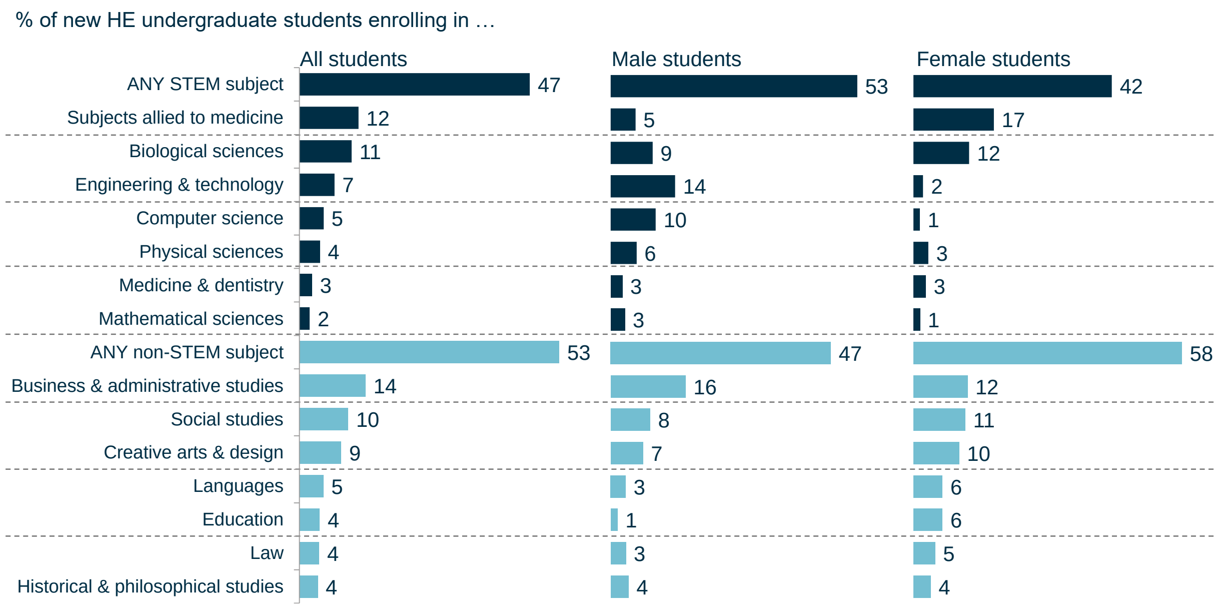


Figure B.4: 2017/2018 student subject enrolments by gender (HESA data)[49]



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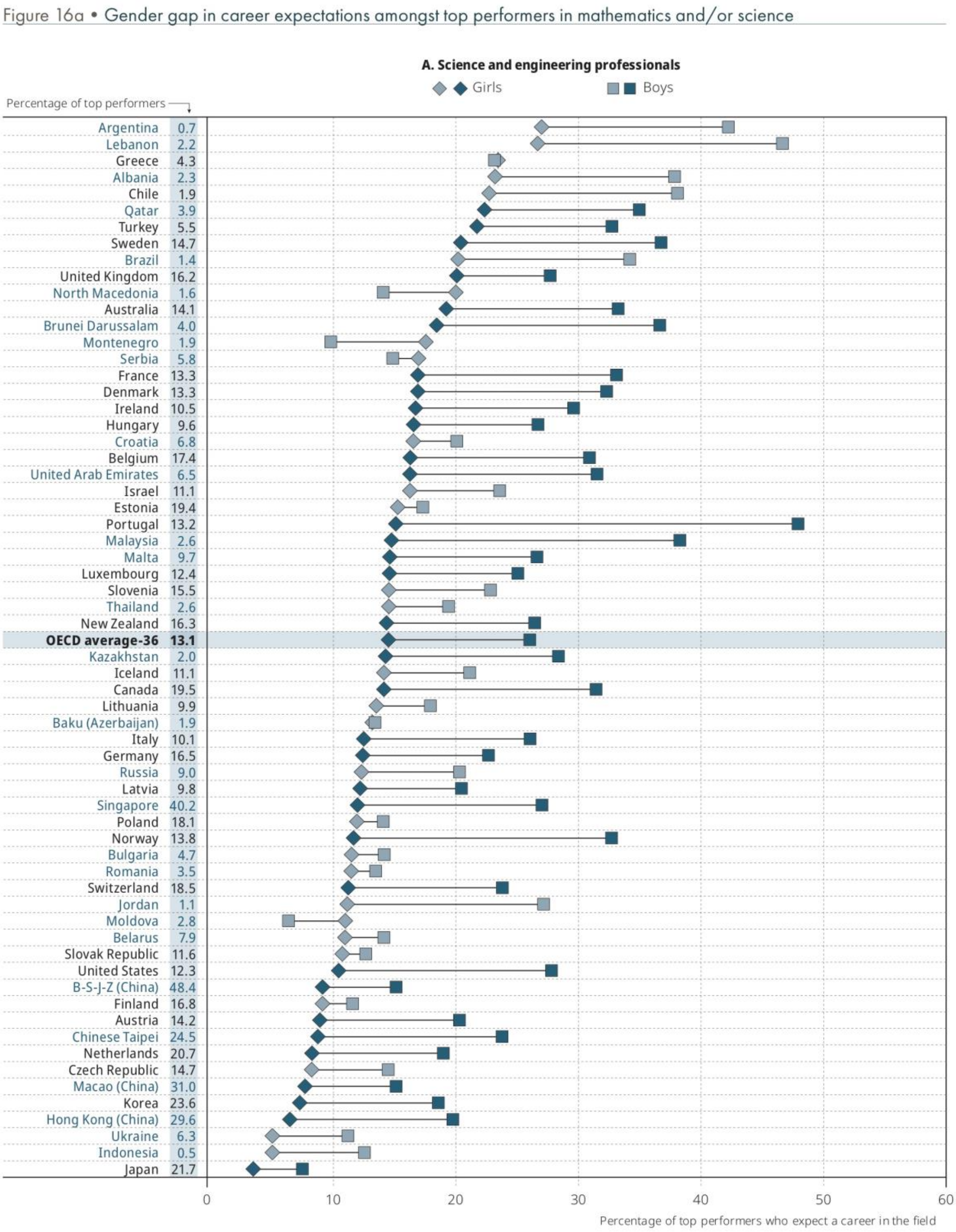
[48] HESA (2018) Higher Education Student Statistics: UK, 2017/18 https://www.hesa.ac.uk/news/17-01-2019/sb252-higher-education-student-statistics

[49] HESA (2018) Higher Education Student Statistics: UK, 2017/18 https://www.hesa.ac.uk/news/17-01-2019/sb252-higher-education-student-statistics

B.3. Additional charts referred to in Chapter 11

Figure B.5: PISA 2018: Gender gap in career expectations amongst top performers in mathematics and/or science: science and engineering professionals (recreated from OECD, 2019c)[50]



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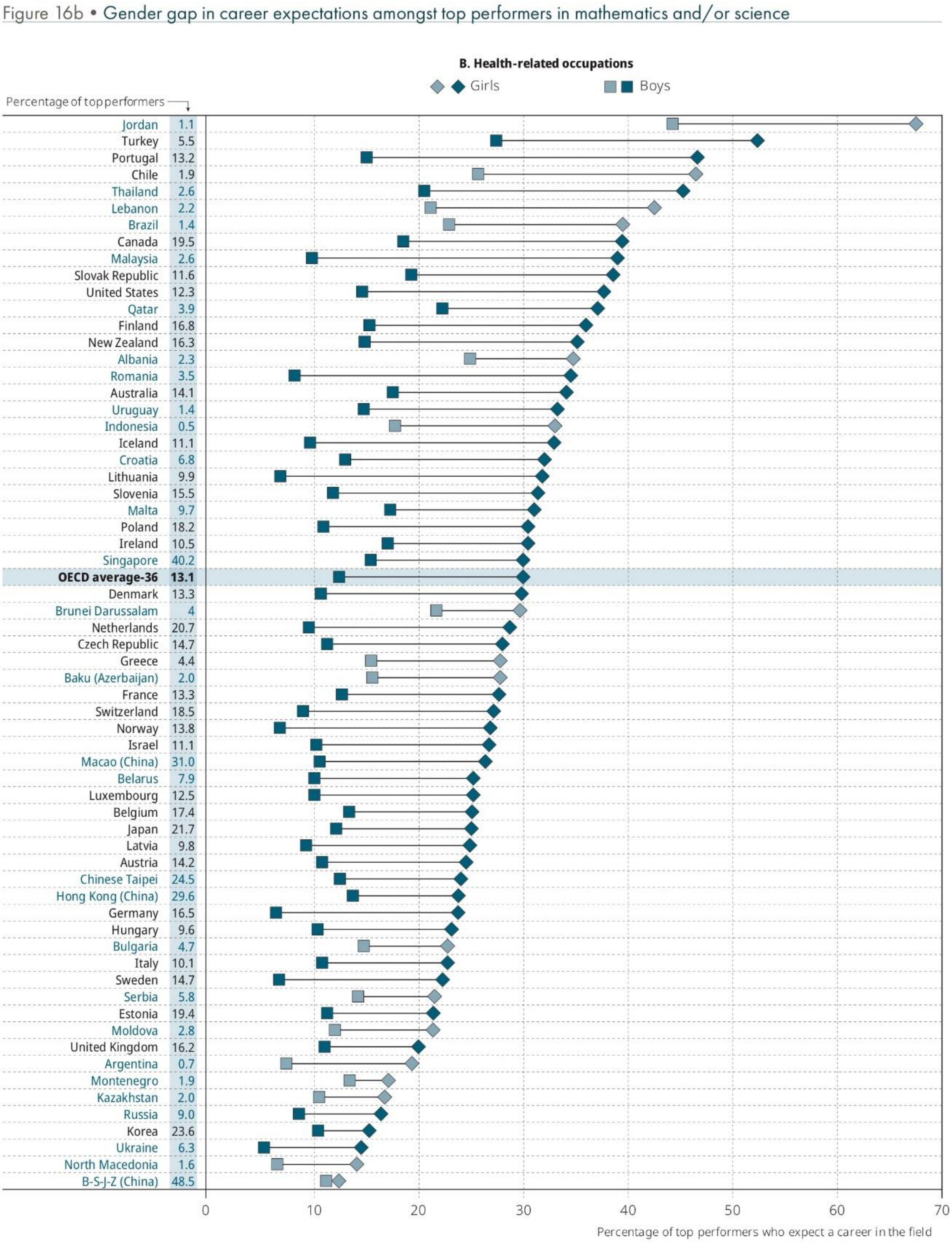
[50] PISA 2018 Insights and Interpretations.
https://www.oecd.org/pisa/PISA%202018%20Insights%20and%20Interpretations%20FINAL%20PDF.pdf

Figure B.6: PISA 2018: Gender gap in career expectations amongst top performers in mathematics and/or science: health-related occupations (recreated from OECD, 2019c)[51]



[51] PISA 2018 Insights and Interpretations. https://www.oecd.org/pisa/PISA%202018%20Insights%20and%20Interpretations%20FINAL%20PDF.pdf

Appendix C: Science knowledge quiz

C.1. How the quiz score was derived

The survey included a science knowledge quiz intended to measure young people's scientific literacy. This comprised ten true-or-false questions. Two versions of the quiz were produced. For young people in years 10 to 13, the quiz was identical to the version used in SET 2016 as well as in other science surveys, such as the Wellcome Monitor and Public Attitudes to Science surveys. A new ten-item quiz was developed for years 7–9 which was more suitable for younger children and based on the year 7 curriculum.

Each version of the quiz included ten true/false questions relating to knowledge of different areas of science.

Table C.1: Quiz questions used to derive quiz score

	Years 10–13		Years 7–9	
1	Electrons are smaller than atoms.	True	A soluble substance can dissolve	True
2	All radioactivity is man-made.	False	Universal indicator paper goes red in alkaline solutions	False
3	All plants and animals have DNA.	True	An animal cell has a cell wall	False
4	More than half of human genes are identical to those of mice.	True	A shark is a mammal	False
5	The cloning of living things produces genetically identical copies.	True	Photosynthesis happens in the leaves of a plant	True
6	Lasers work by focusing sound waves.	False	Force is measured in kilograms	False
7	By eating a genetically modified fruit, a person's genes could also become modified.	False	In a circuit diagram, the symbol for a lamp is a plain circle	False
8	The oxygen we breathe comes from plants.	True	Sounds are produced by vibrations	True
9	It is the mother's genes that determine the sex of the child.	False	Fossil fuels are renewable	False
10	One kilogram of lead has the same mass on Earth as it does on the moon.	True	The particles in a gas have no bonds	True

For each question, respondents chose from the following answer options:

- Definitely true
- Probably true
- Don't know
- Probably false
- Definitely false

The quiz was scored by giving respondents a point for any correct answer, that is, if the correct answer was 'True', a point would be scored for an answer of either 'Definitely' or 'Probably' true. Respondents were then divided into three groups based on their total score from the ten questions.

The distribution of scores is provided below.

Years 7–9 quiz classification*:*

- Low (25% of respondents) – 0–5 correct answers
- Medium (54% of respondents) – 6–8 correct answers
- High (21% of respondents) – 9–10 correct answers

Years 10–13 quiz classification:

- Low (26% of respondents) – 0–5 correct answers
- Medium (53% of respondents) – 6–8 correct answers
- High (21% of respondents) – 9–10 correct answers

C.2. Validity of the science quiz score

The science quiz score has been used as the primary measure of science knowledge in this report.

For those respondents in years 12 or 13 who had agreed that NPD data could be linked to their survey answers, we were able to compare their quiz scores to their achieved key stage 4 science results. In this way, we could assess the use of these quiz scores as a proxy measure for a young person's level of science attainment.

Two variables from the NPD were considered as measures of science attainment:

- **Highest pass point score achieved in science GCSE and equivalents:** This includes the highest score from all GCSEs, including the combined science GCSE (double award), the single science GCSEs (biology, chemistry and physics) and computer science GCSE. The point score is based on the new grading scale that ranges from 9 to 1 (9 = highest score). The points awarded to combined science are averaged, which means, for example, that a combined science grade of a grade 6 and a grade 5 would be averaged to two 5.5 points.
- **Highest category of key stage 4 science GCSE or equivalent achievement:** This is divided into three categories, as follows:
    - i. Achieved two science GCSEs or equivalent at A*–B
    - ii. Achieved two science GCSEs or equivalent at A*–C (but not at A*–B)
    - iii. Did not achieve two science GCSEs or equivalent at A*–C

A moderate correlation was observed between the science quiz scores and these variables: 0.520 with the overall key stage 4 science score and -0.433 with the highest category of key stage 4 or equivalent achievement.

It was not possible to use NPD data as the primary measure of science attainment for two main reasons. First, 10% of respondents did not give permission for their data to be linked in this way and so their NPD data was unavailable for analysis. Second, there was no recent science attainment data available for young people in years 7 to 11 as either they had not yet completed their key stage 4 exams or the NPD data were not yet available. Although key stage 2 teacher assessment scores were available for younger students, these were not considered sufficiently reliable to be used as an overall measure of science attainment and would have been very out of date for older students in years 10 and 11.

C.3. Mean quiz score by population group

As the quiz score has been used as a proxy for science knowledge throughout this report, it is useful to look at how students across different demographic groups performed in the science quiz. This provides a useful context in terms of understanding the patterns of findings in this report in relation to different demographic groups.

Table C.2: Mean quiz score by survey subgroup (score out of 10)

Total sample		***Family science connections score (FSCI)***	
All year 7–9s	6.7	High (many connections)	7.4
All year 10–13s	6.7	Medium	6.8
Academic year		Low (no connections)	6.0
Year 7	6.5	***Science pathways (years 10–13 only)***	
Year 8	6.8	Double science	6.4
Year 9	6.9	Triple science	7.6
Year 10	6.5	***KS2 teacher assessment level (years 7–11 only)****	
Year 11	6.9	Below expected level	5.5
Year 12	6.7	Expected level or above	6.9
Year 13	6.5	***KS4 highest GCSE science grade (years 12–13 only)****	
Gender		Grades 1–3	5.2
Male	6.9	Grades 4–6	6.8
Female	6.5	Grades 7–9	8.4
Ethnicity		***Highest category of key stage 4 science GCSE or equivalent achievement****	
White	6.7	Achieved two science GCSEs or equivalent at A*–B	7.8
Mixed	6.6		
Asian	6.8	Achieved two science GCSEs or equivalent at A*–C (but not at A*–B)	6.7
Black	6.7		
Other	6.7	Did not achieve two science GCSEs or equivalent at A*–C	5.7
Eligibility for free school meals*			
Yes	6.2		
No	7.0		

**NPD-linked data*

The overall mean score was 6.7. As shown in Table C.2:

- Within the year 7–9 cohort, quiz scores rise slightly by year group, with the highest scores in year 9
- Within the year 10–13 cohort, scores are highest in year 11 before dropping slightly in years 12 and 13, which we would expect as many students by this stage are no longer studying science
- Males achieve slightly higher scores than females
- There is relatively little variability by ethnic group
- Students eligible for free school meals achieve lower scores than non-eligible students
- Students with many science connections achieve higher scores than students with no science connections
- Triple science students perform much better than double science students
- There is a strong association between quiz scores and a range of attainment variables based on linked data derived from the NPD

Appendix D: Profile of achieved sample

The profile of the weighted sample is a very good match with the population profile as shown in Table D.1.

Table D.1: Profile of achieved sample

		Unweighted sample (%)	Weighted sample (%)	Population* (%)
School year	7	12.1	15.5	15.5
	8	12.7	14.8	14.9
	9	11.3	14.6	14.6
	10	16.3	14.3	14.3
	11	17.1	13.9	13.9
	12	15.9	13.3	13.3
	13	14.7	13.7	13.7
Gender	Male	48.6	51.1	51.1
	Female	50.4	48.9	48.9
Region	North East	4.3	4.4	4.7
	North West	13.3	13.5	12.9
	Yorkshire and the Humber	10.5	10.7	9.9
	East Midlands	8.6	8.6	8.6
	West Midlands	11.2	11.4	11.3
	East of England	11.5	11.4	11.4
	London	14.0	14.0	15.9
	South East	16.1	15.7	15.7
	South West	10.4	10.3	9.5
IDACI	Quartile 1	23.3	25.1	25.0
	Quartile 2	24.2	24.9	24.9
	Quartile 3	25.3	24.8	24.9
	Quartile 4	27.2	25.1	25.1
Overall school performance	Bottom 25%	19.9	24.6	24.6
	Middle	50.7	50.2	50.1
	Top 25%	29.4	25.2	25.3
Ethnicity	White	73.9	73.7	73.2
	Black	5.9	6.1	6.0
	Asian	12.5	12.4	11.7
	Mixed	5.2	5.1	5.5
	Other	1.4	1.4	1.9
	Unclassified	1.1	1.2	1.7

***Population statistics for school year, gender, IDACI quartiles and overall school performance are derived from the stratification reference variable used in sampling. Population statistics for region and ethnicity are derived from** https://www.gov.uk/government/statistics/schools-pupils-and-their-characteristics-january-2019

Appendix E: Segmentation of young people

Kantar carried out a segmentation analysis to investigate any underlying patterns in the population of young people with respect to interest in science and computer science. The motivation for this analysis was to further understand how the observed variation in both science and computer science interest is associated with factors such as young people's self-perceived ability in these subjects, their science knowledge (quiz score) and features which have encouraged or discouraged them to learn science and/or computing.

Full details of the statistical methodology used to create the segments is covered in the Technical Report published alongside this report.

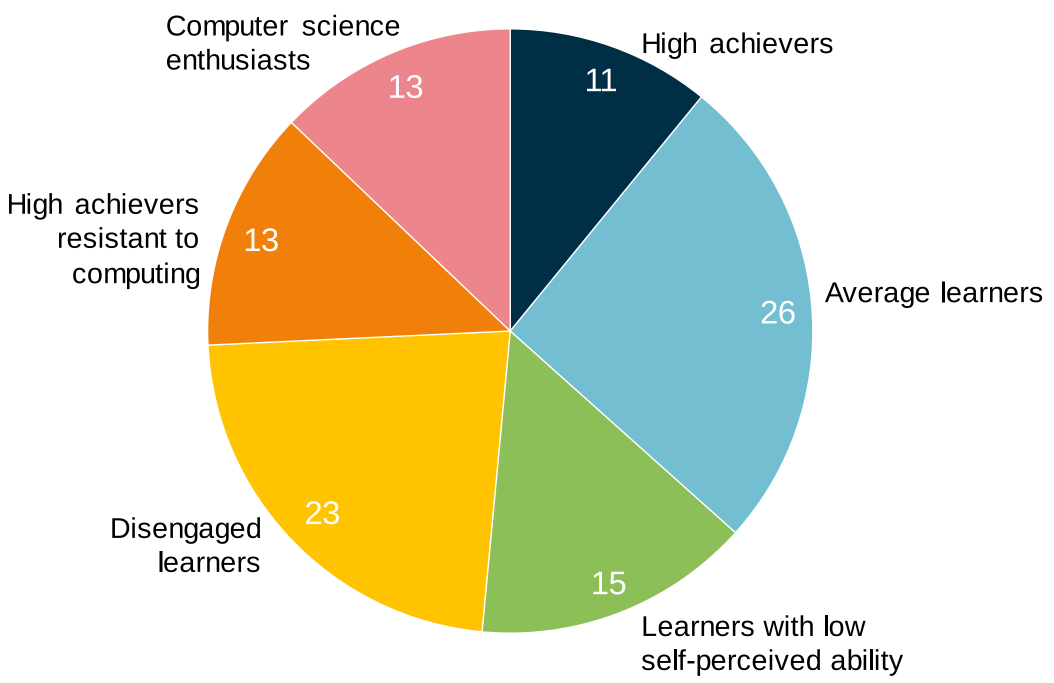
E.1. Size of the segments

The segmentation analysis grouped the sample into six segments. Figure E.1 shows the proportion of young people belonging to each segment. Note the segmentation does not cover the whole sample as some questions used in the segmentation were based on modular subsets of the full sample. The segmentation is based on 2,362 young people in years 7 to 13.

The rest of this appendix provides a detailed description of each segment.

Figure E.1: Breakdown of young people in years 7–13 by segment (2019)

% of all in years 7-13 included in the segmentation



Base 2019: All year 7–13s included in the segmentation analysis: Total 2,362

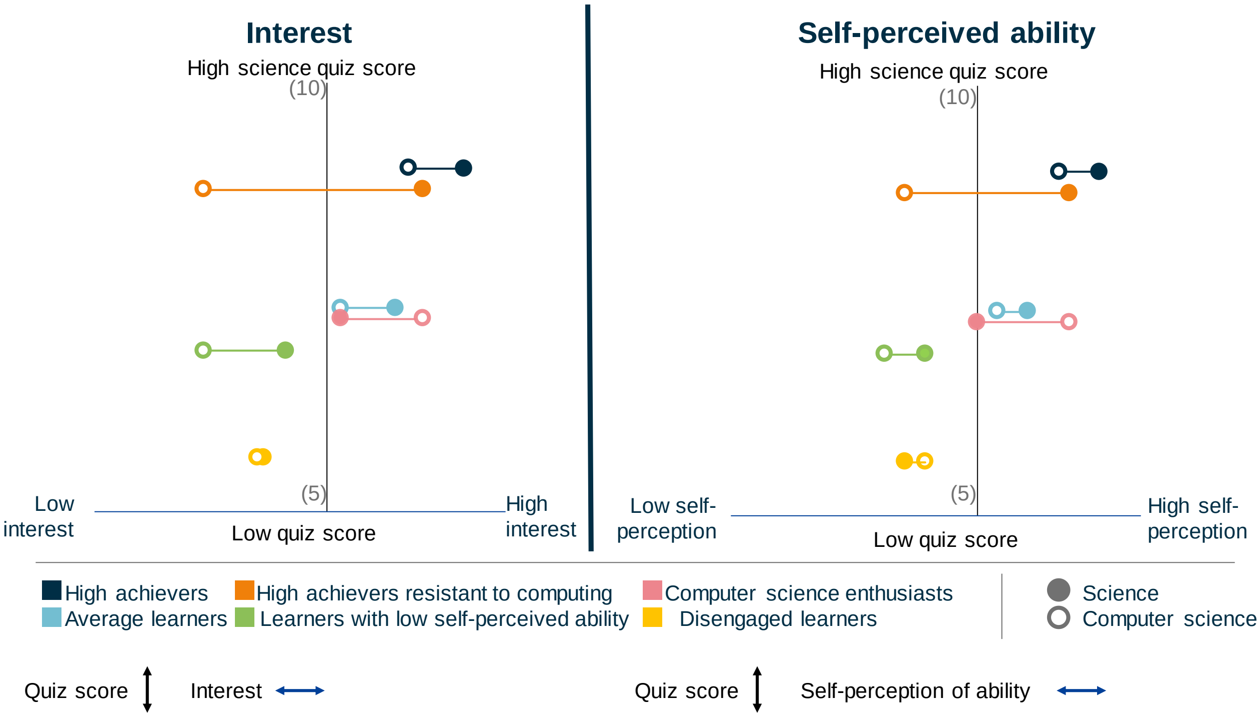
E.2. Profile of the six segments by quiz score, interest and self-perceived ability

Figure E.2 first provides an overview of the relative positioning of each segment in terms of the level of interest in science and computer science, self-perceived ability in these subjects and science quiz score.

The chart on the left-hand side displays interest by quiz score. The vertical axis displays the relative positioning of the segments by quiz score: for example, High Achievers exhibit the highest quiz scores and Disengaged Learners the lowest quiz scores. The horizontal axis displays the mean interest score for both science (closed circles) and computer science (open circles). For example, High Achievers have the strongest interest in science and Disengaged Learners have the weakest level of interest, while Computer Science Enthusiasts have the strongest interest in computer science and the lowest interest levels are found among High Achievers Resistant to Computing and Learners with Low Self-perceived Ability.

The chart on the right-hand side is similar, although this displays self-perceived ability by quiz score. So, for example, High Achievers have the highest self-rating in science, while Learners with Low Self-Perceived Ability have the lowest self-rating in computer science.

Figure E.2: Profile of the segments in terms of interest in science/computer science, self-perceived ability and quiz score



Bases 2019: High achievers (261); Average learners (585); Learners with low self-perceived ability (372); Disengaged learners (515); High achievers resistant to computing (340); Computer science enthusiasts (289)

A brief profile of the six segments in relation to these attributes is given below

High Achievers

This segment represents 11% of the population of young people. The segment is characterised by high science quiz scores and high levels of interest and self-perceived ability in both science and computer science.

Average Learners

This segment represents 26% of the young person population, the largest segment. In general, this represents the average pupil – with average science quiz scores, average self-reported ability and average interest in both science and computer science. The members of this group were no more or less motivated or demotivated by specific aspects of science lessons when compared with the overall average (see section E.3 below).

Learners with Low Self-Perceived Ability

This segment represents 15% of the young person population. This group exhibits fairly average science quiz scores; however, young people in this segment are less interested in both science and computer science when compared with young people in other segments and exhibit markedly lower levels of self-perceived ability in both subjects.

Disengaged Learners

This segment represents 23% of the young person population, one of the largest segments. This segment is characterised by low quiz scores and lack of interest in both subjects. These young people exhibit average to low self-perception scores.

High Achievers Resistant to Computing

This segment represents 13% of the young person population. Like the High Achievers segment, this segment is associated with high quiz scores and high levels of interest in science. However, unlike the High Achievers group, this group expressed very little interest in computer science (lower than all other segments) and exhibit much lower levels of self-perceived ability in computer science

Computer Science Enthusiasts

This segment represents 13% of the young person population and is characterised by a pronounced enthusiasm for computer science. This group achieved average quiz scores but rated themselves as better at and more interested in computer science than any other segment (Figure E.2).

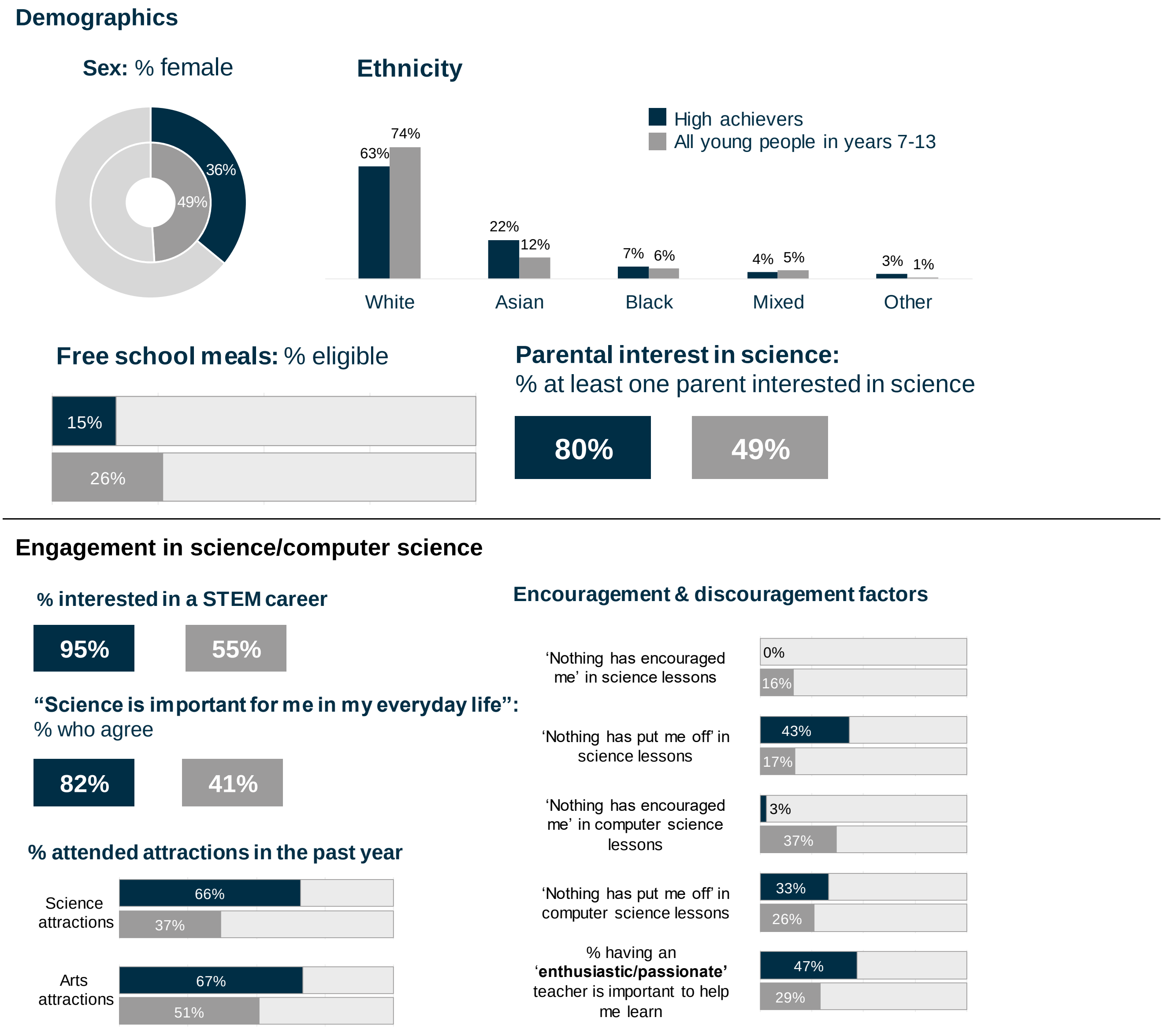
E.3. Profile of the six segments

The charts that follow provide more detailed descriptions of each segment, including their demographic make-up and how engaged they are in science and STEM across several measures.

High Achievers

As shown in Figure E.3, this segment is composed of almost twice as many males than females and has a higher percentage of Asian pupils than any other group. This segment is more affluent than average (based on entitlement to free school meals) and is much more likely to have a parent interested in science. These young people were more likely than those in other segments to cite a range of reasons for being encouraged to learn science and computer science and were especially likely to cite a passionate teacher as one of the top factors that helped them to learn science. This was also the group most inclined to want a career in STEM, to feel that science was relevant to their everyday life and to visit science attractions[52].They were also more likely than average to visit arts-based attractions.

Figure E.3: Profile of the High Achievers segment



Bases 2019: All year 7–13s (6,409); all High Achievers (261)

[52] In this chapter, science attraction attendance is based on the attendance figure *excluding* zoos/aquariums.

Average Learners

As shown in Figure E.4, this segment closely reflects the demographics of the whole population in terms of ethnicity, family income and parental interest in science. However, it comprises a slightly higher proportion of males compared with the average.

When compared with other segments, this group is not particularly encouraged or discouraged by any specific factors listed in the survey. However, at an overall level, based on the proportion who said that nothing had either encouraged them or put them off science or computing science, members of this group are slightly more positive than average. This group closely reflects the average in terms of attendance at science and arts attractions and level of interest in a STEM career. Members of this group are slightly more likely than average to perceive science as relevant to their everyday life.

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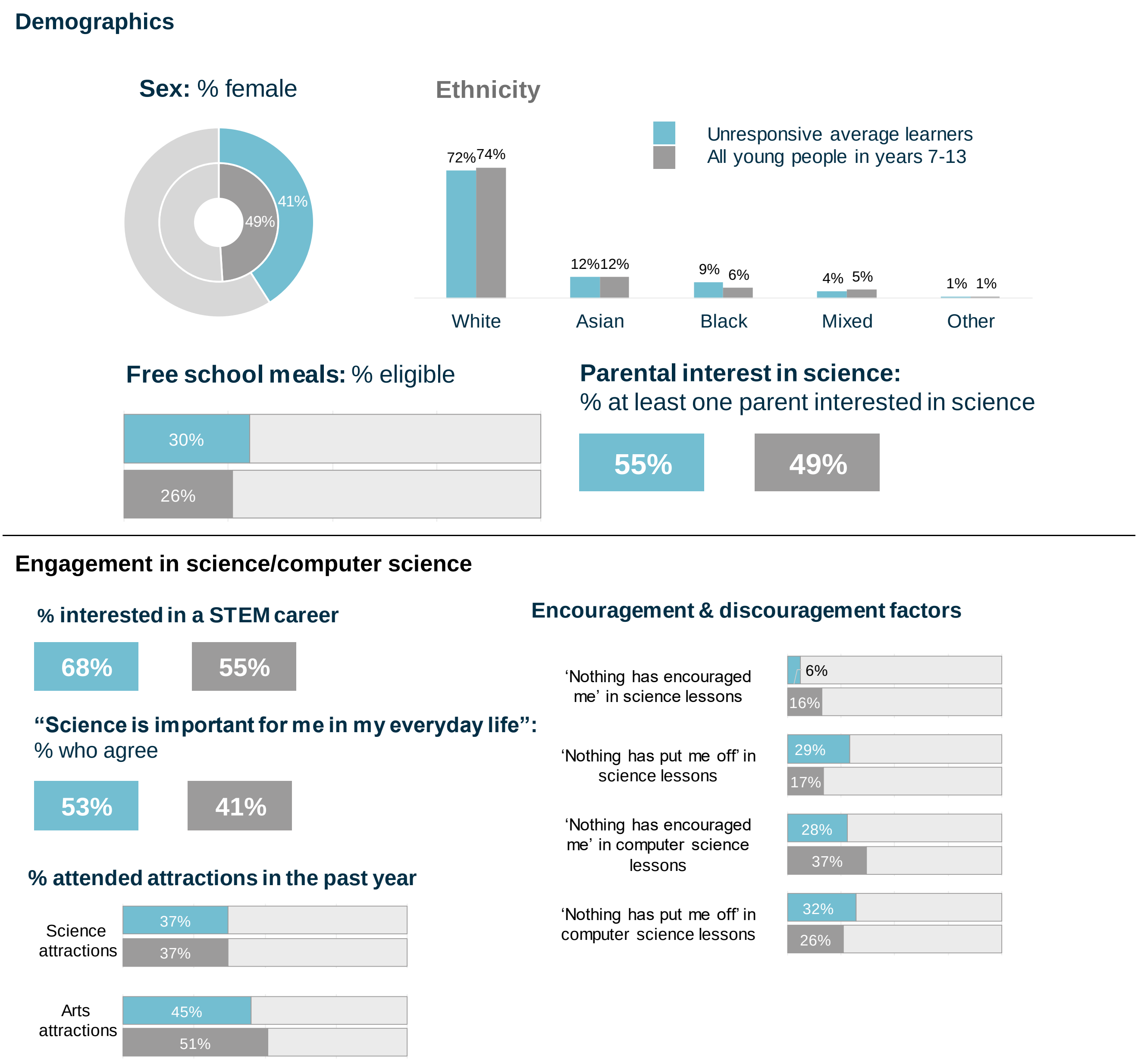
Figure E.4: Profile of the Average Learners segment



Bases 2019: All year 7–13s (6,409); all Average Learners (585)

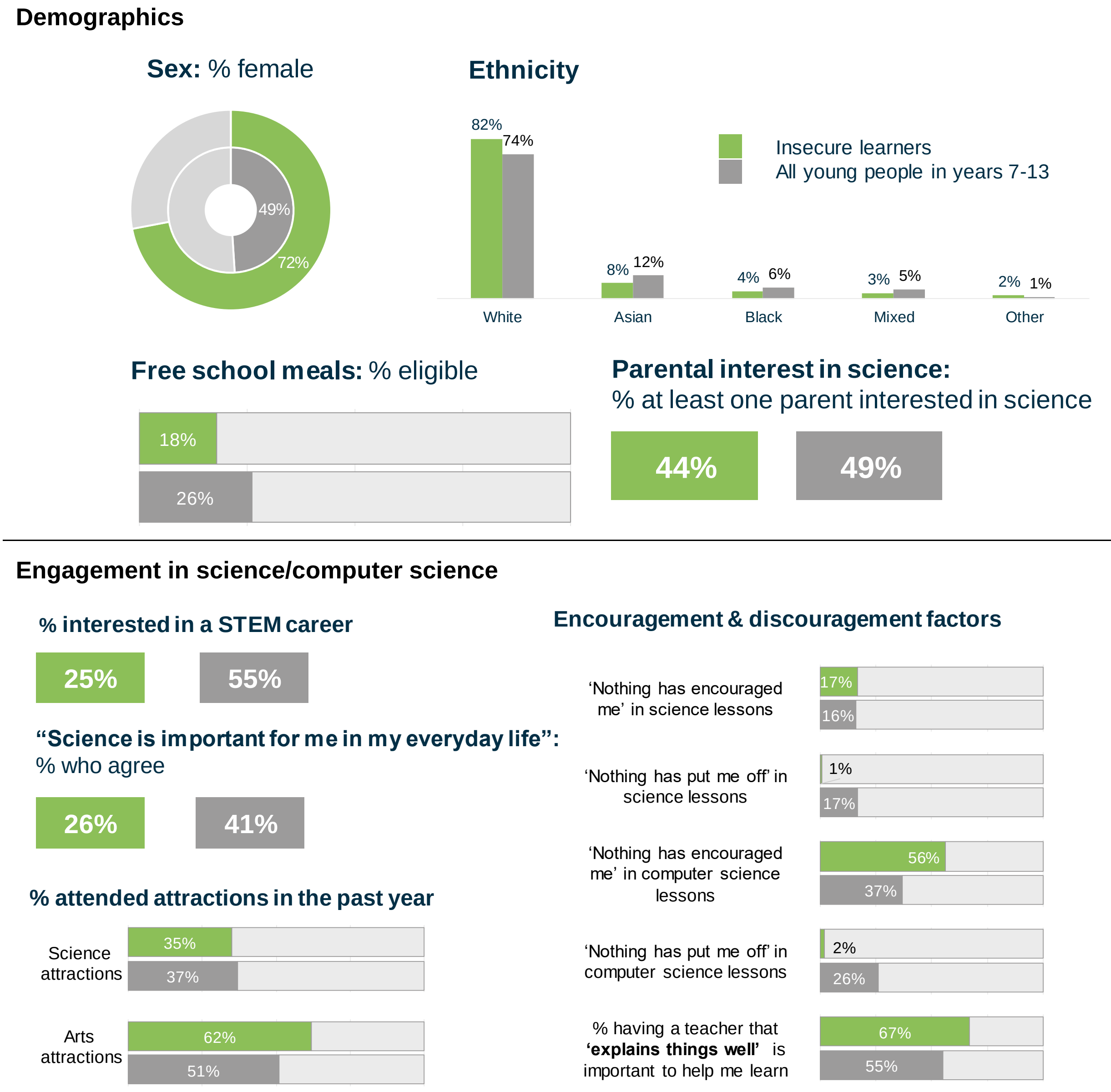
Learners with Low Self-Perceived Ability

As shown in Figure E.5, this group is predominantly female and contains a slightly higher than average proportion of white young people and students from affluent families (based on free school meal entitlement).

Compared with other segments, members of this group were more likely to report being discouraged by a range of barriers in both science and computer science (they were especially likely to cite difficulty and volume of work as off-putting factors in science). They were also more likely than average to cite a teacher who can explain things well as one of the top factors that helped them to learn science.

This group were also much less interested than average in pursuing a STEM career and also less likely to consider science as relevant to their everyday life.

Figure E.5: Profile of the Learners with Low Self-Perceived Ability segment



Bases 2019: All year 7–13s (6,409); all Learners with Low Self-Perceived Ability (372)

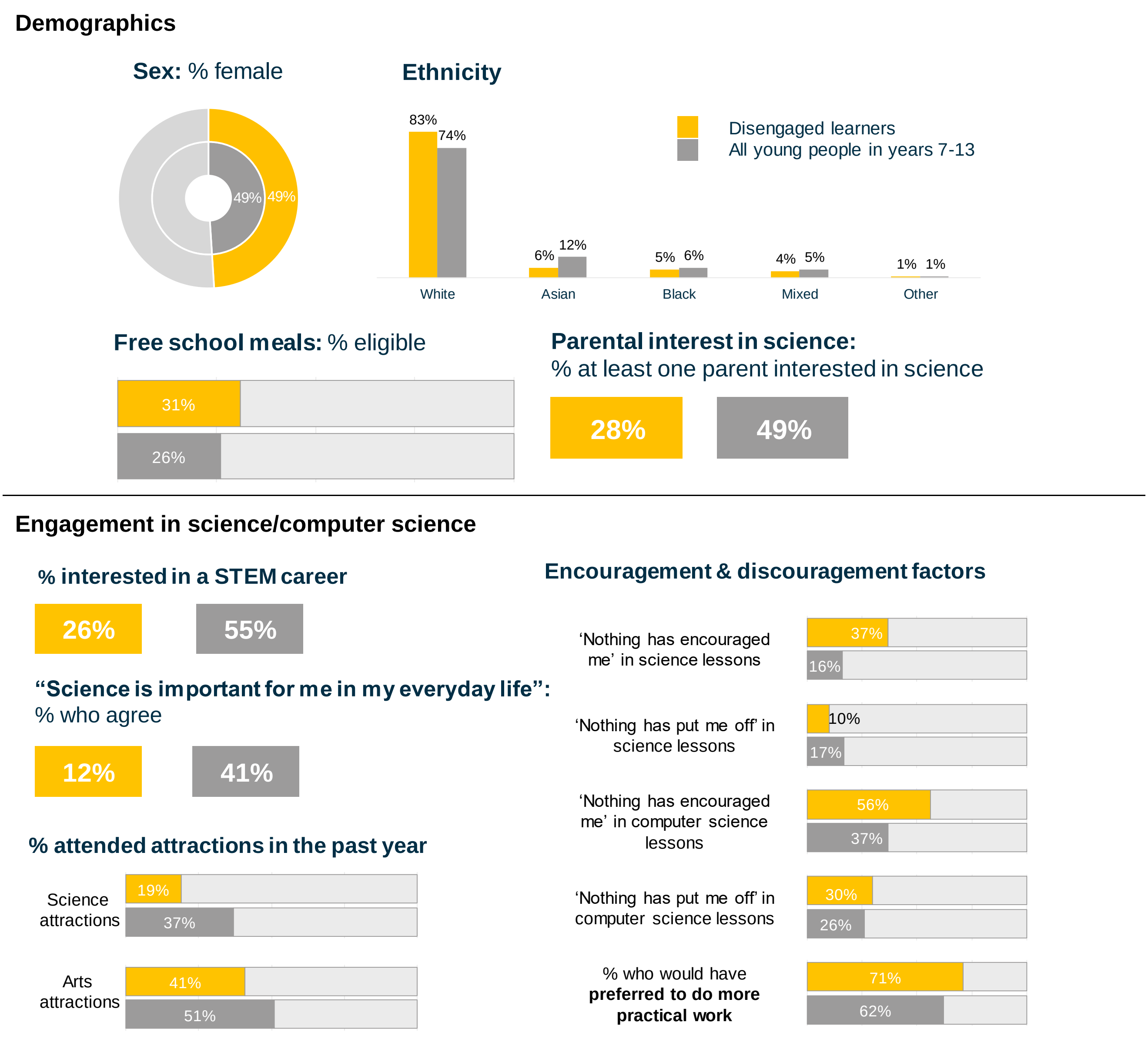
Disengaged Learners

As shown in Figure E.6, this segment comprises a slightly higher than average percentage of white students and students from disadvantaged backgrounds and they are much less likely to have a parent interested in science. The gender profile is similar to the average.

Members of this segment were more likely than average to say that nothing had encouraged them in either science or computer science and were less likely to be planning a future career in STEM, to visit science (and arts) attractions, and to consider science as relevant to their everyday life.

Members of this group were particularly likely to say that they would have liked to do more practical work than they were currently doing.

Figure E.6: Profile of the Disengaged Learners segment



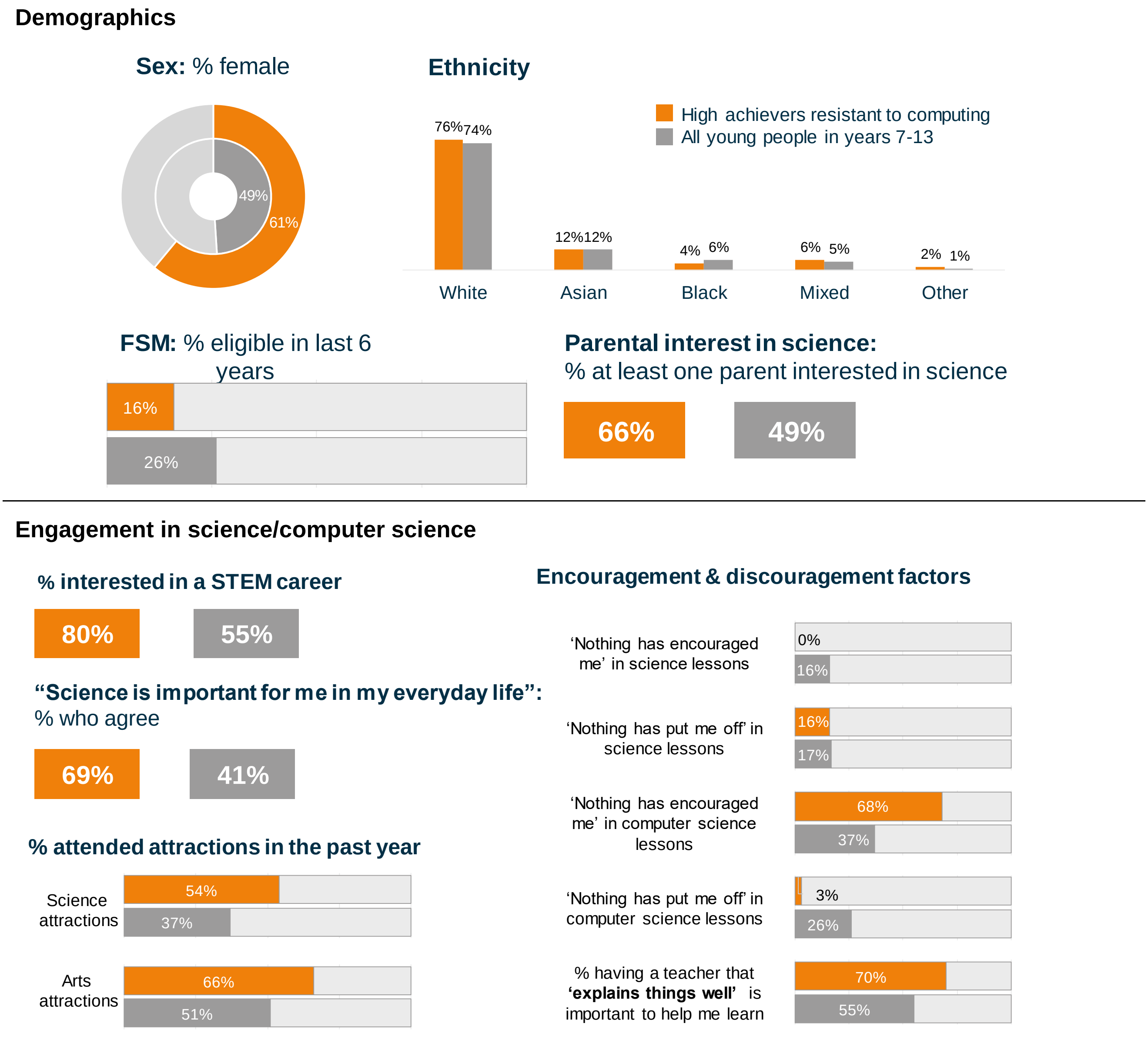
Bases 2019: All year 7–13s (6,409); all Disengaged Learners (515)

High Achievers Resistant to Computing

As shown in Figure E.7, this group consists of more females than males (in contrast to High Achievers). However, like High Achievers, they are more affluent than average and are more likely to have a parent interested in science. The ethnicity profile is aligned with the average.

Compared with other segments, members of this group were especially likely to say that nothing had encouraged them in computer science and they cited a much wider range of barriers to this subject. Like High Achievers, they showed higher than average interest in science outside of school and in a STEM career and were more likely to consider science as relevant to their everyday life. They were also more likely than average to cite a teacher who can explain things well as one of the top factors that helped them to learn science.

Figure E.7: Profile of the High Achievers Resistant to Computing segment



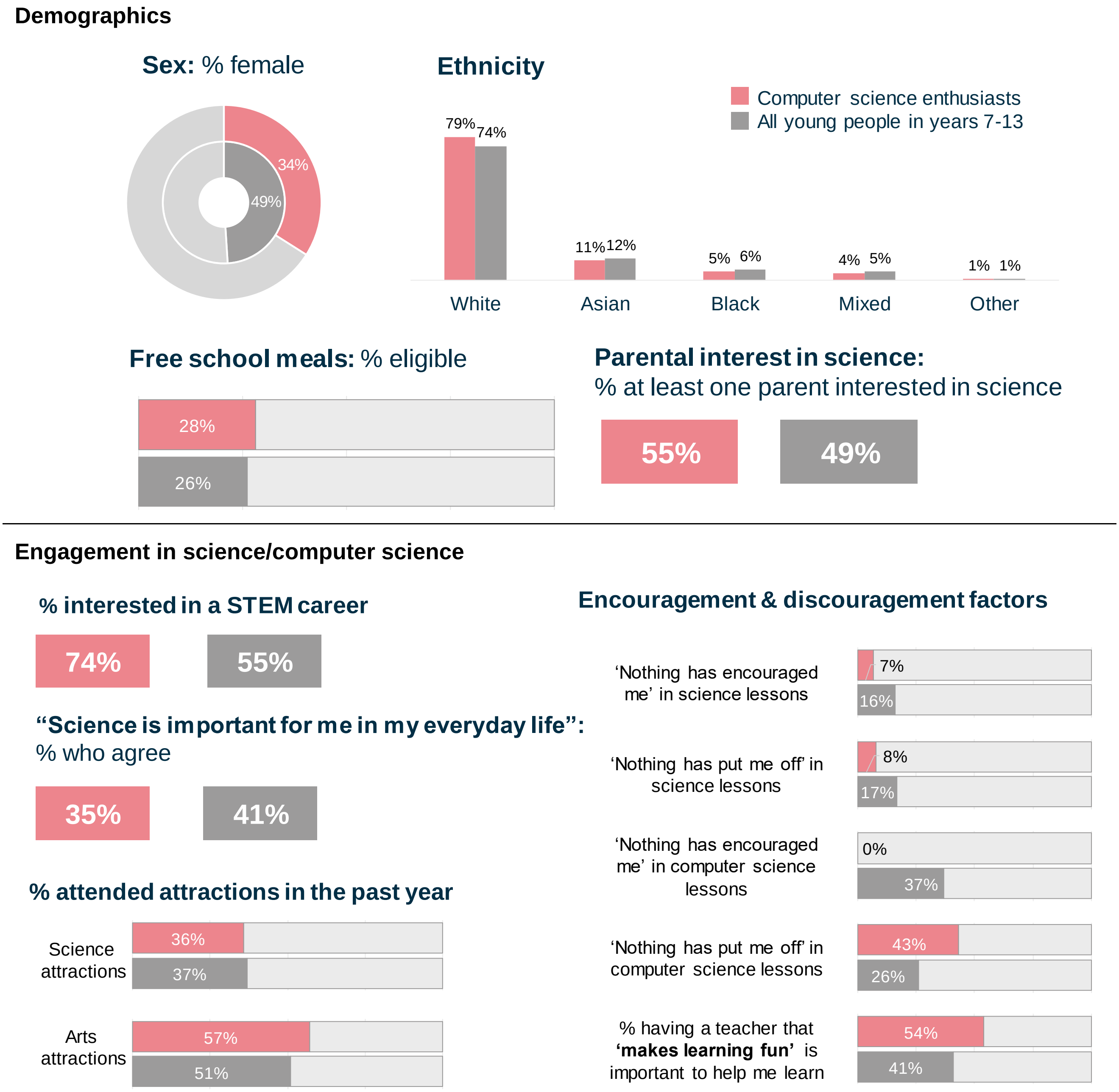
Bases 2019: All year 7–13s (6,409); all High Achievers Resistant to Computing (340)

Computer Science Enthusiasts

As shown in Figure E.8, this segment is composed of almost twice as many males as females, but otherwise remains average in terms of its other demographic characteristics.

Members of this group were encouraged in computer science by a much wider range of factors than those in other segments (especially finding the subject creative and interesting). In science lessons, they were especially likely to cite a teacher who can make learning fun as one of the top factors that helped them to learn science. They were more interested than average in pursuing a career in STEM.

Figure E.8: Profile of the Computer Science Enthusiasts segment



Bases 2019: All year 7–13s (6,409); all Computer Science Enthusiasts (289)

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